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# Labour Migration and Gendered Agricultural Asset Shifts in Southeastern Mexico: Two Stories of Farming Wives and Daughters

Claudia Radel, *Utah State University*

Human-Environment Interactions 4

Marina Fischer-Kowalski
Anette Reenberg
Anke Schaffartzik
Andreas Mayer *Editors*

# Ester Boserup's Legacy on Sustainability

## Orientations for Contemporary Research

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Ester Boserup's Legacy on Sustainability

# Human-Environment Interactions

## VOLUME 4



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Editors

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# Preface

In the year marking the 100th anniversary of Ester Boserup's birthday, the international scientific conference "A Centennial Tribute—Long-Term Trajectories in Population, Gender Relations, Land Use, and the Environment" was held at the Institute of Social Ecology in Vienna, Austria. The main objective of this event was to commemorate Boserup's scientific and political achievements and to explore the importance of her thoughts for the current scientific discourse. Following this call, 120 participants from 21 different countries in Europe, Asia, Africa, North America, and Oceania gathered in Vienna. The diversity of fields in which Boserup's work has found resonance resulted in the conference becoming a platform of truly interdisciplinary discourse. Participants came from a wide range of academic backgrounds, such as agricultural sciences, biology, geography, history, ecology, landscape planning, physics, sociology, environmental sciences, and economics. The contributions, a selection of which are included in this book, paid tribute to Boserup's agenda as she herself described it:

> My own research focused on the interplay of economic and non-economic factors in the process of social change, both today and in the past, viewing human societies as dynamic relationships between natural, economic, cultural, and political structures, instead of trying to explain them within the framework of one or a few disciplines. (Boserup 1999)

The need to adequately address the complexity of sustainability issues from the vantage point of different disciplines as described by Boserup continues to hold true today. Boserup was not only a scientist but also a diplomat. She spent much of her lifetime on making her scientific insights bear fruits in international policies: Across many years, she was consultant and delegate to the UN Economic Commission for Europe (UNECE), the UN Industrial Development Organisation (UNIDO), the Food and Agriculture Organisation (FAO), and the International Labour Organisation (ILO). Many traces of her work are buried in the archives of these organizations. Her keen interest in understanding the interrelations between population growth, gender issues, rural development, agriculture, and environmental problems was driven both by academic curiosity and practical concern and allowed her to question development issues with a persistency that continues to impact current discourses.

This book is the fourth volume in the human-environment interactions series which provides a broad scope of the research on the pervasive impact that human

activities have on the earth system. Within this series, the book at hand has a unique focus as it proposes a re-evaluation of Ester Boserup's pioneering work in the field of sustainability science by tracing her impact on current research.

Boserup's theories on the role of women in development, first published in 1965 and followed by a second book in 1970, and on the interplay between population dynamics, agricultural growth and the environment, as outlined in her most comprehensive book in 1981, continue to resonate in many fields of research and in the current discourse on sustainability. The conference was organized into three larger interrelated thematic areas all of which are also represented by the contributions in this book:

1. Long-Term Socio-Ecological Change
2. Agriculture, Land Use, and Development
3. Gender, Population, and Economy

In interpreting society as a coupled social and biophysical system, Boserup was one of the pioneers of a holistic investigation of Long–Term Socio-Ecological Change. This issue was a focus of both the conference and this book. Boserup conceptualized human societies–in their present-day form and in their historical development-as dynamic relationships between natural, economic, cultural, and political structures. She maintained that such dynamics also characterize subsistence agriculture societies which the development theories of Boserup's time considered to be static and "backward". Boserup's analysis in this regard is reinforced by a number of contributions to this book. At the same time, other contributions show that in her insistence on the gradualism of development, Boserup underestimated the huge impact that the use of fossil fuels would have on agriculture, developing societies, and on the overexploitation of resources worldwide.

A second focal point for the conference and this book was agricultural production and land use, viewed in the context of complex interrelations between societal development and factors such as population dynamics, gender relations, and education. Ester Boserup contradicted the theses put forth by the British Reverend and scholar Thomas Malthus. He postulated that population growth would invariably lead to poverty because agricultural production would not be able to keep up with the increasing demand for food. Boserup responded by documenting the ability of rural societies to innovate. But she not only suggested that it was possible for agricultural production to keep pace with a growing population, she also indicated that some of the innovation required in the process depended on a certain population density, i.e. was driven by population growth, rather than being hindered by it. In the 1970s, Boserup had thus positioned herself in opposition to the mainstream theories and policies of development.

Boserup played a pioneering role in making the relevance of gender relations for societal development visible. This work forms the third focus of the conference and this book. Boserup pointed out that neglecting the work performed by women results in an incomplete picture of the overall labour force and division of labour on which a society is based at a given stage in its development. It is noteworthy that her

perspective seems to influence the composition of the research community significantly: Contrary to the normally observed gender balance at scientific conferences, more than half of the participants at the Boserup Conference in Vienna were female scholars. Moreover, two thirds of the chapters in this book have female lead authors

Finally, the conference was enriched by presentations of scholars personally acquainted with Ester Boserup and able to give insights into issues especially important to her.

Hence, a broad spectrum of Boserup's ideas is covered by the chapters in this book. The first three chapters are a comprehensive review of her political and scientific work. Section 2 focuses on the applicability of Boserup's reflections on land use, technology, and agriculture by drawing from a wide range of case studies on different temporal and spatial scales. Section 3 emphasizes the key role of women and gender relations for agriculture and development. All together, the 16 chapters in this volume symbiotically illustrate how the main strands of Boserup's theories are reflected in contemporary research.

The interdisciplinary systemic perspective and the manner in which Boserup positioned herself at the interface between academia and politics form integral parts of her intellectual legacy. From the variety of academic backgrounds and agendas to the countries from which the scholars come: It is the diversity of the contributions to the conference and also of the chapters in this book that best reflect the continuing impact that Ester Boserup's work has on scientific research today.

Vienna and Copenhagen
February 2013

Marina Fischer-Kowalski
Anette Reenberg
Anke Schaffartzik
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# Part I
# Ester Boserup's Intellectual Heritage

# Chapter 1
# Ester Boserup: An Interdisciplinary Visionary Relevant for Sustainability

**B. L. Turner II and Marina Fischer-Kowalski**

**Keywords** Sustasinability science · Agricultural change · Women in development

Largely unfettered by disciplinary dogma, Ester Boserup observed human-environment relationships through an expansive analytical lens. Her ideas on agricultural change, gender, and development shook up research and practice in the mid-1960s and early 1970s, and remain cogent one-half century later for the development dimensions of sustainability. In this, the 100th year since her birth, it is worthwhile to take stock of her impact on research and practice and how her ideas continue to shape and be reshaped by current research.

## 1.1 Background

Born in Copenhagen on May 18, 1910, Ester Borgesen graduated as Ester Boserup in 1935 with a Candidatus Politices, a MA-level degree she described as mostly theoretical economics plus courses in sociology and agricultural policy (Boserup 1999). She worked for the Danish government (1935–1947), a period in which she gave birth to three children, and the U.N. Economic Commission of Europe (1947–1965) on agricultural trade policy. In this last capacity, she and her husband, Mogens Boserup, worked in India from 1957–1960, an experience that transformed her view on agricultural development. Returning to Denmark, Boserup took on consultancies and served on various commissions as she penned her most important works, at least two of which would have far reaching impacts on interdisciplinary research and

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real-world practice, become the subjects of intensive academic scrutiny, and lead to her award of three honorary doctorate degrees in the agricultural (Wageningen), economic (Copenhagen), and human sciences (Brown). Boserup was elected Foreign Associate, National Academy of Sciences, USA, 1989. She died in Geneva, Switzerland, September 24, 1999.[1]

## 1.2 Agricultural Change

Boserup erupted on the international, trans-disciplinary scene in 1965 with the publication of her landmark book, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (Boserup 1965). This brief, non-technical work offered a powerful set of ideas in opposition to neo-Malthusian and other prevailing ideas of the time about agricultural development. Turned down by several publishers, her book was discovered and enthusiastically embraced by other social sciences, foremost those parts of anthropology and geography dealing with (quasi) subsistence, smallholder farming systems. *The Conditions of Agricultural Growth* has been published by five different publishing houses in 17 issues from 1965 to 2008, and translated into French, Swedish, Japanese and Estonian.

The large and sustained impact of this work has at least a three-fold explanation. First, it addressed an enduring theme the relationship between population and environmental resources, which has regularly resurfaced in different expressions, at least since the work of Thomas Malthus in 1798. Boserup challenged his proposition that the relatively slow-growth in the "food ceiling" served as the upper limit for the more fast-paced, potential growth in population. She reversed the causality, arguing that increases in population (or land) pressure trigger the development or use of technologies and management strategies to increase production commensurate with demand. Agricultural intensity thus rises with population density (or land pressures in related literatures), absent constraints on the process.[2] Over the long run, this process transforms the physical and social (e.g., land tenure, labour markets, and other societal structures) landscapes, the historical dimensions of which Boserup elaborated in *Population and Technological Change: A Study of Long-Term Trends* (Boserup 1981).

The endogeneity of the techno-managerial strategies of agriculture was foundational to her thesis and influenced the induced innovation thesis explaining the contemporary pathways of investment in and use of agricultural technology at large (Hayami and Ruttan 1985). Despite this, Boserup's thesis that was not well developed regarding qualitative shifts in technology (e.g., to fossil fuels) that fundamentally change land-labour and thus structural relationships in society (Krausmann et al. 2008). She did trace the broad strokes of industrial technology on agriculture in sparsely populated and underdeveloped lands (Boserup 1981), and

[1] For details on the life of Ester Boserup see (Abernethy 2005; Boserup 1999; Tinker 2004) and http://irenetinker.com/publications-and-presentations/ester-boserup.

[2] Boserup was not the first to link land (or population) pressures to intensification (Turner et al. 1977), but she was the first to set the relationship into a conceptual model specifically aimed at agricultural change. See, however, the work of A. V. Chayanov and C. Geertz noted in this text.

argued that it was not applicable to some subsistence farmers because the relative costs of labour- versus industrial-based foods favoured non-adoption of the last (Boserup 1965, p. 120). These concerns, however, were not explicitly inserted into her base thesis.

Second, Boserup's early work disputed assumptions about farming behaviour applied in development. Mirroring the ideas of the Russian A. V. Chayanov, she argued that the behaviour of subsistence farmers differed from commercial ones (Boserup 1975).[3] Subsistence farmers responded to household (consumption) more so than market demand and sought to minimize risk to household needs, not maximize gain, affecting the allocation of land, labour, and *landesque* capital.[4] Farmers shifted known techno-managerial strategies, or explored innovations in them, only if land-labour dynamics pressured them to do so. This production logic was subsequently demonstrated to be present, side-by-side or variously mixed with market behaviour, among many smallholder households worldwide (Brookfield 1972, 2001; Dorsey 1999; Netting 1993; Turner and Brush 1987).

Third, Boserup questioned neo-Malthusian and related assumptions permeating development practice, foremost that smallholder, subsistence farmers were at the mercy of their own population dynamics and in desperate need of external assistance associated with those views. Her ideas were heard and explored by major institutions involved in agricultural and rural development, including the World Bank (Binswanger and Pingali 1988; Pingali et al. 1987; Tiffen and Mortimore 1992, 1994).

Boserup's thesis remains important today for the various subfields contributing to sustainable development. Its foundations have been tested—demonstrating the ability to explain the variance in the intensity of subsistence-like cultivation—and variously elaborated and critiqued (Angelsen 1999; Brookfield 1972, 2001; Carr 2004; Lambin et al. 2000; Morrison 1996; Stone 2001; Turner and Brush 1987; Turner and Shajaat Ali 1996; Winfrey and Darity 1997). Substantial work over the past decade continues to find links between land pressures and agricultural intensification or to demonstrate the rudiments of household production logic underpinning the thesis (Carswell 2002; Demont et al. 2007; Lambin et al. 2000; Laney 2002, 2004; Malmberg and Tegenu 2006; Stone 2001; Wood et al. 2004; Zaal and Oostendorp 2002).

Influential ideas are rarely unchallenged, and so have been Boserup's. One set of critiques have focused on the paucity of attention given to societal structures and the processes underlying them for agricultural change. Boserup insisted that social structures mattered for this change and development in general, but viewed them as endogenous to changes in land pressure and technology, changing over the

[3] One of us (Turner) once asked Boserup why she did not cite the 1920s work of Chayanov in her own. She replied that she had never read or heard of Chayanov at the time, and explained the close similarities of their logic to the fact that both he and she were essentially drawing on the same "school" of economic thought.

[4] Landesque capital is a term employed in human, political, and cultural ecology and land change science to refer to permanent land improvements for production, such as terrace or irrigation systems, especially among non-commercial land managers.

longer-term. Neither she nor the initial research she inspired explored the variance in these structures on agricultural intensity, although other potentially important factors were. Much attention has been given to societal structures over the last decade (Brookfield 2001; Lambin et al. 2000; Netting 1993; Stone 2001; Turner and Shajaat Ali 1996), the results of which can be incorporated into the Boserup-inspired induced intensification thesis (Turner and Shajaat Ali 1996).

Induced intensification envelopes a constellation of research that has explored the roles of environment, gender, empowerment-social capital, household composition, tenure, off-farm employment opportunities, ethnicity, state policies, level of analytical aggregation, and other factors on agricultural intensification under different land pressures (Abizaid and Coomes 2004; Börjeson 2007; Coomes et al. 2000; Kabubo-Mariara 2007; Keys and McConnell 2005; Murton 1999; Shriar 2001; Stone 2001; Stone and Downum 1999; Wood et al. 2004; Zaal and Oostendorp 2002). Relaxing assumptions imposed in Boserup's scheme, this research reveals the conditions leading to the process of land expansion (Malmberg and Tegenu 2006; Pascual and Barbier 2006; Place and Otsuka 2000; Tachibana et al. 2001) or land abandonment and migration (Ananda and Herath 2003; Demont et al. 2007; Gray and Kevane 2001; Reenberg 2001; Stone 2001; Turner and Shajaat Ali 1996) versus intensification. This brings us back to the original, enduring theme and articulation of those conditions leading to Boserupian, Malthusian, or other outcomes (Geertz 1963).

## 1.3 Women in Development

Drawing on field observations in India but blossoming during her subsequent experiences in Senegal, Boserup challenged development research and practice yet again with the release in 1970 of *Woman's Role in Economic Development* (Boserup 1970). Her thesis was so obvious in hindsight, it is somewhat difficult to understand why it was so challenging. Women have always been an important component in the practice of agriculture beyond the corporate-commercial farming systems of the world, and yet their consideration was missing in economic theory and development practice of the time. Boserup argued that western-led development reduced the status of and opportunities for women. Her challenge to rectify this omission is credited, even by her critics (Aikman and Unterhalter 2005; Arun and Arun 2002; Benería 2003; Datta Gupta 2002; El-Bushra 2000; Jackson 2002; Lind 2003; Patel and Parmentier 2005; Singh 2006; Vazquez Garcia 2001), with helping to inspire the United Nations Decade for Women (1976–1985). Indeed, the United Nations Development Programme distributed a summary of her book at the first World Conference on Women held in Mexico City in 1975, the U.N.'s International Women's Year. A digest version of her book was also prepared by the U.S. Agency for International Development (USAID) and distributed to all U.S. embassies. Boserup not only anticipated gender studies, or at least their application to development, but set strong analytical standards for engaging the multifaceted realities of this research and provided the foundation for the Women in Development (WID) perspective. WID has received so much attention that development practice has lost sight of men,

according to some views (Bannon and Correia 2003). *Woman's Role in Economic Development* has been released by five publishers in seven issues from 1970 to 2007, and has been translated into French, Spanish, Italian, Swedish and Indonesian.

Boserup and WID observed that women were discriminated against at all levels of the development process in the 1960–1970s (Peinado and Céspedes 2004). Boserup and WID did not reject the modernization effort for this omission. Rather, they argued for women to be made an explicit part of the development program, while paying attention to cultural variations regarding women's productive roles. Drawing on historical data, Boserup argued that economic development created a gender gap (female equity) that evolved in a curvilinear manner. Modernization initially enlarged the gap owing to economic changes that disintegrated established household relationships, but subsequently closed it, especially owing to increased women's education. It is this facet of WID that continues to draw considerable research attention. Some field-based tests support the proposed curvilinear relationship, or parts of it, while other studies suggest a linear relationship in which the gap is not closed (Datta Gupta 2002; Forsythe et al. 2000; Hannum 2005; Matthews and Nee 2000).

Almost in passing, Boserup speculated in the conclusion of *Woman's Role in Economic Development* (Boserup 1970, p. 224 f.) that increased education for women in the developing world might reduce family size. This observation thrust Boserup into the U.N. World Population Conference in Bucharest in 1974 and subsequent international programs addressing population. Interestingly, demographers would subsequently demonstrate that drops in the fertility rates worldwide track with the level of women's education (Becker et al. 2010; Caldwell 1980).[5]

WID and Boserup continue to draw attention from alternative views within gender studies at large. Critique holds that WID is, at its base, a "neoclassical economic construct" which is insufficiently nuanced and too focused on questions of education within the modernization paradigm (Aikman and Unterhalter 2005; Basu 2002; Benería 2003). WID, is accused of failing to consider domestic production, isolating reproductive from productive work (Benería 2003; Onyejekwe 2004; Silvey 2001). If this challenge is applicable for WID, it seems odd to extend it to Boserup, if only by implication. After all, her agricultural interests were directed to household or domestic production, and her gender gap is predicated on understanding that modernization disrupts established household gender roles, which includes reproductive and productive elements. Regardless, these and other critiques gave rise to Women and Develop (WAD) and Gender and Develop (GAD) counterviews.

Both WAD and GAD view women as active agents in the production and development process, and reject their former omission in the modernization project as inadvertent (Benería 2003; Onyejekwe 2004; Parpart 1993). WAD champions a socioeconomic class view in which unempowered men share the same unfavourable fates in the development process as do most women. This shared position, WAD argues, changes only if international social structures change. GAD, in contrast, views the roles assigned to both sexes not as given but as a social construction, and thus the organization of women in changing their roles is a central issue in development. The

[5] Critiques of the fertility-education relationships remain, however, e.g. (Basu 2002).

inequalities of modernization must be addressed through structural changes, specifically political ones, because the institutions discriminating against women may be impervious or highly resistant to economic development (Aikman and Unterhalter 2005; Benería 2003; Parpart 1993; Silvey 2001). Recent studies treating themes embedded in WID, WAD, and GAD suggest that elements of all three are useful for the question at hand (Chithtalath 2006).

What might have been Boserup's response? First and foremost, she was versed in both normal science and critical theory. While her professional lens was large, she remained firmly anchored in science and attempted to enlarge or expand economic analysis rather than replace its science base with alternative explanatory perspectives. Boserup explicitly recognized the role of societal structures in the development process. She differed from WAD and GAD positions, perhaps, in that she viewed structural change as taking place over the long term and as endogenous to the development process: "structures change under the influence of other structures although they may be resistant to such changes for shorter or longer periods, and are changing only when the pressure is strong or persistent" (Boserup 1999, p. 58). Boserup encouraged economic develop research to incorporate this broader and historical view, even providing a framework for it (Boserup 1996).

## 1.4 Appreciating an Innovative Scholar

Few social scientists of the last half of the twentieth century can match the impacts that Boserup has had on interdisciplinary research and outreach-practice, especially regarding human-environment relationships in development context. Indeed, an even smaller number have drawn the attention of researchers and scholars holding such a large range of world views. Without writing a formula and rarely constructing a diagram, her conceptual or "informal" models of agricultural change and women's role in development have been formalized, tested, and retested, and remain significant for research and practice.[6] Her insights were gained by a comprehensive observational lens, the parameters of which were not bound by disciplinary tenets. As she noted, long-term development analysis must be " ... interdisciplinary and their authors need to follow major developments in some other disciplines than their own" (Boserup 1999, p. 59). In this sense, Boserup's approach remains as important for contemporary sustainability science as do her theses about the sustainability dimensions of agricultural change, women, and development.

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[6] In 1996 Robert W. Kates encouraged Boserup by letter to employ diagrams to illustrate her concepts more clearly. Her last publication of which we are aware (Boserup 1996) did so.

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# Chapter 2
# "Finding Out Is My Life": Conversations with Ester Boserup in the 1990s

**Jon Mathieu**

**Keywords** Biography · Interdisciplinarity · Science-policy interface

Ester Boserup began an international career as a consultant and independent researcher when she was approximately 50 years old. She had previously spent more than two decades as a civil servant in the Danish administration in Copenhagen and with the United Nations in Geneva. Yet she had been conducting research in these administrative positions as well, and she did so until her last days. "Finding out is my life", she used to say. What she found, and how she presented it, was often surprising. This was also the case with two publications that she produced after the age of 85: a short article on *Development Theory: An Analytical Framework and Selected Applications* (1996) and a booklet called *My Professional Life and Publications 1929–1998* (1999).

The article was remarkable in that it included a type of formal model building and a retrospective on the tradition of economic and social thinking. Neither issue was part of the common repertoire of Boserup's writing. Indeed, she had been critical of the trend towards formalisation and model building in economics; she was more interested in the real world than in scholarly positions. The booklet came as a surprise as well because Boserup had been sceptical about autobiographies. She considered autobiography a difficult genre that often provided a biased and untrue picture of authors and their past activities. This might have been the reason Boserup restricted her own autobiography to her professional life, devising it as a sort of bibliography with comments and providing very little information about her private life.

Having been asked by a scholarly journal to write a portrait of Ester Boserup, I had the opportunity to conduct a long interview with her in her home in Ticino, Switzerland in October 1992. Afterwards, I visited her regularly until her death in September 1999. During that period, we conducted about a dozen extensive conversations. I usually took notes during or after the visits about her most important

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statements, and a few of these talks were tape-recorded.[1] In this article, I intend to provide an overview of Boserup's thinking in the 1990s. She was famous in the scientific community during the 1970s and 1980s, but less is known about the last decade of her life. It is interesting to see how she reconsidered her work and career during that period. Based on the conversations and the two remarkable publications of her last years, we can attempt to look at Boserup's work through her own eyes.[2]

## 2.1 Conversations

We began our first interview with the book Population and Technological Change: A Study of Long-Term Trends (1981), which Boserup used to call her "historical book".[3]

> I was a bit scared when I published that book. Now I will have all the historians checking up on me, I thought, but I am no historian after all. In my writing, I try to look at what people do in different fields and to find the mainstream. I cannot go into depth with everything. It is clear that one has to specialise. However, if everybody is specialising, it does not work either. Somebody should have the courage not to specialise and to look at how one can bring things together. That is what I have tried to do.
> I have the feeling that people know how difficult and necessary it is to make connections. At least, I had very few reactions saying, 'Ah, she does not know this and that'. Normally, people are eager to learn more about other things. However, popularisation is dangerous in my position. I was asked several times to write for a broad public, and I always declined in the recent decades. If I bring things together for scientific purposes, I should abstain from popularisation. Otherwise, people would say it is not serious. Thus, I write with footnotes and for scholars who have a standing in their field and can pass it on to others.

Later in the talk I asked Boserup about her vita and how her work related to it. "I can say one thing about that," *she replied:* "If I have been controversial and if I write against Malthusianism and neoclassical economics implicitly and sometimes explicitly, it is most probably also because my career is different since I did not want to teach at university." You did not want to make an academic career?

> Only with research and not with teaching, and that was not possible in Copenhagen when I finished my study in economics in 1935. So I worked in the administration, It was very interesting and I learned a lot. Later I went into the United Nations and in development planning. Had I chosen a university career instead, I would have read all these books and said: 'This is true, everybody says so.' I would not have had the courage to say it is incorrect.

Could you please say something about Malthus and Boserup—they often come together in scientific discourse, don't they?

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[1] For the portrait, see (Mathieu 1994). I subsequently published an obituary and an analytical essay: (Mathieu 2000, 2010).

[2] A review of Boserup's thinking from a different perspective is provided by Irene Tinker (Tinker 2004). A longer version of this paper was presented at Cornell University, Ithaca, NY, in March 2001 and is available on Tinker's homepage under the same title.

[3] The following sections are based on a tape-recording of the interview conducted on October 16, 1992 in Brissago. In the first part, Boserup spoke German; afterwards, she switched to English. Most quotes have been copy-edited to some degree.

> Yes, that is funny. In my first book on agricultural growth, there was a flap noting that I turned Malthus on his head. I did not say that; it was the publisher. A great advertisement, of course. In reality, I wrote very, very little about Malthus. Malthus said many things on many issues, and you always find a counter-example. I am not interested in old economists but in how things relate to each other today. Therefore, I also had to write against Malthusian currents since they are considered a sort of basic truth. It was a tremendously simplified theory: Malthus knew nothing about agriculture, people always died from hunger, and so on. That's why he only grasped a small corner of the total picture and blew it up. It is incorrect to say that I turned Malthus on his head. That would have been just another simplification.

Yet Boserup could also see positive aspects in Malthus: "At least he was interested in the real world," she remarked when speaking about very formalised trends in modern economics. After hesitation in the 1960s, Boserup did not join the increasing reliance on mathematics in economics. Therefore, she found herself in a delicate position when someone presented a mathematical "Boserup model" and wanted a reaction from her, which happened several times. Some people said she should engage more in that discussion and take a stand on the proposals.

> But you know, these people are mathematicians. If they want to call their models 'Boserup models', why should I be against it? I get a chance that others are becoming interested in what I have to say. I consider the theoretical presuppositions for the specific model, and often I cannot identify with them.

Because I am a historian and interested in cultural history, I asked Boserup about the role of culture in development research and whether she considered these aspects and factors.

> Yes, in a few papers. It is certainly true that culture should be included. But it also depends on your subject. When I wrote the agricultural book in the 1960s, I decided to leave the women out for another occasion. You cannot put everything in one book, at least I can't. And I always felt that I have neglected two things: political science and the cultural dimension. You can't do everything. I started in economics and got into agriculture, which is already technology. And things simply become too complicated if you try to put everything into it. At one time, one day, perhaps, people can build a huge, beautiful model putting in all the sciences. However, the time has not come yet.

The talk lasted three hours or more, and on the following occasions, the conversations were of similar length and breadth. Boserup gave her opinion on a wide range of subjects: historical developments, authors and books from different disciplines, current trends in the economy and politics, and aspects of her life and work. Yet one point seems to me of special interest at this juncture as it provides a manifest reflection of her thinking in that period.

## 2.2 An Analytical Framework for Development Theory

In the summer of 1995, Boserup began to experiment with a diagram. At first, there was a small circle on a sheet of paper with some notions and names: Population, Technology, Mode of Production, Social Structure, Ricardo, Marx, Max Weber, and a fourth name I could not decipher because her handwriting had become very difficult

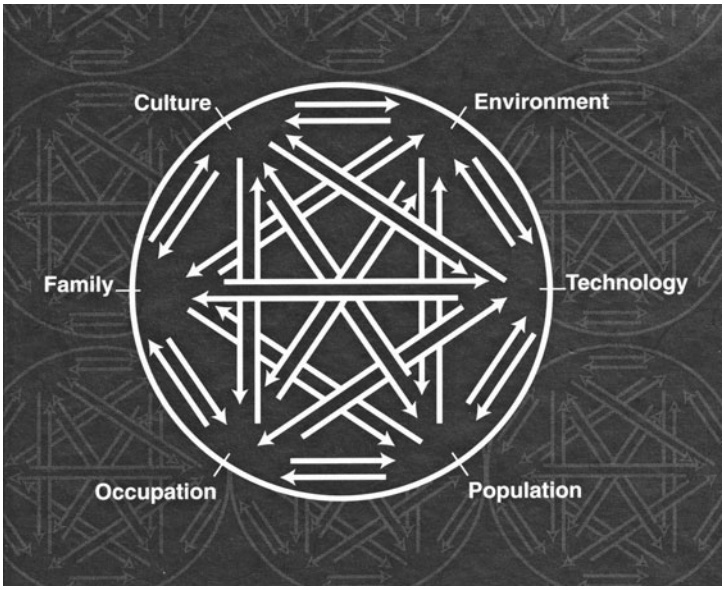


**Fig. 2.1** Cover image of My Professional Life and Publications 1929–1998. (Boserup 1999)

to read (possibly Warren S. Thompson, the pioneer of the Demographic Transition). "I am just thinking a bit and playing around with ideas", Boserup remarked when she saw my surprise. The experiment took form throughout different stages during the winter and became a note published in the September 1996 issue of the *Population and Development Review*. Its purpose was stated in the following words: "In this note, I suggest a framework for a concise interpretation of contending theories of development and for description of a variety of development processes. In doing so, my aim is to stimulate interdisciplinary discussion of development problems".[4]

The diagram had become a circle with six notions (called "structures") and a variety of arrows showing the interconnections between them and the direction of the impact. It was also a symbol of interdisciplinarity and was considered so important by Boserup that she let the publisher use it for the cover of her autobiography three years later (see Fig. 2.1). In that booklet, she summarised the 1990s under the heading "Boserup models" and stressed the long-term and dynamic feature of the idea: "By contrast to most formal economic models, which deal with short term analysis (i.e. a few years or less), my 'informal' model-building is concerned with long-term analysis, i.e. changes over decades or centuries".[5] Thus, the structures themselves were considered open to change.

[4] (Boserup 1996, p. 505).

[5] (Boserup 1999, p. 58).

It might be interesting to look at the article as a work in progress from the stage of intuition to the final publication.[6] Let us start with the selection of the main notions or structures: initially, there were four of them (Population, Technology, Mode of Production, Social Structure), then five (Population, Technology, Structure, Culture, Environment), and finally six (Environment, Population, Technology, Occupation, Family, Culture). Thus, at the intermediate stage, the Mode of Production was dismissed, whereas Culture and Environment were included. Later, Structure no longer satisfied Boserup. She first divided it into Economic Structure and Family Structure and then changed these expressions to Occupation and Family.

A remarkable feature of this model for interdisciplinary discussion is the fact that it was not based on disciplines as a starting point but rather on the six domains or structures. As Boserup stressed in a personal letter, this was a conscious decision. Perhaps it was related to her special career outside academia with its disciplinary boundaries (see her own explanation for not being orthodox, quoted above). In the letter, she also reflected on where political science and economics would find their place in the diagram. She suggested that they did not belong to any structure or form a structure of their own but "sometimes" explained the working of the arrows.[7]

Of course, the choices made by Boserup also reflected her own work. The book on agricultural growth (1965), for example, was very much about population, technology, and environment, and her *Woman's Role in Economic Development* (1970) addressed occupational and family structure. We could try to compare the six notions with the subjects of Boserup's books and articles in detail. One result, however, seems to be clear from the onset: culture was marginal in her older studies and thus reflected a new issue in her thinking. It could even have been a principal impetus to begin the entire experiment. When I first saw the nascent circle diagram in July 1995, Boserup was reading an anthropological dissertation that friends had sent her from Denmark and was concerned about the static, holistic way in which the author used the concept of culture. She thought that this culturalist (if not racist) perspective could perhaps become influential. This was one motive for her to reconsider her own position and to integrate culture in a dynamic way.

## 2.3 Selected Applications

Following the analytical framework, the article presents "selected applications". These applications are of two types: they refer to development theories and development processes. Again, during the making of the article, the chosen applications changed, and we can gain an idea of Boserup's method of conceptual work by looking at the various stages of elaboration.[8]

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[6] The following sections are also based on personal letters with drafts from Ester Boserup in winter 1995/1996.

[7] Letter of December 6, 1995.

[8] For the sources to this section, see note 6.

The selected theoretical approaches began with four names (Ricardo, Marx, Max Weber, and an unknown), then enlarged to eight names, and ended up with six names: (1) Adam Smith, (2) Malthus, (3) Ricardo, (4) Marx, (5) Max Weber, and (6) Neo-Malthusians. From the intermediate to the last version, Boserup changed the name of Paul Ehrlich to the abstract "Neo-Malthusians", omitted both the first approach of the Physiocrats and the last in the series, a "Generalised Boserup model" (we will examine that model in the following section). Characteristic of this choice is the inclusion of classical eighteenth and nineteenth century authors and thus the focus on well-known names.

Boserup explains that she did not choose well-known theories to present her view of them but rather to demonstrate the usefulness of the schematic representation. A small circle designates the "start of the dynamic process", that is, the basic argument and first mover in the view of the described author. By means of the starting point and the arrangement of the arrows, one can immediately grasp the similarities and differences between these contending theories. In the sample, the differences clearly prevail, and the approaches do not utilise all of the domains or structures. They work with only three or four of them: for example, Adam Smith with population, technology, and occupation and Max Weber with culture, family, occupation, and population. Each author in the sample omits one to three of the structures in the circle.

The selection of development processes did not change significantly from the first to the last version of the article. It ultimately included six applications as well: (1) from hunting and gathering to crop production, (2) the autonomous village, (3) pastoralists and nobility in the Eastern hemisphere, (4) the process of urbanisation, (5) industrialisation in Western Europe, and (6) fertility decline and cultural change in Western Europe.[9] According to Boserup, the selection focused on long-term population change, again to show the usefulness of the schematic representations: "My experience from my book on *Population and Technological Change* dictated the placement of some of the arrows, and the graphic representation helped me to discover structures and causal influences that I had hitherto overlooked".[10]

Taken together, Boserup adds, the models represent "what are usually considered the major stages in the development process". In doing so, they portray "a process of gradual change, from full self-sufficiency of individuals and families to more and more elaborate occupational networks".[11] In contrast to the sample of authors, who did not exhaustively cover the interdisciplinary circle, this second series of development models made full use of the six structures in each case. It seems plausible that Boserup used the graphic representation as a thinking tool to review and reorganise her earlier work. One indication of this can be seen in the fact that some placements

[9] In a first version, for the sake of the immediate discussion, Boserup drafted a "tentative model" on "Urbanization in the Alps" relating to research I was conducting at that time. In a second version, she began with a model on the "Hunter-Gatherer", which was also later dismissed.

[10] (Boserup 1996, p. 510).

[11] (Boserup 1996, p. 511).

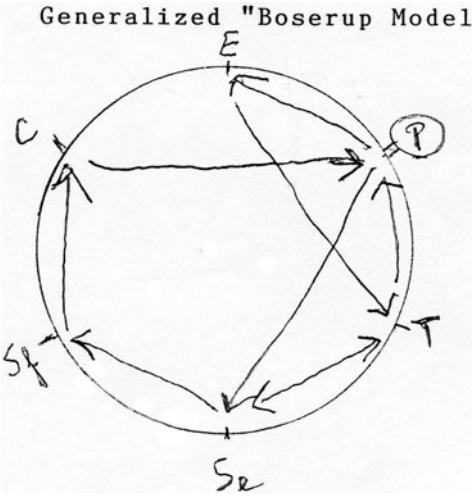


**Fig. 2.2** Generalised "Boserup Model": draft by Ester Boserup (January 1996). *E* environment, *P* population, *T* technology, *Se* economic structure (later: Occupation), *Sf* family structure, *C* culture. The small *circle* around *P* designates that Population is considered the first mover or "start of the dynamic process" in the model

of the arrows changed from one version to the other. In the first draft of the development models, fertility decline was characterised by not less than 14 arrows. For the publication, she reduced these to eight.

## 2.4 Boserup in Self-Perception

As mentioned above, in a draft version of the article, Boserup proposed a "Generalised Boserup model" that concluded the series of development theories. Later, she dropped this application for reasons that are unclear. Perhaps she wanted the paper to state her thoughts in a more neutral manner. Perhaps she was motivated by the growing certainty that the paper should have two series of applications, one for the theories and one for the processes. As she manifested her own view of long-term developments in the process series, she could omit the Generalised Boserup model in the theory series.[12] In the draft version, she commented on the model with one sentence: "The last 'Boserup model' shows how I personally see the crucial relations between all the structures in a 'generalised' model" (Fig. 2.2).

The arrows of the model are described in the draft as follows:

[12] The two types of application changed during the elaboration. Boserup began the diagram reflection with authors and notions (summer 1995); then, she focused on the authors (autumn 1995) and later on development processes (December 1995). In the next (much longer) draft, she combined the two series, with the processes first (January 1996). Afterwards, she reduced the number of applications and changed the order, putting the author series first (February 1996). This version was similar to the published article (September 1996). I base these observations on my notes and on her letters. There may have been some versions in between that I did not see.

| | |
|---|---|
| P–E | More people, less area per person. |
| E–T | More frequent cropping in diminishing returns to labour and capital. |
| P–Se | Larger market, higher technology and productivity (like Adam Smith) |
| Se–T–Se | Dynamic changes in economic structure and productivity. |
| Se–Sf | Women working, children at school, motivation for few or no children. |
| Sf–C | Ideal of equality of the sexes. |
| T–P | Modern contraception, reduced marriage frequency, and low fertility. |
| C–P | Low status of family, frequency of divorce, declining population, except for immigration from less developed economies. |

From a biographical perspective, the model shows the gradual enlargement of Boserup's arguments and her effort to integrate them into a single coherent pattern. The first two arrows correspond to the book on agrarian intensification (1965), and the next two are addressed in the 1981 book on population and technological change. The women and family issues of the other arrows reflect her gender studies, which resulted in her 1970 book on woman's role in economic development and in many subsequent articles.

The model is driven by population growth, which corresponds to the starting point of Boserup's international academic career. The first two arrows relate to the debate with Malthus and Ricardo, and the next integrate the Adam Smith argument on the positive effects of population growth for market formation, division of labour, and technological innovation. However, the drafted Generalised Boserup model also refers to the demographic transition in developed societies by integrating the effects of modern occupational structures and technology on family and population patterns.[13]

The reduction of long-term development processes to eight "crucial relations" between the selected structures is a very strong form of abstraction, and some would most likely judge it an excessive simplification. There is no absolute measure for what is a useful and enlightening reduction of complexity and what is an exaggerated and misleading form of selective perception; it all depends on the context. In this case, the generalisation grew out of reflection on a lifetime of work and a desire for coherence. Ultimately, Boserup did not consider it necessary to publish the generalised model in her article.

In that article, she put forward the importance of interdisciplinary discussion and the usefulness of the proposed basic framework for this debate. She stressed that the framework could be used for many purposes, in micro and macro studies, in historical and recent studies, in conceptual studies, and so on. Her selected applications were only meant to serve as examples. She warned readers that the formulation reflected her professional bias. According to Boserup, "this exercise is a means to develop a technique that can point up disagreement among disciplines and promote fruitful discussion".[14]

[13] In the selected models of the development process, Boserup used population as prime mover in the first five stages and occupation in the last stage of fertility decline and cultural change in Western Europe (Boserup 1996, p. 510).

[14] (Boserup 1996, pp. 506, 511).

Generally speaking, the framework article of 1996 and the intellectual autobiography of 1999 show clearly that Boserup saw herself in a position apart from the main currents of economics in the last decade of her life, when she had received considerable formal appreciation from the scholarly world. Between 1978 and 1985, she had been made Doctor honoris causa by three European and US universities, and in 1989, the National Academy of Sciences in Washington, DC elected her a Foreign Associate by an interdisciplinary vote. In her *Analytical Framework and Selected Applications*, Boserup's non-conformist position is reflected in the wide range of historical periods and extra-economic factors included. In *My Professional Life and Publications*, the last chapter on the 1990s is mainly a critique of classical and recent economics. It points to the conflicts created by rapid technological change and the attempts of many groups and governments to prevent cultural change: "The importance of these problems for economic development is overlooked by economists, when they make the assumption that rational behavior is the rule whatever the circumstances."[15]

This takes us back to the conversations in her home in Ticino and Boserup's statement that she did not join the mathematical revolution in economics. The rejection of a high degree of formalisation and mathematisation, however, was not a rejection of theory. Boserup was interested in the current theoretical debates in economics, but this interest resulted from a desire to understand the real world and to find explanations for actual experience.

> Of course, I was not unique. There are many people involved in practical development work sharing the same view, and when they write papers, they are not orthodox. Yes, I am certainly not orthodox. On the other side, we have economists retiring more and more to an ivory tower and making models, which are often unrealistic.[16]

## 2.5 Conclusion

Some years ago, Irene Tinker, in a well-informed and warm review of Boserup's thinking, called the cover illustration of the intellectual autobiography with the circular diagram a "mantra" reflecting the stress on interdisciplinarity in the last period of her work.[17] A mantra is a sound or a word that is often repeated and is considered capable of creating spiritual insight and transformation. It is certainly true that the circle diagram was a type of repetitive self-reflection. It helped Boserup hold her work together and place it in the scientific context of the end of the twentieth century, when the debate on interdisciplinarity reached new levels.

Yet, we should also consider that the "mantra" was the outcome of a systematic and serious intellectual process, as the drafts of its creation clearly show. Proposing such an informal model in a world of highly formal models was further proof of courage. With Boserup, interdisciplinarity was more than an academic battle cry; it

[15] (Boserup 1999, p. 60).

[16] Interview of October 16, 1992 (see note 3).

[17] See note 2, internet version.

formed a life experience deeply linked to her way of "finding out". The attempt to discover interconnections between different fields was an attempt to contribute to the explanation of real life, independent of academic boundaries. And the attempt to organise the interconnections in a circle diagram was an attempt to give it a coherent and unequivocal form. One could call it the most concentrated version of her legacy.



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# Chapter 3
# Boserup's Theory on Technological Change as a Point of Departure for the Theory of Sociometabolic Regime Transitions

**Marina Fischer-Kowalski, Fridolin Krausmann, Andreas Mayer and Anke Schaffartzik**

**Abstract** This chapter is devoted to the core theoretical propositions unfolded in E. Boserup's 1981 book Population and Technological Change and represents an attempt to take these ideas further. The 1981 book makes an effort to provide a theoretical explanation for the full course of human history, from hunting and gathering communities through various stages of agricultural societies right into the industrial transformation. First we re-examine her own data, confirming her core thesis about average agricultural output per area risingwith population density at the expense of declining output per labour hour, but demonstrating a strong discontinuity at the industrial end of her technology scale.Clearly, what is measured at this end, the transition to fossil fuel use in agriculture, leads to saving labour. Second, we explain our theory of sociometabolic regime transitions and try to show how much this theory learned from Boserup. This theory, though, supposes that it makes a fundamental difference if societies base practically all of their processes on solar energy, its conversion into plant biomass and, consequently, on agriculture as the key energy supply sector, or if they base their processes on fossil fuel energy sources - this is a qualitative leap beyond what Boserup introduces as gradual distinctions. In a third part, based on our comparative research on resource use, we elaborate on three examples for the lasting validity of Boserup's arguments: on the non-linearity between population growth and land requirements, on the transferability of this thesis to other resources as well, and finally on the persistent relevance of population density as key factor allowing for lower resource consumption. This chapter confirms Boserup's role as

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an eminent theorist and analyst of the development trajectory of agrarian societies, but also points to her weakness in understanding the industrial transformation.

**Keywords** agricultural change · population density · industrial transformation · sociometabolic regimes · land and labour intensity

## 3.1 Introduction

Ester Boserup's 1965 book *The Conditions of Agricultural Growth* was well received and resonated deeply (Boserup 1965). In contrast, Boserup's most mature and comprehensive book, 1981's *Population and Technological Change: A study of Long-Term Trends* (Boserup 1981), in all its complexity, seems to have received less attention.

This chapter is devoted to the core theoretical propositions unfolded in this 1981 book and represents an attempt to take these ideas further. In her work *Population and Technological Change*, Boserup not only had the ambition to elaborate and generalise her ideas from 1965, she also made a number of attempts to explore the validity of her arguments using quantitative analysis. She did so mainly using national-level data (skilfully digging out the information on the few countries for which the data were available at the time), analysing the interrelations of her two main variables—population density presumably as the independent variable and technological change as the dependent variable—as well as the joint impact of both on other variables. This methodological approach that she helped pioneer is still very common, particularly in the context of reports from international organizations, but the data situation has, of course, much improved since.

What we attempt to show in this chapter is not only that the theory of sociometabolic regime transitions genuinely builds upon Boserupian foundations (even if it contradicts her preoccupation with gradualism) but also that data generated in the context of material and energy flow accounting (Haberl et al. 2004) are very suitable for putting her key propositions to empirical tests.

## 3.2 Boserup's Main Theoretical Propositions, and her Efforts at an Empirical Proof

In the preface, Boserup (1981) describes the claims of this book in relation to her book on the conditions of agricultural growth (1965). Because the latter focuses only on agricultural technology, it had to "abstain from the analysis of the effects of technological change on population change. It therefore discussed only the effects of population change, not its causes. This book deals with all types of population-linked technologies, and I have made an attempt to deal with both sides of the interrelationship." (Boserup 1981, p. ix) Her later book, she says, has a broader

scope; whereas the earlier book focuses exclusively on agricultural societies, the later volume also deals briefly with pre-agricultural communities and, in much more detail, with societies in early stages of industrialization. However, even in the later book, she makes "no attempt to discuss the most recent technological innovations in the highly industrialised societies." (Boserup 1981, p. x) "This book is not a revision of *The Conditions of Agricultural Growth*," Boserup points out, "but only an attempt to broaden and deepen it." Discussing the criticisms she received for her previous work, she self-confidently asserts "that I was on the right track and have nothing to regret, so far as the theory is concerned" (ibid.).

In other words, the 1981 book makes an effort to provide a theoretical explanation for the full course of human history, from hunting and gathering communities through various stages of agricultural societies right into the industrial transformation. Its overall structure complies with this ambition: a chapter on the theoretical framework is followed by a historical chapter on *population and technology in the ancient world*. She then discusses *the role of demographic factors in European development* and the diffusion of industrial technologies. Finally, she deals with *demographic transition and technological change in the Third World.*

Her basic theoretical framework for the core interrelation between demographic dynamics and technological development reads as follows (Boserup 1981, p. 5 ff.): Inventions, or the acceptance of spreading inventions, have a strong demand component, and rapid population growth can generate such a demand. Thus, population change induces inventions and technological change and also facilitates technological change: more people available make doing things differently possible. There is also a feedback loop in that technological change leads to further population change.

Increased population density in an area has a dual effect on the availability of life-sustaining natural resources: On the one hand, it makes life easier because it allows for burden sharing in accessing these resources. On the other hand, in the long run, the ratio of natural resources to the population decreases. "One or the other tendency may prevail" (Boserup 1981, p. 5). As a result of both tendencies, an increase in population density "provides an incentive to replace natural resources by labour and capital" (Boserup 1981, p. 6).

These are the key theoretical propositions that lead her through the rich material throughout her book. She operationally defines her key variables: population density and technological change. Both variables are measured at a national level, using the few internationally available data of her time. Density is fairly straightforward: she defines 10 density classes (in persons per $km^2$ each distinguished from the next by factor 2: 0–1, 1–2, 2–4, 4–8 . . . 128–256, > 256) that she will later group together.

Next, she specifies technological levels (Boserup 1981, p. 12 ff.). Among the indicators she uses, per capita energy consumption (in coal equivalents), which can be considered practically equivalent to the amount of fossil fuel use, comes first. Next is the number of telephones per 1,000 inhabitants (again in its dependency upon electricity bound to fossil fuel use), an indicator of extending communication beyond the local community and of interconnectedness. Average life expectancy, as an indicator of health infrastructure, food supply and literacy rates, rounds out the set. She ranks the countries by each indicator, constructs an index in which each

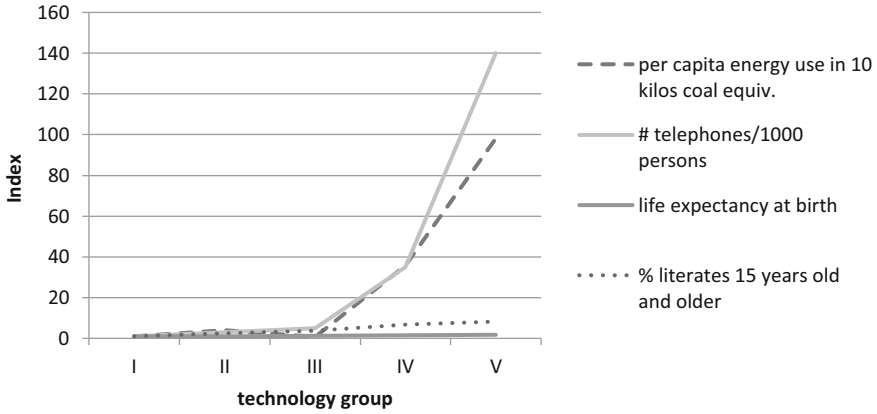


**Fig. 3.1** Indicator values by technology level. (According to Boserup 1981, p. 13, Table 2.3; calculated as indices, value of technology level I = 1)

indicator carries equal weight, and finally puts the countries into 5 groups by the resulting index, with each group containing an equal number of countries (for the year 1970) (Fig. 3.1).

Boserup presents the relation between indicators and technology groups in the form of a table. In general, the technology groups exhibit a rise in life expectancy, literacy, and "connectivity" from one group to the next using different levels of fossil fuel inputs. What becomes much more apparent when presented graphically is the relative homogeneity of technology groups I–III according to these indicators. Then, there is an increase through group IV to group V clearly related to fossil energy use. Thus, what she shows here are not the subtle differences within the agrarian regime that were her original focus (differentiation by fallow periods and gradual intensification of land use) but the progressive use of fossil fuels as a source of energy.[1]

In her next step, she puts her core hypothesis of 1965, that high population density, far from making people starve, moves them in a position to advance technologically, to a test with these data. The results (see graph in Fig. 3.2) do not convince her. She feels there is no longer as close a correlation as between population density and high technological levels as "there seems to have been before the industrial revolution" (Boserup 1981, p. 14), but even now she sees a pronounced inverse relationship only happening rarely, recognizing that "it became possible for a sparsely populated area by very rapid technological development to become the leading industrial nation in little more than a century." (Boserup 1981, p. 144)

Clearly, the proportion of high-density countries is highest among the top technology group, but the proportion of low-density countries does not continuously

[1] This transition is also reflected in several other tables in chapter 1 (Boserup 1981); there is never a more or less steady increase from group 1 to group 5. However a consistent pattern can be observed that groups 1–3 are fairly similar and then there is rapid change through 4 to 5. She fails to register this explicitly.

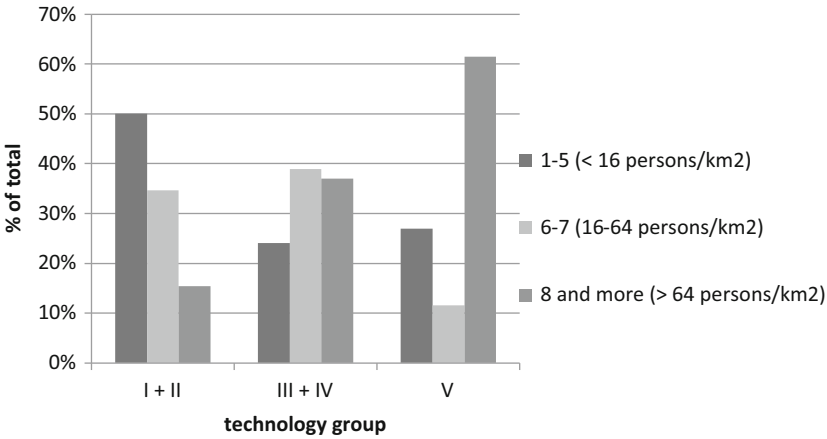


**Fig. 3.2** Population density and technological level in 1970 (∼ 100 countries). (According to Boserup 1981, p. 14, Table 2.5; technology groups as in original)

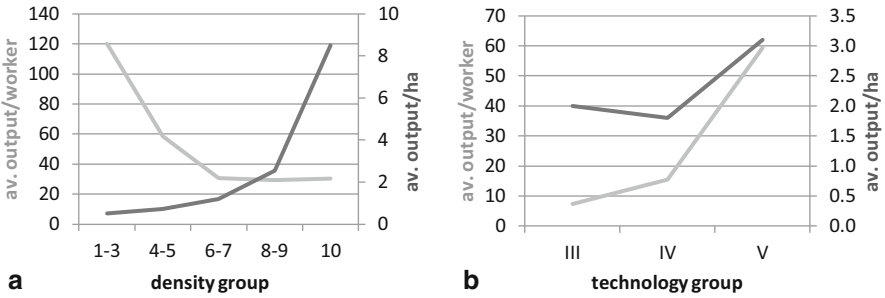


**Fig. 3.3** The overall effect of density (**a**), and technology (**b**) on output. (According to Boserup 1981, p. 27, Table 3.13; number of countries per cell very small (1–4)

decline with technological advancement—there must be other factors involved as well. The issue could be resolved more easily if she drew a theoretical dividing line between population dynamics and technological advancement under agrarian regime conditions, where her hypothesis is highly plausible and corresponds very well to historical observation, and the roles of population dynamics under industrializing and industrial conditions that are somehow qualitatively different.[2]

Even the findings concerning her core thesis that average agricultural output per area rises in dependency upon population density at the expense of declining output per labour hour confirm her theory, but still there is a strong discontinuity with technology level V, the industrial end of the scale (see Fig. 3.3).

Yield per worker does not depend much on population density but strongly depends on technology. Density plays a role only in technology group V (with output per

[2] Practically, of course, this would always be blurred because there is often a protracted transition phase between one system state to the other.

worker declining as predicted). Clearly, what this technology scale measures, i.e., transition to fossil fuel use, reflects itself in an emphasis on saving labour.

From multivariate and bivariate perspectives (Fig. 3.3), one sees output per hectare rise with population density and output per worker decline. This finding confirms Boserup's core theoretical assumption. However, with technology groups, the old assumption does not hold; both output per hectare and output per worker increase with the technological level because a technological level is not defined as improved technology within agricultural society but as the degree of transition towards the use of fossil fuels.

Why does Ester Boserup not draw a dividing line between systems functioning differently, as she herself repeatedly recognises?

She clearly disapproved of the arrogance of modernist exceptionalism in bringing technological innovation and change to "traditional" communities that would otherwise be static. For this reason, perhaps, she opposed the dichotomous distinction of "modern" and "traditional" altogether and introduced a much richer set of qualitative distinctions of food supply systems, differentiated by what she considers the decisive variable for land use intensity: fallow periods (Boserup 1965, p. 15 f., 1981, p. 18 f.). This line of reasoning was highly innovative vis-à-vis the simplistic distinctions of classical political economy between cultivated land and unused land and the derived processes of extension (cultivating additional land) and intensification (increasing output) and was inspirational for contemporary land use science (see Chap. 5 by Erb et al. in this volume). Nevertheless, it still shares with the classics a particular blind spot: an unawareness of the crucial role of sources of energy.

For her, contrary to mainstream thinking, tools and their improvement, as well as input factors such as fertilisers, pesticides and herbicides, play a secondary role. Her core argument, simplified, is that population growth increases density and makes it necessary to find ways to use land more intensively, which is equivalent to reducing fallow periods (up to annual multicropping), which in turn drives technological development; solutions also rely on the availability of more people and more labour power.

It makes a fundamental difference if societies base practically all of their processes on solar energy, its conversion into plant biomass and, consequently, agriculture as the key energy supply sector, or if they base their processes on fossil fuel energy sources. In the first case, societies as a whole absolutely depend on a positive high EROI (energy return upon energy investment[3]) from agriculture, and if it is low, such societies are constrained in their complexity. In the second case, they can afford to subsidise agriculture energetically. For agriculture, the subject of much of Boserup's writing, this makes a huge difference, a qualitative leap beyond what she introduces as gradual distinctions. In the following paragraph, we will explain how we, building upon Boserup's ideas, argue the need for drawing a qualitative distinction between what we call agrarian and industrial sociometabolic regimes.

[3] On the concept of EROI, see (Hall et al. 1986, p. 28)

## 3.3 Understanding Qualitative Change: Sociometabolic Regimes

The metabolism of all pre-industrial societies is based on the use of biomass and thus upon the ability of plant organisms to utilise solar energy via photosynthesis to create energy-rich material from carbon dioxide, water and mineral compounds. In the form of nutrition and animal feed, biomass provides the energetic basis for sustaining the existence of humans and their livestock and can be converted into mechanical energy. Combustion (burning fuelwood, for example) provides space and process heating for domestic households (cooking), mining (metal smelting) and light. The conversion of heat into mechanical energy was not possible prior to the invention of the steam engine; thus, the availability of mechanical energy was subject to strict limitations. Water and wind power play an important yet very much subordinate role in terms of quantity. With few exceptions,[4] biomass was by far the most important energy source until the industrial revolution, generally accounting for 99 % of all available primary energy.

The production of available energy is based upon the controlled transformation of ecosystems by labour with the aim of increasing the utilisable yield of biomass; i.e., upon the colonisation of nature. The basic precondition for this form of subsistence is that a positive energy yield (EROI) is obtained from agrarian activity; through agrarian land-use, significantly more energy in the form of biomass must be produced than is expended in the form of human labour (and prerequisite energetic expenditures such as nutrition). It has been estimated that in Central Europe before the beginning of industrialisation in the agrarian economy, an EROI of c. 10 to 1 was achieved (Krausmann 2004; Leach 1976). Any surplus may be used to supply the non-agrarian sectors of society—that is, to provide nutrition and fuelwood for urban centres, as well as feed for the draught animals that have to transport all this material.

The higher the surplus, the more complex the possible societal structures become. However, this surplus is never particularly high because a system must be very well organised for the work of 10 farm families to be able to sustain more than 1–2 other households (such as aristocratic landowners, craftspeople or bureaucrats). Under the agrarian regime, reactions to increases in food demand, which are usually caused by population growth, initially involve expanding the area dedicated to agrarian production—and this may often lead to attempts to capture new territories. As a last resort, where land is scarce and territory limited, the option remains to apply a greater investment of labour to the same land area with the aim of achieving a greater yield, in other words, the intensification of land-area use. However, the yield per invested hour of labour declines as intensity of use increases and asymptotically approaches a physical limitation, from which point there is no benefit to be achieved by further

[4] In the seventeenth century in the Netherlands, for example, the exploitation of large peat deposits, intensive use of wind energy and a dense network of waterways suitable for shipping formed the energetic basis for an exceptional economic development, the Dutch Golden Age. It is estimated that during this period, up to 1.5 million tonnes of peat were dug annually, involving the excavation of 700 ha of peatland each year. Peat is a source—albeit not one of the oldest—of fossil energy. See (De Zeeuw 1978).

intensification. In other words, growth is possible but leads to a diminishing marginal utility of labour. When this limit is reached, we find the "typical" picture of agrarian societies, in which the majority of the population, including children, incessantly performs demanding physical work while still suffering from shortages of essential resources. This logic, which Ester Boserup has studied on a worldwide basis and of which she provides a detailed description, represents a fundamental limitation of societal development in agrarian regimes: as a rule, growth in this regime eventually leads, despite progress made regarding methods of husbandry and plant cultivation, to the stagnating or even diminishing availability of per capita material and energy resources.

Furthermore, the absence of the possibility to transform heat energy into mechanical work limits the degrees of freedom. Mechanical work can only be performed through the physical work of humans, animals and water/wind energy; thus, the productivity that was thereby attainable remained relatively low.[5] Altogether, the size and structure of societal metabolism and its spatial differentiation were subject to limitation through the controlled solar energy system. In Europe, before the beginning of the Industrial Revolution, 2–4 t of raw material and 30–70 gigajoules (GJ)[6] of primary energy were appropriated per capita and year, whereby biomass accounted for over 80 % of all material and 95 % of all energy inputs: food for human populations, livestock feed and wood for construction and fuel. Regional differences in metabolism were related in particular to the varying relevance of holding livestock and climatic conditions.[7]

Starting in seventeenth century England, increased use of coal led to the development of a new energy system. At the core of this energy transition was a transition from the use of energy flows with low power density in the form of biomass that is regrown annually to the exploitation of large-scale energy deposits that had accumulated over geological eras and existed in a concentrated form as coal, with a high power density (Smil 2003). Initially, coal was used solely as an often quite unpopular fuel for stoves in the households of manufacturing workers in urban centres, whose increasing requirements could not be supplied by fuelwood alone. Fortunately, coal supplies in England were found close to these centres, and coal could also be transported at low cost via waterways.[8]

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[5] One should imagine that a Pharaoh with 2000 labourers to build the pyramids had little more capacity at his disposal as a worker would today using a large road construction machine.

[6] One Joule represents 0.24 calories and is a very small unit. A megajoule (MJ) = $10^6$ J, a gigajoule (GJ) = $10^9$ J and an exajoule (EJ) = $10^{18}$ J. The energy content (calorific value) of 1 kg of wood is roughly 15 MJ, that of coal is 20–30 MJ and that of petroleum is 45 MJ.

[7] The highest biomass conversion rates are seen in pastoral societies with a very high per capita livestock holding and the lowest are recorded in societies whose means of subsistence rely predominantly on human physical work and plant-based diets (for example, in the rice-cultivating societies of south and southeast Asia).

[8] These densely populated manufacturing centres had come into existence because, as early as the seventeenth century, the English owners of large estates found it more profitable to use their land for the production of the raw materials of the textile industry than to produce foodstuff for a rural population, which, in their eyes at least, was seen as partly expendable.

In nearly all other world regions, by contrast, only regional urban-industrial centres were affected by this metabolic transition. Accordingly, the average per capita coal use remained negligible in countries such as India, China or Brazil even at the beginning of the twentieth century, comprising far less than 100 kg/capita and year. Indeed, the European countries that were in the process of industrialising had an active interest in using colonialism to ensure that other world regions played a role as suppliers of cheap agricultural products and other raw materials, as well as outlet markets for growing industrial production and certainly not in allowing them to participate in industrial development themselves (see further discussion on this theme below).

Later, steam engines enabled the conversion of coal into mechanical power, which led to a dramatic increase in the available capacity compared to what had existed under the previous regime. The possibility of extracting, transporting, processing and consuming materials underwent radical change, and an entirely new form of societal metabolism came into being as a result. In addition to biomass, huge quantities of coal, construction materials and ore were extracted and processed. In the United Kingdom, materials used, for example, increased from 60 to 400 million tonnes per year between 1750 and 1900. Population growth during this phase happened at a somewhat slower pace than the increase in material and energy use. For the first time in history, there was rapidly growing demand for non-agricultural workers. The mechanical performance of large coal-powered machines created conditions that produced an immense number of jobs required for final manufacturing. During this phase, although there was a rise in per capita material and energy consumption, it did not produce an increase in mass prosperity but was instead channelled into the expansion of the factory system and into exports.

Coal represented a first important step towards emancipating the energy system from the land area and removing traditional limitations on economic growth. Rolf Peter Sieferle coined the vivid phrase "subterranean forest" for this phenomenon (Sieferle 1982). He showed that the energy (calorific value) contained in the amount of coal that was combusted annually in the United Kingdom by 1850 had already reached the equivalent of the fuelwood that could be produced from a virtual forest area the size of the entire country. By 1900, this amount had risen to an area equivalent to a subterranean forest covering four times the land area of the entire country (see Fig. 3.4). We may interpret this finding to mean that to maintain societal metabolism at the same level, the United Kingdom would have required a territory four times greater than its actual land area and entirely covered in forest for use.

However, coal use did not remove all the limitations of the solar energy system. A very profound reliance upon the area-dependent resource of biomass remained in place: the need for nutrition. Access to more (technical) energy had not in any sense replaced human physical work but in fact had increased the demand for labour power in need of nutrition. In a similar way, the railway did not replace the need for draught and working animals; on the contrary, the wide-meshed network of railway lines, in combination with an increase in transported goods and people, led to an increasing demand for working animals. Stocks of draught animals grew continuously into the twentieth century. Similarly, coal did indeed provide a substitute for fuelwood,

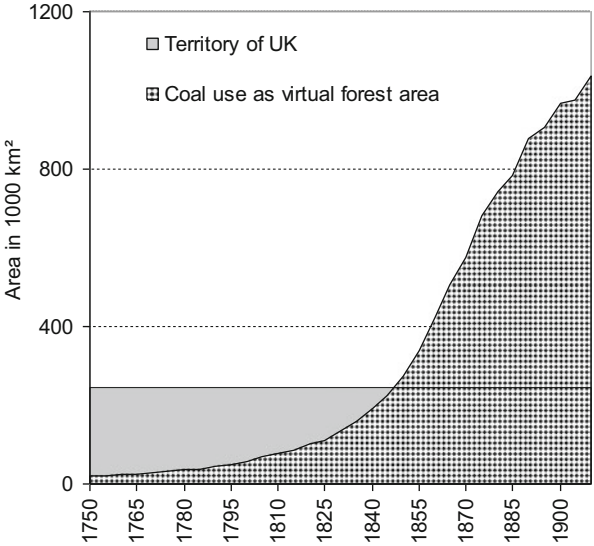


**Fig. 3.4** Coal use in the United Kingdom (UK) as virtual forest area. (Source: Krausmann and Fischer-Kowalski 2012, p. 346, according to Sieferle 1982). Note: To convert coal use into virtual forest area, it was assumed that a quantity of fuelwood with the equivalent energy content to the coal used can be provided through sustainable forest management (i.e., through the use of annual growth and not standing timber mass). The forest area required to produce this volume of fuelwood is presented as a virtual forest area.)

but more timber than ever before was required for building the railways and for the emerging paper industry. Altogether, the demand for biomass grew paradoxically alongside the transformation of the energy system to feed people and animals and to supply new industries with raw material. At the same time, the potential for expanding the cultivatable area was largely exhausted, and the means of raising area productivity were limited. The most important limitation was the chronic shortage of fertiliser. Although mineral fertilisers, such as guano, Chile saltpetre and superphosphate, were increasingly used in agriculture by the end of the nineteenth century, the volumes employed were low and limited to special crops such as oranges or tobacco and the supply of plant nutrients for most of the cultivated land still had to rely on farm-internal means (manure, leguminous crops, etc.). Thus, a fundamental limitation upon traditional agriculture remained in place, which, in spite of successful biological innovations such as new cultivated plants and new land-use practices, led to stagnating grain yields in the nineteenth century.

In the USA, a completely different development took place; a rapidly growing population but an extremely low population density of only 2 persons per km$^2$ meant that with the expansion of the railway system, huge swathes of fertile prairie land could be cultivated for food production. Within a few decades of homesteading, over 100 million ha of high-quality agricultural land were gained in the Midwestern USA between 1850 and 1920, after the indigenous peoples, with their extensive land-use practices, had been violently expelled (Cunfer 2005). The nutrient-rich soils of the Great Plains allowed for high initial yields with little labour input. The labour productivity of this system of agriculture was extraordinarily high and enabled a small rural population to supply the densely populated urban centres on the coasts as well as to export large quantities of foodstuff to Europe. By around 1880, the USA was already exporting over 4 million tonnes of grain, providing basic nutrition for over 20 million people (Krausmann and Cunfer 2009).

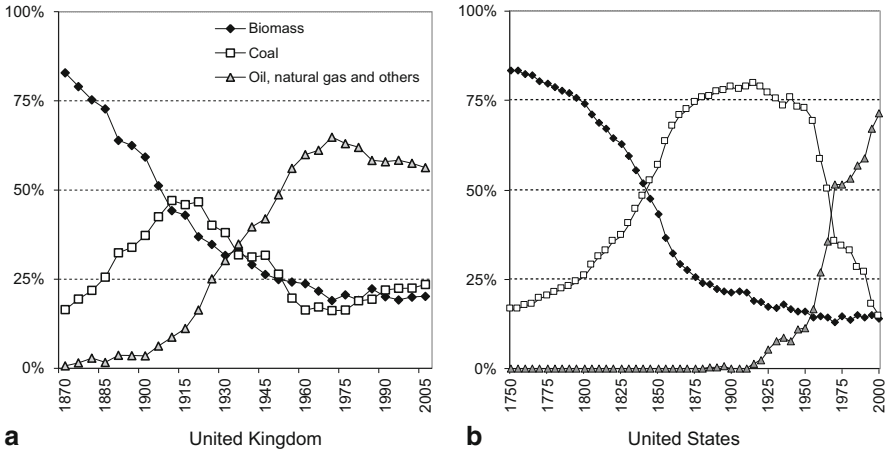


**Fig. 3.5** The establishment of new energy sources in the United Kingdom (1870–2006) (**a**), and the United States (1750–2000) (**b**). (Data sources: Authors' calculations based on Schandl and Krausmann 2007, p. 97 (United Kingdom), and IEA 2008; Krausmann et al. 2009; Podobnik 1999). Note: In this diagram, the share of the total primary energy supply, represented by the three fractions of biomass, coal and oil/natural gas (including other energy forms), is depicted. The biomass fraction includes all biomass used as food for humans and livestock and biomass used for all other purposes, together with fuelwood

Not only the agrarian productivity of a pioneer country but also another resource—oil—positioned the USA to become the leading nation during the next phase of the industrial transformation (Fig. 3.5).

### *3.3.1 The Green Revolution*

As shown, in the nineteenth century, the USA was able to effectively compensate the weaknesses of the English transformation model (i.e., difficulties in producing sufficient food for a high-density and growing population) and to turn this to its advantage. However, it became clear that this level of agricultural productivity had no long-term potential and after only a few decades, ran up against massive ecological limitations. The combination of large land areas with a low investment of labour was only possible because the prairie soil, then being ploughed for the first time, contained huge reservoirs of plant nutrients accumulated over a long historical period. These reservoirs, however, quickly began to deplete in the first decades of ploughing. The yields began to decrease, and enormous problems with erosion appeared (Cunfer 2005). However, in a situation where oil could be obtained cheaply and with a bundle of technologies coupled to this new energy source, a new and successful agricultural model was possible. The tractor allowed for the substitution of all animal labour and a large proportion of human labour in agriculture, much as the motor saw raised the speed of tree-felling in comparison with the axe by a factor of 100–1,000 (and thus

enabled the rapid deforestation of the rainforests). The agrochemical industry, based on petroleum and natural gas, helped to lift the chronic limitations on plant nutrients from which agriculture was suffering. From the 1920s onwards, huge amounts of atmospheric nitrogen were made available for agricultural use using the Haber-Bosch process, which requires a high energy input (Smil 2001). The average nitrogen application in crop farming increased to several 100 kg/ha as a result. Together with industrial potassium, phosphate fertilisers, pesticides and successes in plant and livestock breeding, area yields and labour productivity in agriculture were amplified within a very short space of time (Grigg 1992).

Starting in the USA and disseminated by agricultural companies active on the global market, these new agricultural methods were spread around the world under the term *green revolution*.[9] They found application in Europe after World War II. As a result, the proportion of the population engaged in agriculture fell to 5 % or less. The *green revolution* also took hold in large sectors of agriculture in the southern hemisphere and helped create conditions in which global food production was able to keep pace with the quadrupling of the world population in the twentieth century.

The industrialisation of agriculture required a massive transformation of the agrarian landscape, which had to be rendered suitable for machine activity. This transformation led to a range of specific environmental problems. The position of agriculture in societal metabolism and the energy system changed fundamentally. Industrialised agriculture requires a high energy input, and today, more energy is invested in agricultural production than is subsequently obtained in the form of food, which is partly due to the large quantity of high-quality agricultural produce that is fed to livestock. In general, agriculture has been altered during the course of the sociometabolic transformation from being the most important source of useful energy to becoming an energy sink (Pimentel and Pimentel 1979). With the industrial transformation, society has made itself dependent on abundant external energy sources for the most important part of its metabolism, namely, the feeding of its population.

This industrial stage of agriculture does not comply with Boserup's theory of population growth driving technological innovation and leading to a substitution of natural resources by labour and capital. Bringing a completely new natural resource into play introduces a completely new pattern.

## 3.4 Examples of Later Research Findings that Could Have Been Anticipated from Boserup's Theory

### *3.4.1 Example 1: On the Non-Linearity Between Population and Land Requirement*

One of Boserup's core ideas is inspirational: the anti-Malthusian message of a non-linear relationship between the (growing) number of people and land requirement,

[9] The term green revolution was first coined in 1968 by William S. Gaud, the director of the United States Agency for International Development USAID. See also (Leaf 2004).

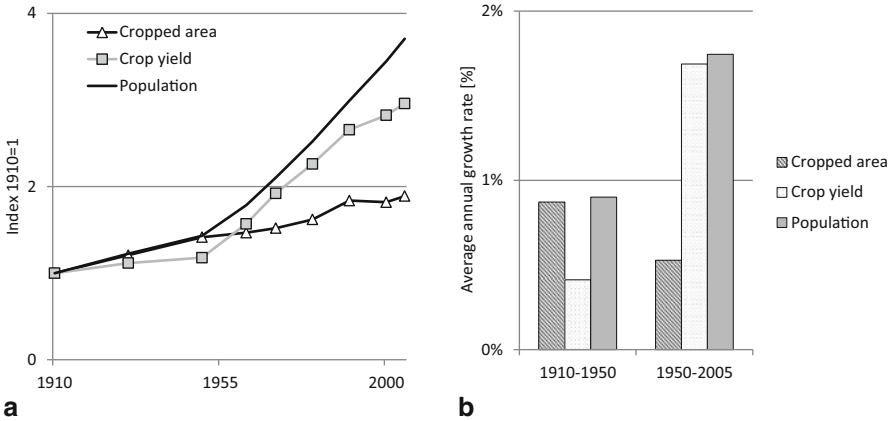


**Fig. 3.6** Development of global cropped area, average crop yields per unit area and population in the twentieth century. Indexed Development from 1910 to 2005 (1910 = 1) (**a**), and average annual growth rates for the period 1910–1950 and 1950–2005 (**b**). (Based on Krausmann et al. 2013). Note: Since the *green revolution*, these changes have been achieved not by increasing human labour inputs (on the contrary, the number of people globally working in agriculture has decreased) but by increasing labour input in its technical form, namely direct or indirect energy input on the basis of fossil fuels

with the key intervening variable being the intensification of use. This proposition held on a global level throughout the twentieth century (Fig. 3.6). One must assume, though, that generating more output on the same cropland was achieved by different methods before and after the *green revolution*, with its fossil fuel-based inputs and tools. Whereas before the *green revolution*, the mechanisms described in Boserup (1965), namely reduced fallow periods and, in extreme cases, shifting to multicropping, at the expense of increasing labour investment, presumably dominated and achieved an increase in output that could not quite keep up with population growth (so that there still had to be a substantial expansion in cropland), after the *green revolution* (i.e., from the late 1950s onward), the growth in yields far exceeded the growth in cropland. In the most recent decades, however, yields have again grown at a slower pace than the world population (Fig. 3.7).

During the heyday of the *green revolution*, the number of tractors increased two-and-a-half fold, and the use of mineral fertilisers increased fivefold. Again, we see a structural break from the late 1980s onward in which these inputs have stagnated and the overall energy input in agriculture dropped and has remained stable on a substantially lower level. If we relate this to the results shown in Fig. 3.8, it is apparent that rises in crop yields and rises in fossil fuel-based inputs relate closely. No doubt this may change again in the future; the increasing prices of fossil fuels (and maybe even outright oil scarcity) and agricultural products may create a situation in which more labour-intensive forms of agriculture regain their place in society.

One international mistake could have been avoided by looking more closely at Boserup's works. The original global estimates of land available for biofuels ("unused

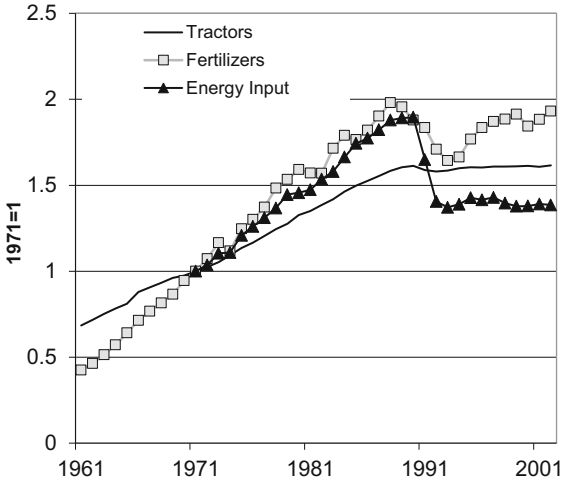


**Fig. 3.7** Global trends in agricultural inputs 1961–2005. (Source: FAO 2007; IEA 2008. Note: The number of tractors is a conservative estimate for the input of labour, as the size of tractors has increased considerably since 1961.)

land") were much too high (Haberl et al. 2010 provide an excellent overview). Boserup would have taught them that on this populated planet, there is no such thing as "unused land" (regardless of what it looks like on satellite images); the intensity of land use is a matter of degree, with—for example—extensive pastures contributing essentially both to the nutrition of people and to the fertilization of their cropland.

### *3.4.2 Example 2: Generalizing the Thesis of Non-Linearity to Other Resources*

An analogous argument may apply to the human use of other natural resources as well: although population numbers are one of the strongest drivers of the requirement of energy and material resources, technological innovations allow, through

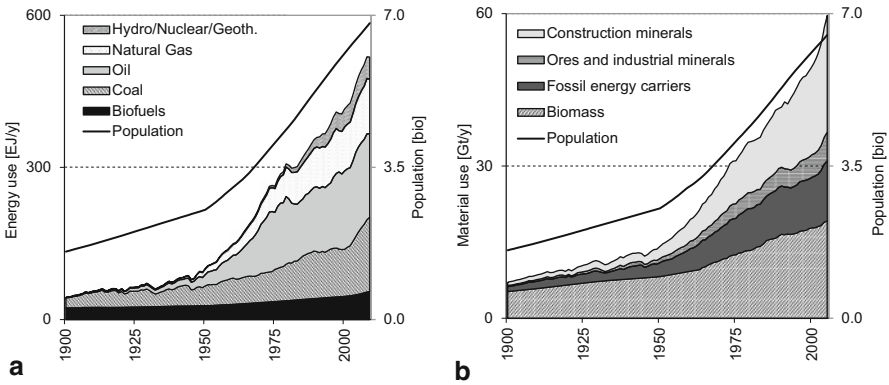


**Fig. 3.8** Global primary energy use (**a**), and material use (**b**), 1900–2010. (Source: Krausmann et al. 2009) (data update 2011)

increasing efficiency, a certain degree of non-linearity in this relationship. Under the agrarian sociometabolic regime (or agricultural societies, as Boserup would say), an increasing population density allowed for urbanization, and urbanization both offered the conditions for further technological development and required them (such as fortifications, new means of transport and transport infrastructures, new weapons, etc.). However, urbanization and a lifestyle beyond the daily toil of agriculture was clearly limited by the low agricultural surplus that could be taxed from peasants, limits to transportation (land transport for bulky materials could only cover a few kilometres; ships were the only viable alternative), and limits to timber and fuel wood that used to be quickly exhausted in the vicinity of urban centres. (See part II in Boserup 1981, pp. 15–92; see also Sieferle 1982) Thus, once the basic infrastructural investments were completed, the requirements of natural resources (food, feed, timber and fuelwood, fibres, clay, metals and mineral building materials) grew at most at the pace of the population and, one may speculate, maybe often below for scarcity and efficiency reasons. There was a certain built-in mechanism for territories to grow but not a built-in mechanism for individual consumption to grow.[10]

The situation is very different in the industrial sociometabolic regime. There, technological innovations mainly reduce labour requirements and drive income (Ayres and Warr 2009). The more resources for a certain service are saved through innovation, the more resources are consumed overall (Sorrell and Dimitropoulos 2008). During all of the twentieth century, marked by the expansion of the industrial regime, the global resource consumption of energy and all other materials increased much faster than the already very steep rise of the world population (see Fig. 3.8). In effect, per capita consumption of natural resources almost tripled during this century, and it is continuing to rise as the industrial regime expands to more and more countries.

All this could not have happened with biomass as the core source of energy. Industrial agriculture uses large amounts of fossils to boost annual harvests of net primary production by an order of magnitude (Haberl et al. 2007).

The rise of per capita energy and materials consumption, i.e., the non-linearity of resource requirements with elasticities above 1 in relation to population growth, is particularly pronounced in two phases (see Fig. 3.9). One phase is the period between the world economic crisis in 1930 and the first oil crisis in 1972—this is precisely the period of booming oil in the US, reconstruction after World War II in Europe, and the worldwide spread of the so-called *green revolution* in agriculture (Pimentel et. al 1973). The other phase has been visible on a global level since the turn of the twenty-first century, but regionally started much earlier: the rapid industrial transformation, on a fossil fuel base, of a number of so-called emergent economies such as China, Brazil, Korea or India.

The first decade of the new century was marked by a shift in resource prices; for the first time in many decades, there was a steep trend upward (the long-term trend had always been declining) for oil and gas, cereals, and many metals and minerals. In the

[10] For the elites, growth of territory, of course, was the major mechanism for becoming richer; however, compared to today, differences in consumption levels between the rich and the richer were negligible.

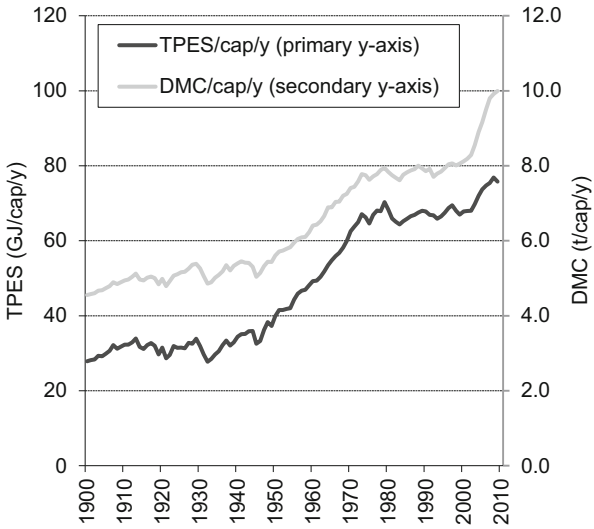


**Fig. 3.9** Per capita global energy and materials use during the twentieth century. (Source: Krausmann et al. 2009) (data update 2011)

same decade, a major global financial crisis (which also exists today) and structural shifts in world trade occurred (Dittrich and Bringezu 2010). If Ester Boserup had had the chance to use these sociometabolic indicators for her analysis, what conclusions would she have come up with? Would she have been able to maintain her generally positive outlook on population growth and technological advancement?

### *3.4.3 Example 3: On the Role of Development and Population Density in Driving Resource Use*

Development, in the sense of a transition from an agrarian to an industrial regime, implies a much more substantial increase in resource use than Boserup could be aware of. On the basis of a number of historical and contemporary case studies, several authors (Haberl et al. 2011; Krausmann et al. 2008) published the following estimates (Table 3.1). Primary energy use[11] per capita has increased by a factor between 3 and 5, far beyond the range of any agrarian society; biomass use, although absolutely not decreasing, only supplies 10–30 % of the energy used. The same holds true for materials use—with the energy available, 3–5 times as much material can be mobilised. In addition, the fraction of the population working in agriculture has decreased from above 80 % to less than 10 %. With the demographic transitions that have come along, population density has increased 3- to 10-fold, leading to a very

[11] Measured as Domestic Energy Consumption (DEC), which includes, beyond the primary energy from commercial sources as measured by TPES (total primary energy supply), the food and feed energy consumed. Thus, it is a much better indicator for comparing energy requirements across historical periods in which food/feed energy comprised most of the energy used.

**Table 3.1** Comparing the agrarian and the industrial regime: Population density, per capita resource use and agricultural population. (Source: Krausmann et al. 2008)

| | | Agrarian | Industrial | Factor |
|---|---|---|---|---|
| Energy use (DEC) per capita | [GJ/cap] | 40–70 | 150–400 | 3–5 |
| Energy use (DEC) per area | [GJ/ha] | < 30 | < 600 | 10–30 |
| Biomass (share of DEC) | [%] | > 95 | 10–30 | 0.1–0.3 |
| Material use (DMC) per capita | [t/cap] | 3–6 | 15–25 | 3–5 |
| Material use (DMC) per area | [t/ha] | < 2 | < 50 | 10–30 |
| Population density | [cap/km$^2$] | < 40 | < 400 | 3–10 |
| Agricultural population | [%] | > 80 | < 10 | 0.1 |

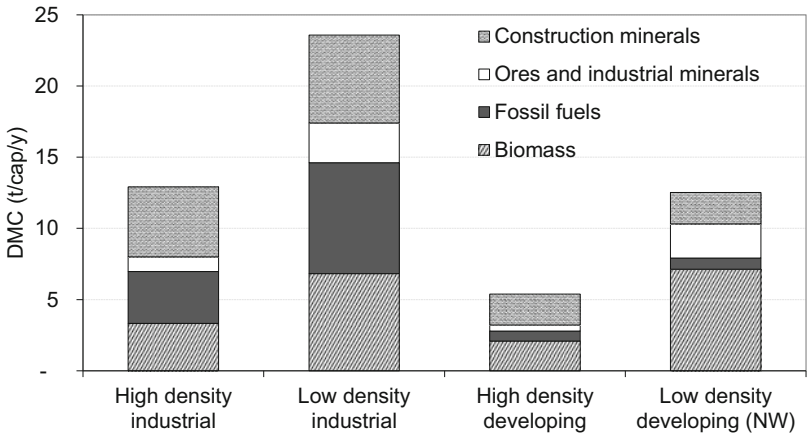


**Fig. 3.10** The combined effect of development status and population density on per capita material use (175 countries in the year 2000). (Based on Krausmann et al. 2008)

strong increase in the impact (or, rather, pressure) of humans per unit area. The Boserupian idea that humans, specifically because of a higher density (and therefore rising collaboration and inventiveness), could be able to buffer the negative impacts of their increasingly intensive use upon the environment was partly true as far as local and regional impacts in rich countries are concerned but not on a global or long-term scale.

On a global level, nevertheless, the mitigating effect of population density can be demonstrated. Both among developing (i.e., in the middle of a transition from agrarian to industrial in the year 2000) and among fully industrialised countries, countries with above-average population densities are able to provide their people's welfare at a substantially lower level of per capita consumption of natural resources (Fig. 3.10). This finding relates to different patterns of (historically evolved) lifestyle and consumption. Densely built urban centres, for example, demand much less infrastructure materials for supply, disposal and transportation (Weisz and Steinberger 2010), as well as less energy for heating and transport, than scattered settlements. In the same vein, densely populated regions tend to develop a diet that is not as resource (and area) demanding as the diet in regions where there is plenty of food available.

In the opposite direction of causality, one finds natural resources (such as timber, or mining products) being extracted preferably in low density areas, which boosts the metabolic rates in these regions. High density areas are instead only the consumers of these resources, and the "upstream flows" do not weigh on their metabolic rates.

This difference was considered so striking that UNEP based its scenarios of future resource use on the assumption that developing countries, over the coming decades, would tend to emulate the metabolic rates of industrial countries but maintain differences according to population density (UNEP 2011). Nevertheless, the IRP came to the conclusion that the already ongoing continuation of metabolic convergence would lead to an untenable level of global resource use, running up not only against all climate concerns but also against global resource constraints (fossil fuels, metals). Thus, Boserup, in contrast to most of her contemporaries, correctly viewed population growth and density increase not just as rising but also as alleviating environmental burdens.

## 3.5 Conclusion

Although Ester Boserup, in both her 1965 book and her 1981 book, provides one of the most subtle and theoretically profound descriptions of the dynamics of agricultural societies, she fails to perceive the qualitative differences introduced by the use of fossil fuels. Her trust in human ingenuity makes her overlook the possibility of a substantial overshoot of human use of resources beyond what the earth system may provide us in the long run. Writing her later book a few years after *Limits to Growth* by Meadow et al., she makes no reference to this work, as she had not done in her first book to Rachel Carson's *Silent Spring* (although the two women were personally in contact[12]). Her personal engagement in favour of development opportunities, her strong anti-Malthusian sentiment and her theoretical roots in classical political economy did not allow her to see something obvious: that the widespread use of fossil fuels disrupted the logic of the agricultural society so well analysed by her, and that it created a new dynamic that may eventually eradicate the natural conditions for human welfare on the Earth.



[12] According to personal communication with Faye Duchin.

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# Part II
# Land Use, Technology and Agriculture

# Chapter 4
# The Dwindling Role of Population Pressure in Land Use Change—a Case from the South West Pacific

**Torben Birch-Thomsen and Anette Reenberg**

**Keywords** Solomon Islands · Agricultural change · Coping strategies · Shifting cultivation · Rural livelihoods

## 4.1 Introduction

In this article, we will explore a contemporary coupled human-environmental system on a small island in the South West Pacific with the aim of portraying historical changes in the resource management strategies, notably the agricultural land use, in this former subsistence system.

Anthropologist and human-environment geographers have in various contexts considered such well-defined units as optimal laboratories for in-depth analyses of the dynamic complexities of human-environment systems (e.g. Fox et al. 2003; GLP 2005; Haberl et al. 2006; Lambin and Geist 2006; Scoones 1999; Walker et al. 2006; Zimmerer and Bassett 2003). Our reason for embarking on this study originated precisely in this tradition inasmuch as one of the classical human ecological studies from the 1960s has provided us with an excellent and very detailed set of baseline information about the land use-population-environment nexus approximately 50 years ago (Christiansen 1975). A recent opportunity to revisit and study the same environment using the same theoretical and conceptual mindset has provided us with unique material for a longitudinal analysis, which forms the backbone of the current chapter. Several sources of data were used including secondary data, a household survey, a population census, land use mapping based on remote sensing supported by ground truth, field walks and group interviews. The primary data were collected

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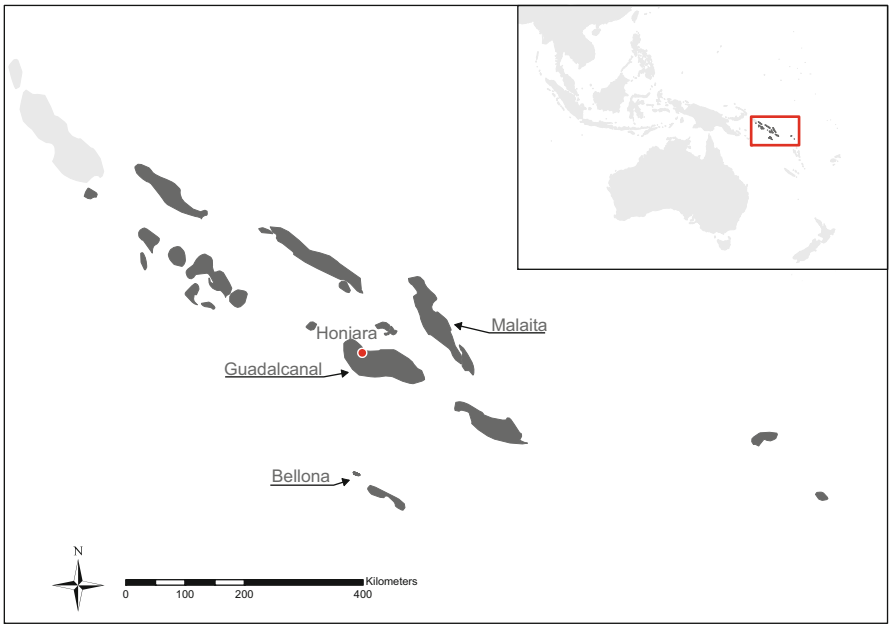



**Fig. 4.1** Map of the study site—Bellona Island in the Solomon Islands. (Source: Reenberg et al. 2008)

during three fieldwork periods on Bellona: a pilot study in September 2006, a major fieldwork period from early November to late December 2006 and follow-up fieldwork in January–March 2007.

The object of our study is Bellona Island, which is part of RenBel (Rennell and Bellona), the smallest of the nine provinces of the Solomon Islands (Fig. 4.1). Bellona lies between 11° and 12° south, approximately 180 km south of Guadalcanal, where the national capital Honiara is located.

The island is an uplifted coral atoll of 16.23 $km^2$, with steep cliffs towards the sea surrounding a more fertile plain in the centre of the island, which is the former lagoon floor and has locally high levels of phosphoric content. Due to the morphology of the island and numerous rock outcrops, only around one third of the island is considered suitable arable land (Breuning-Madsen et al. 2010).

The climate is tropical, with 3,000–4,000 mm of rainfall per year. Due to low water retention of the soils and the lack of access to surface water, less wet periods (May–August) may result in severe water shortage and stress. Frequent and intense cyclones also have a major impact on the environment and economy of Bellona in periods.

The inhabitants of the island, the Bellonese, are descendants of Polynesian migrants who arrived from Wallis Island (approx. 2500 km east of Bellona); in this respect, they belong to an ethnic minority in an otherwise primarily Melanesian society (Christiansen 1975). The total population is 2080 (in 2007), but the number of people actually present varies considerably over the course of the year due to

the well-established tradition of seasonal migration to other parts of the Solomon Islands or abroad. The island is divided into three administrative districts: Sa'aiho (2.56 $km^2$), Ghongau (10.34 $km^2$) and Matangi (3.33 $km^2$).

Agriculture is a prominent element in the livelihood portfolio. Subsistence production based on a shifting cultivation system supplemented by fishing has traditionally been the livelihood of the Bellonese. However, since first being described in the mid-1960s (Christiansen 1975), the livelihoods of the Bellonese have included an array of non-subsistence activities such as copra production, short-to medium-term labour migration, government employment and external economic support (remittances) from kin living and working away from the island (mostly in Honiara) (Reenberg et al. 2008).

We will, in the following, specifically focus on how this significant change in some of the major conditions for the local livelihood in general, and the island's agriculture in particular, has influenced the land use transformation on Bellona Island in the course of the last 50 years. The present case will illustrate that the link between agriculture and rural development may not be as close as otherwise often perceived.

## 4.2 Our Theoretical and Conceptual Lenses

### *4.2.1 Agricultural Intensification and Innovation*

Land use practices are known to be closely linked to societal institutions and the population (Turner et al. 2007). The theoretical scholarship on the population–agricultural change nexus has notably been anchored in two seminal works. One is Thomas Malthus's (1798) essay on the intrinsic imbalance between population growth rates and food production. The other is the book by Ester Boserup (1965) that suggests that farmers in "primitive" agricultural systems such as shifting cultivation tend to produce below the maximum because this allows for the optimal input–output efficiency. The conceptual frameworks suggested by Malthus and Boserup have had a huge impact on various scholars who have addressed the issue of how and why agricultural change and land use intensification occur. Although the models are contestable simplifications of real world situations, they have nevertheless provided a constructive starting point from which to discuss the complexity of agricultural change and land use trajectories. A number of classic studies (e.g. Adams and Mortimore 1997; Netting 1993; Turner et al. 1977, 1993; Wiggins 1995) have provided empirical documentation, which supports the perception that Boserup's model fits fairly well for land use systems that rely on land and labour extensive methods when land is abundant. More recent research emphasizes a number of economic, social or political factors that shape land use change beyond what is implicitly assumed in Boserup's simple model (Brookfield 2001; Stone 2001). One crucial issue is that the assumption of a direct, inverse relationship between efficiency and production concentration may not mirror realities (Stone 2001). The possible effect of local input–output energetic and population factors may be overshadowed by other factors; market access may, for example, play a significant role in the change trajectories when the land use system becomes part of a larger, spatial setting (Netting 1993).

Social factors may also become important because agricultural production efficiency can vary culturally or because the demand for agricultural products is culturally determined. Political ecologists, like Blaikie and Brookfield (1987), specifically note that the Boserup model does not take into account the variation in farmers' ability to intensify agriculture as they wish. They stress that even under seemingly similar ecological and socio-economic conditions, population pressure may prompt very different patterns of agricultural change because of differences in farmers' ability to invest, withstand risk and attract subsidies. Hence, they see innovation and opportunity as crucial explanatory factors (Brookfield 2001, p. 189) that can lead to greater land-use intensity without increased labour input. Only in cases where no feasible innovations are available does it become necessary to employ more labour intensive strategies to meet the greater demands of an increasing population. Implementing the "sociometabolic regime" theory Fischer-Kowalski et al. (2011) document how the transition from a pre-industrial agrarian mode of production to a fossil-fuelled intensive system lowered labour time, but increased the pressure on environment. In other words, pathways to intensification in agriculture may need to be seen as more complex, diverse and unpredictable and not necessarily closely related to population change as suggested by Boserup.

A recent attempt to provide a more generic insight into the intensification of agricultural land use in the tropics is provided by Keys and McConnell (2005), who synthesize the findings of a large number of previously published case studies of intensification of agricultural land use in the tropics. The changes in the agricultural system were assessed with regard to the correspondence with biophysical variables as well as a large number of socioeconomic variables. Keys and McConnell (2005) noted, among a range of other conclusions, that a large number of cases did not experience any intensification, which also serves as a reminder that the path to increased inputs and outputs is not a given.

Hence, there is substantive support for the view that population pressure does not work in an unmediated fashion. There is an obvious need to look at the contemporary influence of globalization when discussing human ecology and development. The internal demographic growth becomes part of a larger picture that encompasses seasonal, generational and permanent flows of labour and consumers, as well as of knowledge, skills and priorities of immigrants and return migrants.

In the context of small isolated entities, like the island states that we will use as a case below, the theoretical reflections are taken a step further. Malm (2007), for example, urges researchers to look at the wider relationship to the modern world system when discussing human ecology and development, because society is not synonymous with people living in a certain place. Globalization has had at least two important consequences for local livelihoods. On the one hand, people have been affected by the global flow of ideas, money and commodities. On the other hand, remote societies are increasingly entering into "transnational corporations of kin" (Bertram and Watters 1985) as they include a diaspora of relatives who live and work outside the region but who still to a large extent provide emotional and financial support.

### *4.2.2 A Diagrammatic Heuristic*

In the later years of her scientific career, Boserup (1996) proposed in a brief paper a heuristic framework for a concise interpretation of contending theories of development and for a description of a variety of development processes related to the use of land resources. She proposes considering six structures that have a certain stability, but are subject to change if they are exposed to persistent pressure: environment, population, technology level, occupational structure, family structure, and culture. She sketches the structures as points on a circle, with arrows between any two structures to indicate the origin and direction of pressure one structure may exert on another. The framework was meant as a useful tool to describe the dynamic found in micro studies on the village level as well as to distinguish among the major conceptual approaches in development theory.

First, Boserup uses the heuristic to illustrate how the classical theories of Adam Smith, Malthus, Ricardo, Marx, Max Weber and Neo-Malthusians have different assumptions about the relationships between the structures, although four of them have population growth as a starting point for the process they discuss.

More importantly in the current context, she also suggests the heuristic as a useful lens in development theory when focusing on long-term population change and the interaction of the structures. Building on her works on *Population and Technological Change* and *The Conditions of Agricultural Growth*, she presents six models that are seen as sequential, representing what is usually considered the major stages in the development process of agricultural systems (Fig. 4.2). The stage and traits that are specifically relevant to explore in the current context are depicted in the "autonomous village", the independent territory. The diagram depicts the expected pathway of change in this stage. First, population increases beyond the level that can be supported by long-fallow methods (P => E). Then, in step with the population increase, the cultivation changes to shorter fallow methods (P => T). Landscape becomes specialized between fields, pasture and forest (T => E). Occupational specialization increases, partly because the market becomes large enough to allow for specialized village crafts (E => O). An increasing proportion of youths are trained outside agriculture (O => F). Occupational differences in the village may develop into a caste system, resulting in segregated quarters of living in the village for different occupational groups (O => C). Obviously, Boserup presents this with the caveat that in real life, interventions from outside or resistant structures often prevent this process of adaptation. However, the representational technique is believed to be useful to compare micro studies with results from macro studies from other disciplines and to foster interdisciplinary understanding.

## 4.3 Land Use and Population Change on Bellona

Land use and population development on Bellona Island from 1966 to 2006 have been subject to a detailed exploration (cf. Birch-Thomsen et al. 2010; Christiansen 1975; Reenberg et al. 2008). A combination of on-site registration, aerial photos,

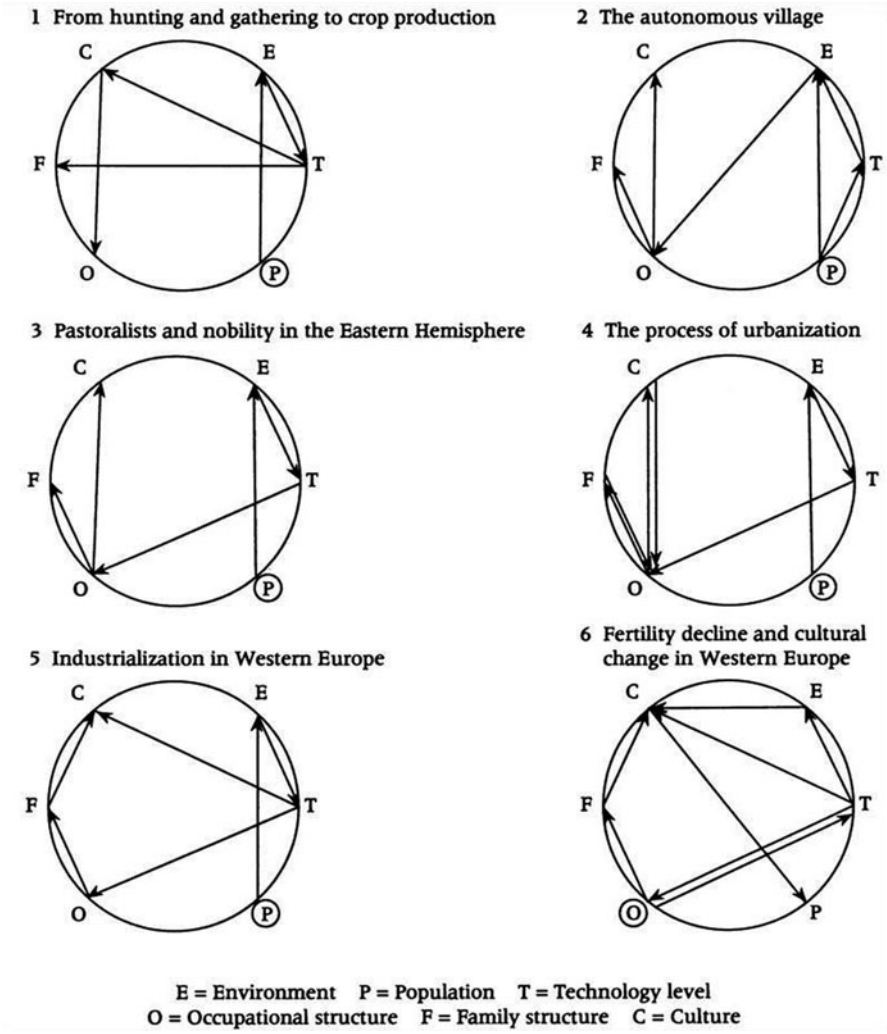



**Fig. 4.2** Analytical frameworks in selected models of the development process. The figure was originally presented in Boserup (1996, p. 510). It focuses on cases in which population change is accompanied by development. The six models should be seen as sequential, one beginning where the previous one ends, permitting population increase to continue because the structures are adaptable. (Source: Boserup 1996)

satellite images, household surveys and group interviews was employed to provide the needed insight into the dynamic development of Bellona's land use, population and livelihood system over the past 40 years. This information enables us to take a closer look at the co-evolution of population pressure and agricultural land use in the confined space of the island, which in Boserup's perspective would resample the "autonomous village" stage.

**Table 4.1** Population data 1966 and 2006, Bellona Island

| Population | 'De jure' | 'De facto' | Population density pers/km$^2$ (de facto)[c] |
|---|---|---|---|
| 1966[a] | 780 | 570 | ~35 |
| 2007[b] | 2,080 | 861 | ~53 |
| Population increase | 167 % | 51 % | |

[a] Christiansen, 1975
[b] CLIP census conducted on Bellona Island in January/February 2007
[c] Total area: 16.23 km$^2$

Two sets of remotely sensed data were used to construct the historic and contemporary land use maps and to analyse land use changes within the study area from the mid-1960s to 2006: aerial photography from August 1966 and a Quickbird satellite image from October 2006.

In-depth group interviews with senior key informants were used to identify main drivers of change from the mid-1960s to 2006 and specifically people's perception of these changes. The population data was carefully selected through a census conducted in January–March 2007 in which all household members were recorded in detail, enabling a differentiation between permanent inhabitants and absentees as a result of the dynamic pattern of permanent and temporary migration.

Below sections 4.3.1 and 4.3.2 present results related to development in population and land use. Whereas the last section (4.3.3) views the results through a theoretical lens.

### *4.3.1 Changing Population Pressure*

Christiansen's (1975) detailed study from the 1960s provides, together with the census conducted in 2007, a unique opportunity to trace the changes in population pressure on the island (Table 4.1). Obviously, two snapshots in time tell us little about the entire transition process but they do provide some indication of the gross direction of change. If the total (*de jure*) population is taken into account, the annual growth rate is 2.4 %, a figure which corresponds reasonably well with that reported by Bourke et al. (2006) for the RenBel Province between 1986 and 1999 (2.2 %). It also indicates that the population growth rate has not changed significantly from the estimates for the period 1938–66 (2.1 % estimated by Christiansen (1975)). However, if the population present on the island (*de facto*) only is taken into account, the annual growth rates for the periods 1938–66 and 1966–2007 are 0.9 and 1 % respectively. This differential is explained by the very high mobility of the population, in particular of the youths. In the 1950s people started seeking job opportunities away from the island, for example in plantations on Guadalcanal or elsewhere in the Solomon Islands. This pursuit of other livelihoods (including educational opportunities) off the island has increased in importance up till today.

Even with the relatively low annual growth rate in the de facto population on the island there has been a pronounced increase in the overall population density (Table 4.1), yet with significant local variation between the three administrative districts (ranging from 76 pers/km$^2$ in Sa'aiho District to 36 pers/km$^2$ in Matangi District).

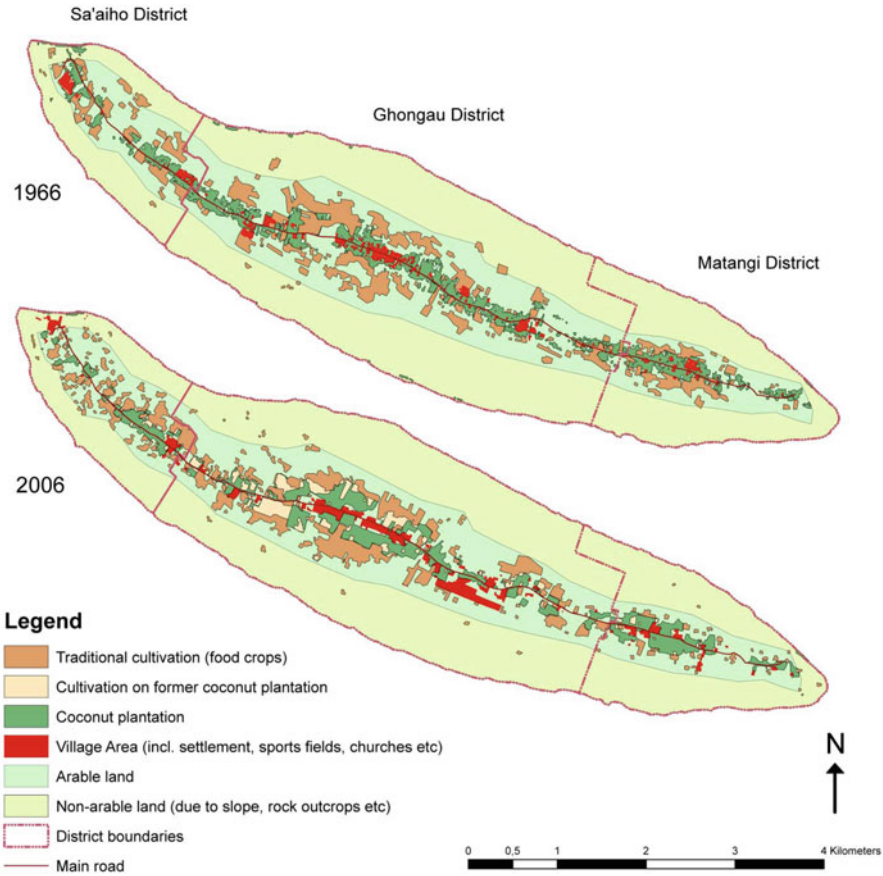



**Fig. 4.3** Comparing land use/cover classes on Bellona in 1966 and 2006, derived from contemporary aerial photographs and Christiansen (1975), and compiled from a Quickbird satellite image and ground truth observations. (Source: 1966, Aerial photographs and Christiansen 1975; 2006, Quickbird satellite image and ground truth observations Birch-Thomsen et al. 2010)

### *4.3.2 Land Use Dynamics*

In order to compare changes in land use between 1966 and 2006, Birch-Thomsen et al. (2010) have classified remotely sensed data into six distinguishable classes (Fig. 4.3). They are able to distinguish between four types of land use: (1) traditional cultivation (land identified to be within a cultivation cycle); (2) cultivation on former coconut plantations, where clearing or thinning of coconut palms has made room for food crop cultivation; (3) coconut plantations comprising dense clusters of coconut palms; and (4) the village area, including areas used for cultural (including sports) and religious activities (churches and burial grounds) and the airstrip. In addition, two classes are indicated: (5) the area suitable for cultivation (approximately 700 ha), estimated on the basis of the observed location of cultivation in both 1966 and 2006 as well as the general topography of the island); and (6) non-arable land, i.e. the rest of the island, covered with secondary and primary forest.

**Table 4.2** Changes in land use between 1966 and 2006

| Change in land use | | 1966 ($km^2$) | 2006 ($km^2$) | Change (%) |
|---|---|---|---|---|
| *Food crops ($km^2$)* | Traditional cultivation | 1.67 | 1.38 | 2 |
| | Cultivation on former coconut plantation | | 0.33 | |
| *Coconut plantation ($km^2$)* | | 1.23 | 1.07 | − 13 |
| *Total land cultivated ($km^2$)* | | 2.90 | 2.78 | − 4 |
| *Village area ($km^2$)* | | 0.19 | 0.39 | + 105 |
| *Food crop area (ha) per pers.* | | 0.29 | 0.20 | − 31 |

The land use history of Bellona from the late 1960s to the present day can be described in brief as follows. The agricultural land use in 1966 was dominated by garden-type food crop cultivation and dense plantations of coconut palms. The cultivation of food crops was, with few exceptions, dispersed/scattered within the zone of arable land, whereas coconut plantations were located close to the main east–west path on the island. The garden cultivation was dominated by vegetative propagated annuals laid or planted in small plots, which had been partly cleared after 3–15 years of fallow—though areas fallowed for longer than 5–6 years were already at this point in time reported to be increasingly rare (Christiansen 1975, p. 93). The traditional shifting cultivation system on Bellona depended on the use of intercropping or mixed cropping with a multitude of cultivated plants utilizing the different types of niches, yet gardens were often distinguished by the dominant plant (such as yam gardens, taro gardens, banana gardens or sweet potato gardens). Already in 1966 it was noted that the cultivation of sweet potato had become more common in response to the population increase as well as the expansion of coconut plantations, mainly because it can be grown after shorter fallow periods and it is less labour demanding than other food crops. The traditional shifting cultivation agriculture required a substantial labour input in its different phases, such as: clearing gardens (using bush knives and axes), burning the dried plant material, digging gardens using sticks to prepare the seedbed, planting by digging in the seed tubers, weeding two or three times (or more) and, finally, harvesting, which often takes place over an extended period of time in order to allow tubers to develop properly. Yam gardens were, however, seen as important in the mid-1960s, notably in terms of cultural identity, status and prestige (Christiansen 1975).

Coconut palms became important during the 1950s and these plots continued to grow in importance through the 1960s. The production, transport and marketing of copra were promoted by a cooperative society, mainly initiated by returning labourers from plantations elsewhere in the Solomons.

Given the extent of the population increase between 1966 and 2006, the corresponding change in land use, as indicated in Fig. 4.3, was surprisingly small (see Table 4.2). Despite a high degree of similarity, some overall changes can be noted. First, although the total land used for food production was basically constant, there was a decline of 29 ha under traditional cultivation. This land use class was still dispersed and mainly confined to the area of arable land, but there was a tendency for an increased number of small isolated plots within the area classified as non-arable

land. A new class—cultivation within former coconut plantations—constituted almost one fifth of the total area for food crop production in 2006. Second, there was a reduction in the area with coconut plantations. The production of copra for export continued until the mid-1980s when it was stopped, partly due to poor marketing prospects and partly because many palms were damaged by Cyclone Namu in 1986 (Reenberg et al. 2008). Third, the village area more than doubled. In addition to an increased number of homesteads, sports facilities (football and rugby fields and basketball courts) and an airstrip take up a considerable share of the arable land.

The traditional practice of shifting cultivation continued to be employed, yet yam and taro declined in importance whereas short fallow and permanent gardens with sweet potato gained prominence. The number of plots with previously very minor or new crops such as maize, cassava and watermelon also increased.

In addition to the land use data presented in Fig. 4.3– the two "snapshots in time"—we have tried to reconstruct the land use prior to and between them on the basis of interviews with senior members of the community (as illustrated in Fig. 4.4). Although little change was observed between 1966 and 2006, it is understood that the temporal variation in land use followed a change path along which the "coconut area" expanded at the cost of "food crop area" in the 1970–80s due to favourable prices at the market—followed by a decline in the 1990–2000s. The more recent cultivation of former coconut plantations indicates a further reduction of this class in the future.

The general trend in the importance of different types of crops corresponds well with reported changes in food preferences on the island (Reenberg et al. 2008). Of the traditional staples, less than half of the sampled households eat yam daily, only one third have taro daily or weekly, and one third never eat taro. In contrast, all households eat sweet potatoes either daily (79 %) or weekly (21 %). The changes in food preference are reflected in a concomitant reduction by almost one third in the food producing area per person living on the island between from 1966 and 2006.

Not only the temporal but also the spatial variations between districts are significant. In the case of Sa'aiho District (towards the north-west), very little or no change has occurred in the total amount of land under cultivation, whereas a reduction of close to a quarter has taken place in Matangi District (towards the south-east). While the area for food crop production in Sa'aiho increased by 12 % from 1966 to 2006, this was almost counterbalanced by the decreasing importance of coconut plantations—many households still rely on traditional food production (see Textbox 1). In contrast, in Matangi the food crop area was reduced by almost 60 % while that of coconut plantations increased slightly. There are three possible explanations for this variation. First, because Matangi District has had the lowest population increase and density, the demand for cropland has been lower. Second, unlike in other parts of the island, the majority of the land in Matangi belongs to a few families, of which one has had few sons for several generations; consequently, land has been concentrated in a few hands, allowing for a continued long fallow cycle. Third, as illustrated by a very low food crop area per person (0.08 ha) and the fact that only minor changes have occurred in the agricultural system, people in Matangi District are less dependent on agriculture for their livelihoods (see Textbox 2). The spatial variation in the observed land use trajectories are mainly explained through institutional factors, of

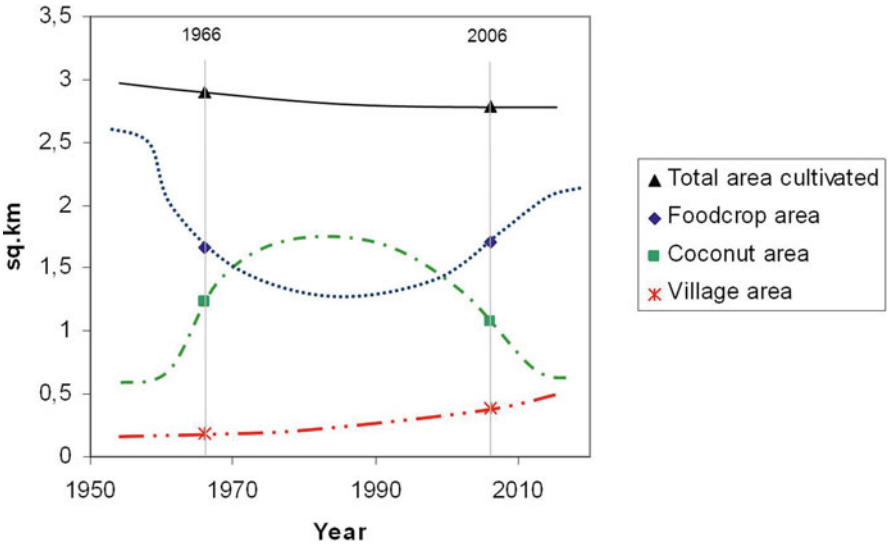



**Fig. 4.4** Hypothesized development in land use based on observations (1966 and 2006) and interviews with the Bellonese in 2006—"foodcrop area" includes both traditional cultivated area and cultivation of former coconut areas

which differences in access to land as well as access to the "new" alternative livelihood options (e.g. migration, seasonal mobility and remittances) play an important role.

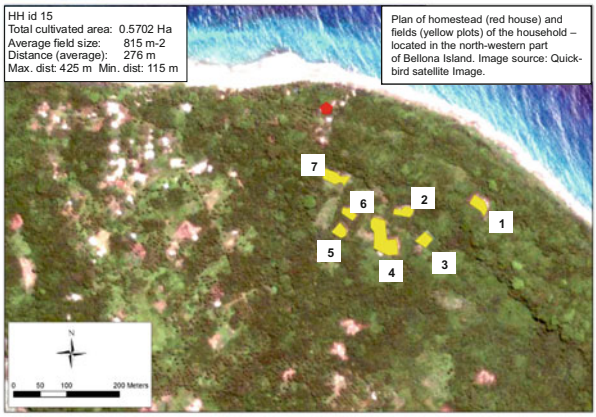
**Photo:** Household head and his eldest daughter. All family members live in the extended household (nine adults and eight children) – none have work outside the island.
Photo: CLIP Team

| Household id 15 | 'Red' symbol |
|---|---|
| Field 1 | Watermelon, maize, beans |
| Field 2 | Sweet Potato |
| Field 3 | Sweet Potato, banana |
| Field 4 | Sweet Potato, watermelon, yams, maize |
| Field 5 | Taro, banana |
| Field 6 | Yams, taro, banana |
| Field 7 | Cassava, sweet potato, papaya, banana, watermelon, yams, tomato |

**Household characteristics:**

The high degree of mixed cropping (see list, upper right-hand corner) shows that the household is highly reliant on subsistence agriculture. Traditional root crops are dominant (yams, taro and sweet potato); another dominant crop is banana. However, new crops like maize and watermelon has been introduced.

The household is living in Sa'aiho District where the population density is 76 pers./km$^2$ and food crop area per person is 0.19 hectares.




Textbox 1

| Household id 1 | Crops |
|---|---|
| House | |
| Field 1 | Banana, yams, taro |
| Field 2 | Maize, sweet potato |
| Field 3 | Taro, yams, beans, cabbage, banana |
| Field 4 | Cassava, sweet potato, cabbage, yams, taro, banana |
| Field 5 | Sweet Potato, maize, watermelon |

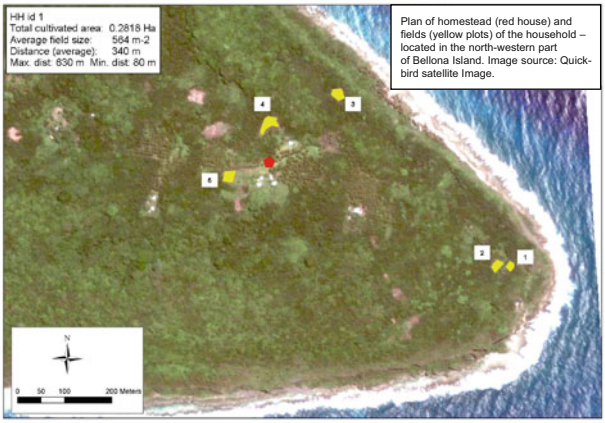
**Photo:** Household head and one of his sons, of whom four live away from the island: one at university in Fiji and three at school in Honiara. Seven members live on Bellona.
Photo: CLIP Team

**Household characteristics:**

As shown in the table (upper right corner) the household's cultivation practices are dominated by more recently introduced crops (maize, cassava, watermelon). Small areas are cultivated with traditional food crops. The area close to the house is dominated by coconut plantation and land use intensity seems low; large areas remain uncultivated.

The household relies on income generated through business in Honiara and the importation of food.

The household is living in Matangi District where the population density is 36 pers./km$^2$ and food crop area per person is 0.08 hectares




Plan of homestead (red house) and fields (yellow plots) of the household – located in the north-western part of Bellona Island. Image source: Quick-bird satellite Image.

Textbox 2

### *4.3.3 Land use change seen through a theoretical lens*

The "grand theories" of agricultural intensification anticipated that the outcome of the population increase would either be decreased productivity due to land shortage, with a possible future collapse of the system (Malthusian path), or increased productivity through intensified land use and innovations (the "Boserupian path"; Stone 2001).

Based on the above analysis it is clear that none of these "grand theories" can fully explain what has been experienced on Bellona Island—not at the "island scale" and even less so at the "household scale". Making use of the holistic understanding of livelihoods, and the assumption that people pursue a range of livelihood outcomes by drawing on a range of assets to pursue a variety of activities (Farrington et al. 1999) may help us understand the complexity and diversity in response to drivers of change. In their reflections on the development within livelihood research, de Haan and Zoomers (2005) advocate the analytical and methodological use of the concept "pathways" to describe patterns of livelihood among particular social groups. Several more general livelihood pathways may be identified on the basis of different access to and availability of assets for the household. One such pathway is shown in Fig. 4.5.

A common response among the Belonese to the increase in population with the given limited agricultural potential of the island has been, at an early stage, to relocate part of the family to the capital Honiara, thereby creating a "multi-locational"

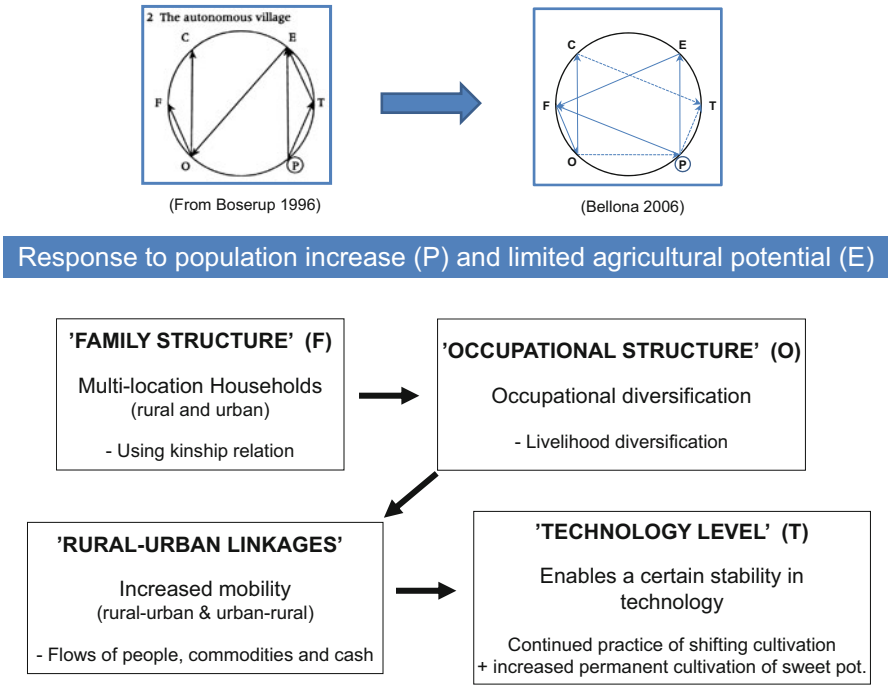



**Fig. 4.5** A possible livelihood pathway on Bellona Island; inspired by Boserup's model (1996) for an analytical framework

household, which can make use of kinship relations in both the "rural" (on the island) and the "urban" livelihood opportunities. This increases access to a variety of livelihood options, and eventually leads to occupational diversification. To sustain the large number of options both spheres (rural and urban) must be maintained through increased mobility of people, goods and money, which strengthen the rural-urban linkages. Through occupational diversification and rural-urban linkages it has been possible to find alternative support systems (through the market) to take the place of agriculture as the main food supplier and thereby to "conserve" the culturally important land use practices despite a more than 50 % increase in population between 1966 to 2006. Furthermore, it has made it possible to maintain the traditional agricultural "shifting cultivation" with no or very few technological changes. Thus, although the pathway of change observed on Bellona initially may have some overlap with Boserup's model of development in "the autonomous village" (see Fig. 4.5), it is clear that present day connectedness calls for more complex analytical frameworks in order to understand the coupled human-environment system. Recent attempts to include the increased global connectedness have been presented in various advancements of the conceptualization of land teleconnections (Haberl et al. 2009; Seto et al. 2012).

## 4.4 Conclusion

While the land use system on Bellona may be seen to examplify a "close to autonomous village situation" in the Boserupian heurisitc rhetoric because of its immediate appearance as a traditional shifting cultivation system, the island specific population-land use nexus and the classical Boserupean trajectory of intensification have been bypassed.

The apparent status quo situation of the land use strategies can be explained by the important cultural value embedded in the traditional agricultural practices. Overall, the area under cultivation in Bellona since 1966 has remained remarkably unchanged despite the significantly increasing population. The land use pattern has also remained fairly constant although a few new crops have emerged in "waves of change" (e.g. coconut palms making way for more permanent gardens of mainly sweet potato and/or watermelon). The production techniques as well as technology have remained unchanged as a traditional shifting cultivation system in the absence of affordable inputs such as agro-chemical fertilizer for more intensive practices, in spite of the fact that the population pressure has grown considerably.

Changes in economic and human resources in Bellona have, however, also made living conditions and food provision challenges very different, mainly as a result of income opportunities occurring from migration, remittances, aid and increasing bureaucracy. Faced with scarce land resources and opportunities found off the island, the Bellonese have under the new circumstances been able to generate alternative livelihoods to subsistence agriculture, for example, through the mobility of family members.

The value the Bellonese give to tradition and culture is another important part of the explanation of the land use stability. Many inhabitants consider traditional agriculture to be an important part of their daily life, beyond rational assessment criteria. Yam gardens are, for example, attributed great importance for cultural identity; they help maintain the social institutions that continue to provide an important social safety net (embedded in various collective labour relations and the sharing of harvests among kin). Alongside the seeming continuation or status quo of the land use pattern, a number of changes have occurred, some closely linked to human–land relations and others to changes in socioeconomic conditions. Notably, the food producing area per person in 2006 has decreased by one third compared to 1966. Apparently the influence of the "modern way of life", particularly on young migrants returning after completing their education or (un)successfully pursuing job opportunities has reduced the inclination for "hard work" in the traditional gardens among the younger generations. Within the last decade, eight new shops have opened on the island, functioning as storage depots for imported foodstuffs and other goods. This indicates that people do have money to spend and that the availability of "modern" food on the island has increased. The overall portfolio of livelihood strategies observed has become much more diversified.

Although our study has shown clear signs of the developments suggested by classic scholarship on the population–agricultural change nexus, it also illustrates how land use practices are closely linked to societal institutions and their ability to adapt to changing socioeconomic conditions. Despite the pressures on land resources

resulting from an increasing population, a high degree of continuity is evident in the traditional shifting cultivation system which, albeit decreased in extent, still plays an important cultural role for the identity of the Bellonese. The traditional cultivation system continues to be a significant component of the contemporary food provision, but as a supplement to the new portfolio of strategies, which supports the increasing number of people on the island.

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# Chapter 5
# Conceptual and Empirical Approaches to Mapping and Quantifying Land-Use Intensity

**Karlheinz Erb, Maria Niedertscheider, Jan Philipp Dietrich, Christoph Schmitz, Peter H. Verburg, Martin Rudbeck Jepsen and Helmut Haberl**

**Keywords** Global land-use · Land-use intensification · Colonization of ecosystems · Intensity indicators · GIS

## 5.1 Introduction

Land use is a pervasive driver of change in the earth system (Steffen et al. 2007; Turner et al. 2007). Today, the majority of the ice-free terrestrial surface has been affected in one way or another by human land use (McCloskey and Spalding 1989; Sanderson et al. 2002), and since the beginning of agriculture, more than one third

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of all pristine terrestrial ecosystems have been converted to human-controlled, permanently managed ecosystems with fundamentally altered ecological characteristics (Erb et al. 2007). By using the land, human societies alter structures and processes in ecosystems and thereby substantially affect global land cover, biodiversity, biogeochemical cycles of carbon, water, nitrogen, and many other patterns and processes, with far-reaching consequences for ecosystems and human well-being (Millennium Ecosystem Assessment 2005). Land use, on the one hand, provides the basis of nutrition, an array of resources and many essential ecosystem services to society. On the other hand, land use is increasingly jeopardising ecosystem functioning and thus threatens the biophysical basis of humanity. This fundamental trade-off related to land use leads to the emergence of an interdisciplinary research agenda, land-system science (Global Land Project 2005), which seeks to improve the observation of land changes as well as the understanding of these changes in a systemic context, including the interactions and feedback loops among social and natural systems (Turner et al. 2007).

Changes in land use encompass two different elements: changes in land cover, i.e., a shift from one land cover type to another such as the conversion of pristine forests to cropland, and changes in land-use intensity, also termed land-cover modification, i.e., a change in the intensity with which a certain land cover type is used (Lambin et al. 2001). Depending on the definition used, intensification denotes increases in inputs (e.g., energy, fertiliser or water) or increases in outputs per unit of land or changes in management practices (e.g., crop rotation, cropping intensity, or technology). Many negative environmental effects are associated with intensification processes, such as nutrient leaching, groundwater and air pollution, or soil degradation (IAASTD 2009; Matson et al. 1997), but environmental benefits exist as well, such as the possible benefits of reduced land demand, which sets land free for biodiversity conservation or carbon sequestration (see, e.g., Burney et al. 2010; Green et al. 2005). Empirical evidence suggests that yield increases in agriculture resulting from intensification were a major factor in the increase in global food production, in particular after World War II, helping to reduce the rate of land expansion in recent decades (FAOSTAT 2011), and this trend is forecast to prevail also over the next decades (Alexandratos 2006; Bruinsma 2003).

Changes in land-use intensity are crucial, but although their importance is widely acknowledged on a general level, they have in our view not received the attention that they deserve in mainstream land-change research over the last decades. The majority of current land-change studies focus on changes in land cover and the effects of such changes on processes such as climate change (Lambin et al. 2000, 2001). Huge progress in land-cover change research was enabled by the increasing availability of remote sensing-derived land-cover data. The soaring amount, resolution and quality of land-cover data have helped to gauge the importance of land-use change as a pervasive driver of global environmental change. This was decisive for establishing land-use change as an important research topic in environmental and sustainability science. Nevertheless, this focus on land-cover change distracted attention from land-use intensification and extensification processes because most changes associated with intensification are not related to changes in land cover and are thus not detectable

by remote sensing (Erb 2012; Erb et al. 2007; Verburg et al. 2011). To illustrate this by extremes: changes in the land system, e.g., from shifting cultivation to permanent agriculture, also change land cover. In contrast, the intensification of permanent agriculture may result in changes that are not detectable by remote sensing or that cause only minor (and thus negligible) land cover changes, if any, regardless of whether intensification refers to increased rates of inputs or increasing production.

Interestingly, this lack of attention is a modern phenomenon. In the mid-1960s, a strong interest in agricultural change and intensity emerged, in particular in the social sciences. The publication of Ester Boserup's book on the conditions of agricultural growth (Boserup 1965) and the rediscovery of the work of A. Chayanov (Chayanov 1986) represent milestones with this regard (Turner and Shajaat Ali 1996). In particular, Boserup's open polemic against Malthusian concepts of population growth and its relation with food production inspired many scholars to hypothesise and empirically analyse the interrelation of population pressure, technological change and land-use intensification (see, e.g., Allen 2001; Blaikie and Brookfield 1987; Grigg 1979; Pingali et al. 1987; Shriar 2000; Tiffen et al. 1994). However, much of this literature was based on a rather implicit understanding of land-use intensity that was not aimed at empirical testing of hypotheses or the development of rigorous metrics (see Lambin et al. 2000; Netting 1993; Shriar 2000). Only a few attempts at defining measurable indicators or metrics of land-use intensity have been made to date (see, e.g., Herzog et al. 2006; Keys and McConnell 2005; Ruthenberg 1980; Shriar 2000; Turner and Doolittle 1978).

The development of conceptually sound and empirically feasible metrics of land-use intensity is thus a precondition for advancing our understanding of past, on-going and future land-change processes, including the complex feedback loops among production and consumption systems (Erb 2012; Lambin and Meyfroidt 2011). Boserup's work on land-use intensity offers a conceptual framework that can serve as source of inspiration for land system science and is well suited to providing a starting ground for returning this aspect of land-use change to the agenda of land-change science.

In this chapter, we reflect on Boserup's notion of land-use intensification processes, review how her work on land-use intensification was used and further developed, and derive insights on conceptually sound measures of land-use intensity. Starting from this basis, we explore three promising approaches that have been suggested as measures of land-use intensity by providing a measure of reference against which output intensity (e.g., yield) can be measured. These three approaches are (a) the technical efficiency (TE) approach (Licker et al. 2010; Neumann et al. 2010; Verburg et al. 2000), (b) the $\tau$-factor measure of agricultural land-use intensity (Dietrich 2011; Dietrich et al. 2012) and (c) the indicator framework "human appropriation of net primary production" (HANPP) (Erb et al. 2009b; Haberl et al. 2007; Vitousek et al. 1986). Based on conceptual and empirical comparisons of these three approaches, we conclude by discussing future opportunities and challenges related to land-use intensity research.

## 5.2 Boserup's Notion of Land-Use Intensification

In her book *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (1965), Boserup outlines her notion of the interplay of population growth, land-use change and agricultural development. In this book, she develops a "historical model" (Brookfield 2001), scrutinising the relation between population growth and agricultural development related to the transition from shifting cultivation to permanent agriculture. Boserup describes the intensification of agriculture as the acceleration of the frequency of harvest events in (shifting) agriculture. She claims that for any given area, human societies move through a universal series of stages of increasing land-use intensity, driven by population growth. As long as population densities are low, only a limited fraction of the total area is cropped; after 1 or 2 years, the land is left idle to recover during several year-long periods of natural fallow. With increasing population density, the fraction of the area under crops increases, and the length of the fallow period is reduced, until the ecosystem changes from a forest mosaic to a shrub mosaic because the fallow time is not sufficient for the trees to grow back fully. In the next stage, shrubs are replaced by grasses. In the final stage, fallow disappears completely or is even replaced by multi-cropping. This increase of cropping intensity is associated with an increase in overall production per unit area and per year. In her original outline, Boserup discerns five archetypes of farming systems along an axis of cropping intensity, from slash and burn agriculture (forest fallow) through bush-fallow to permanent agriculture with multi-cropping (no fallow, more than one harvest per vegetation cycle or year). According to her description, increasing food demand resulting from population growth is the trigger for this development and provides the means to achieve higher yields through an increased workforce.

Although it is only a short book of approximately 100 pages and contains (almost) no figures, tables or graphs but has compelling persuasive power, Boserup's work triggered an avalanche of scientific reviews, critiques, affirmations, contentions, and pronouncements (e.g., Allen 2001; Grigg 1979; Hunt 2000; Robinson and Schutjer 1984; Shriar 2000; Turner and Shajaat Ali 1996). Boserup's basic assertion that agricultural change is a response to uncontainable population pressure forcing agrarian population to pay the price of decreasing labour productivity to achieve higher yields through changed technology was soon to become mainstream in the understanding of agricultural development (Turner and Fischer-Kowalski 2010; Chap. 1 of this publication). Her approach, driven by a fundamental opposition to the Malthusian notion of a "population trap", became a key concept relating agricultural expansion and population growth (Brookfield 2001; Lambin et al. 2000; Turner and Doolittle 1978; Turner et al. 1977). In particular, interdisciplinary research fields—cultural ecology, ecological anthropology, political ecology, and ecological economics, to name but a few—readily adopted Boserup's theories. Since then, many empirical studies have investigated the generalisability of this theory, but they have also formulated nuances and exceptions that allowed for a more robust understanding of land-use change processes (Lambin et al. 2001; Turner and Shajaat Ali 1996).

Boserup's motivation was to challenge the Malthusian belief that the slow, linear growth in yields acts as a "food ceiling" for the faster, exponential growth in population, leading to a "Malthusian trap" of stagnation or even a reduction of the standard of living. She and her followers largely succeeded in reversing this point of view, which had been prevalent at her time in most public discourse, arguing that increases in population act as drivers for adopting technologies and management strategies that increase production proportionally to population growth. According to this new paradigm, it is not the state of technology that determines the level of cropping intensity; instead, technology is envisaged as being endogenously driven by the increasing population pressures—hence, population density is determining land-use intensity. Boserup builds her perspective on the observation that many of the endogenous technological strategies are known to the community long before adoption but remain unemployed due to disadvantages in their application. According to her hypothesis, which was supported by evidence in later studies (Chayanov 1986, see Turner and Shajaat Ali 1996) but also vehemently opposed (see Hunt 2000), along with the technological changes and increased production comes a decline in labour productivity, i.e., the amount of output per working hour. Over the long run, this process transforms both the physical and social structures, which is the theme of her subsequent book *Population and Technological Change: A Study of Long-Term Trends* (Boserup 1981).

Boserup's model is reductionist, as it is based on only two primary forces driving change: population growth and the need to combat the loss of production through the natural deterioration of the soil. In particular, it largely neglects factors that are related to the industrial mode of subsistence, such as market forces, as well as the tremendous increases in labour productivity that are enabled by fossil fuel based technology, an area-independent energy carrier that removed many of the constraints of agrarian society (Erb et al. 2008; Fischer-Kowalski and Haberl 2007; McNeill 2001; Sieferle et al. 2006).[1] In this matter, Grigg (1979) also refers to land expansion as a factor that disproves Boserup's notion of agricultural intensification. However, land expansion without agricultural intensification is restricted to regional biophysical and geographical conditions. Thus, after a certain level of cropland extent is reached, Boserup's theory again holds true, and rising population density will be met by agricultural intensification. Boserup's basic argument, however, that the level of technology is not a determining factor of population density, remains valid, and her oeuvre can be considered a vivid illustration of the argument that there is no "natural carrying capacity" for societies in a particular region (Cohen 1995; VanWey et al. 2005).

[1] Boserup devotes Chap. 13 in the "Conditions of agricultural growth" (Boserup 1965) to this topic and concludes that transferring technology to societies without a fully industrialized urban sector will most likely not realize the full potential of technology due to the lack of skills among the farm workers (p. 120).

## 5.3 Measuring Land-Use Intensity

Metrics of land-use intensity usually describe either the input or the output side of land management. Different schools of thought value these two perspectives differently. Some writers emphasise the input side, as the intensification of agriculture usually involves an increase in the frequency of cultivation, in inputs, in skills or in other technological means. Boserup, by focussing on the frequency of cropping, shares this view. Her notion of cropping frequency as the best metric for land-use intensity is inspired by the observation that, under pre-industrial conditions, the annual crop yields of a parcel of land can be modified only slightly and that only an increased frequency of cropping (or, a higher share of land under direct cultivation; Boserup 1981, see Shriar 2000) allows an increase in production. Her assumption on the output-side remains implicit, however. She assumes only that production is increasing but does not elaborate on this aspect of intensification. Other authors even openly assert that the level of production is not relevant for the measurement of intensity. In such a view, only the input variables such as the workers' labour time, energy, capital, technique-skills, or the frequency of cultivation are relevant (Brookfield and Hart 1971, see Turner and Doolittle 1978).

This view is contested by many scholars, who propose output metrics for studying land-use intensification. In biophysical terms, output intensification relates to increases in production per unit area and period of time, e.g., tons of cereals per hectare and year, i.e., agricultural yield (Lambin et al. 2000). In these terms, output intensification has a reciprocal relation with area expansion. By definition, the amount of land required to produce a predefined amount of output is inversely correlated to yield (Burney et al. 2010; Netting 1993; Rudel 2009). Netting (1993) asserts that observing outputs has the advantage of making no presumption regarding the effect of inputs on productivity, a view shared by Shirar (2000), whereas Turner and Doolittle (1978) argue that output-indicators provide the better-suited metric because the ultimate purpose of many agricultural studies is to explain why yields have increased per unit land area and time, an argument also proposed by Hunt (2000).

Measuring outputs, however, is not straightforward (Hunt 2000; Shriar 2000). In addition to questions of data availability and robustness, there are also challenges related to the unit of measurement (e.g., dry matter, fresh weight, energy, nutritive value, or monetary value) and the methodology used to consistently measure output. Because many land-use systems periodically leave agricultural fields idle to maintain soil fertility (fallow), it is important to relate the output flow to the full production cycle to generate consistent values. Such data, however, are usually not readily available, although recent data compilations provide some new insights (FAOSTAT 2011; Shriar 2000; Siebert et al. 2010). Yields (usually measured as the fresh weight of commercial products) and their equivalents in terms of dry matter, energy or carbon content or nutritive value are highly species-specific, which does not facilitate producing a single metric of land-use intensity. Furthermore, substantial variations in agricultural and forestry yields result from differences in climate and soil conditions. In principle, the actual yield may be relatively high with relatively low input

intensity in areas where local conditions are favourable for crop growth. In areas with unfavourable conditions for crop growth, the yield may be relatively low, despite relatively efficient land management practices. Measuring land-use intensity, however, requires the exclusion of influences caused by the physical environment, such as differences in soil or climate conditions. Therefore, yield data alone cannot serve as indicators of output intensity.

Measuring output intensification thus requires the establishment of an unambiguous and meaningful measure of reference (see, e.g., Hunt 2000). In the literature, three output-based concepts are available that allow to create global, spatially explicit information regarding land-use intensity. These concepts differ in their conceptualisation, the construction of a measure of reference, and their precise meaning as well as their field of application: (a) the technological efficiency (TE) approach (Licker et al. 2010; Neumann et al. 2010; Verburg et al. 2000), an approach that compares actually achieved yields of cropland cultivars with the maximum yield level achieved at locations subject to similar bioclimatic conditions; (b) The τ-factor (tau-factor) measure of agricultural land-use intensity (Dietrich 2011, Dietrich et al. 2012), which applies a dynamic vegetation model for constructing a reference yield value by standardising management effects on cropland and comparing this value with actual yields; and (c) the human-appropriation-of-net-primary-production (HANPP) (Erb et al. 2009b; Haberl et al. 2001, 2004, 2007), an indicator that assesses the effect of land conversion and biomass harvest on ecological energy flows, using the potential NPP (prevailing hypothetically in the absence of land use) as a measure of reference.

### *5.3.1 The Technical Efficiency Approach*

Metrics for the efficiency of agricultural production are used in various studies as indicators of the intensity of land use (Neumann et al. 2010; Tian and Wan 2000; Verburg et al. 2000). This approach originates from economics, where metrics of TE (i.e., the effectiveness with which a given set of inputs is used to produce a certain quantity of outputs) were developed for calculating the efficiencies of firms or other economic units (Coelli 2005). Because agricultural farms are a special form of economic unit, this econometric methodology can also be used to calculate farm efficiencies, and in particular, the efficiency of agricultural production. In spatial analysis across larger scales, the agricultural production within one spatial unit (e.g., a 5 arc min resolution pixel) is considered as one uniform economic unit. The TE metric is then calculated by comparing actual yields with the yields derived from a stochastic frontier production function, which represent the maximum yield given environmental conditions and available technologies (Neumann et al. 2010). Deviations from the frontier function can be caused either by inefficiency of production or by statistical noise (e.g., due to data inaccuracies). Figure 5.1 displays a schematic illustration of the TE concept. Inefficiency of production is interpreted as a measure of the intensity of land management, assuming that the maximum yields obtained under given environmental conditions represent the most intensive (in economics labelled “optimal”) management.

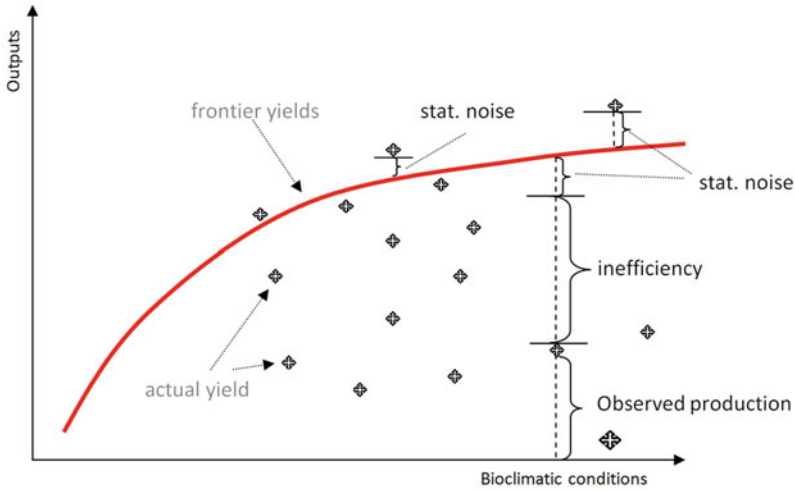


**Fig. 5.1** Schematic representation of the TE approach. The stochastic production frontier (after Coelli 2005; *red solid line*) is based on the highest observed outputs under the inputs accounting for random noise. Efficiency is defined as the ratio of actual yields to frontier yields. The frontier production can lie above or below the frontier production function, depending on the noise effect (data uncertainty)

Neumann et al. (2010) calculated frontier yields and efficiencies of wheat, maize and rice at a global scale, using the following formula and data:

$$ln(q_i) = \beta_0 + \beta_1\, ln(temp_i) + \beta_2\, ln(precip_i) + \beta_3\, ln(par_i) + \beta_4\, ln(soil\_constr_i) + v_i - u_i \tag{5.1}$$

where $q_i$ is the actual grain yield (from Monfreda et al. 2008), $temp_i$ is the deviation from the optimal monthly mean temperature, $precip_i$ is the precipitation, $par_i$ is the photosynthetically active radiation, $soil\_constr_i$ are soil fertility constraints (all of these bioclimatic variables are taken from available global datasets) (see Neumann et al. 2010), $v_i$ is a random error (accounting for the statistical noise) and $u_i$ accounts for the inefficiency effects of production. In the study of Neumann et al. (2010), this latter term is described as a function of irrigation, slope, agricultural population (used as a proxy for labour availability), market accessibility and market influence from various spatially explicit data sources (see Neumann et al. 2010). Licker et al. (2010) used a similar method based on comparing actual yields with the highest obtained yield to calculate the yield gap in different climate zones based on information on the growing degree days and a crop soil moisture index; they achieved similar results to those of Neumann et al. (2010). In a study in China, Verburg et al. (2000) used the TE approach to also study the inefficiency in land use by comparing the actual cropping index (number of crops per year) with the frontier cropping index under the local climatic conditions.

Using efficiency, measured as the ratio between actual yields to maximum achieved yields under comparable conditions, as a proxy for the intensity of land management allows the consideration of variations in biophysical conditions as determinants of the potential yields. The frontier yield represents the currently highest yield under the local environmental conditions. If the best available technology changes, the frontier yield will change as well, i.e., it will generally increase. This increase automatically affects the distance to the frontier yield of non-adopting farms. Thus, the reference value subsumes the current technology level—this is important to note when interpreting the TE as a proxy for agricultural intensity and is one of the reasons that there has been some criticism on the suitability of the indicator for that purpose (Dietrich et al. 2012). The difference between the frontier yield and the actual yield has been interpreted as the "yield gap" at a location, assuming that more efficient management could change the actual yield to the frontier yield.

### *5.3.2 The τ-Factor*

Another yield-based approach is the τ-factor (Dietrich 2011; Dietrich et al. 2012). Although it requires similar inputs to those of the TE approach, it was developed as a direct measure of agricultural land-use intensity. The τ-factor is based on the idea that yield can be considered an indicator of agricultural land-use intensity that is affected by variations in environmental conditions. When two locations with identical environmental conditions growing the same crop are compared, any difference in yield can be attributed to the differences in agricultural land-use intensity in these two locations. If environmental conditions differ, however, the differences in land-use intensity are superimposed by variations in environmental conditions. The τ-factor approach tackles this problem by comparing observed agricultural yields with a reference yield that would be achieved at each site with the same level of input intensity. This reference yield is constructed to ensure that only the differences in environmental conditions are reflected by setting land-use intensity to a constant level. The τ-factor can then be defined as the ratio of actual yield to reference yield. Variability of the τ-factor can thus legitimately be assumed to be solely caused by differences in agricultural land-use intensity, whereas the variations in the reference value can be assumed to be purely environmentally determined.

Dietrich et al. (2012) calculate and map the τ-factor at the global scale by using the "Lund-Potsdam-Jena dynamic global vegetation model with managed land" (LPJmL) (Bondeau et al. 2007). Actual yields are based on the national yield data of the Food and Agriculture Organization of the United Nations (FAO) (FAOSTAT 2011), downscaled by the LPJmL. Reference yields are computed by simulating spatial patterns of crop yields under constant management practices (all management-dependent parameters in the model are set to a constant level). The results of this analysis are shown in Fig. 5.2. The FAO data used by Dietrich et al. (2012) contains only information on harvest yields (yield per area for each harvest event) but not the yields per unit area under land use (land-use yields), which causes changes in cropping

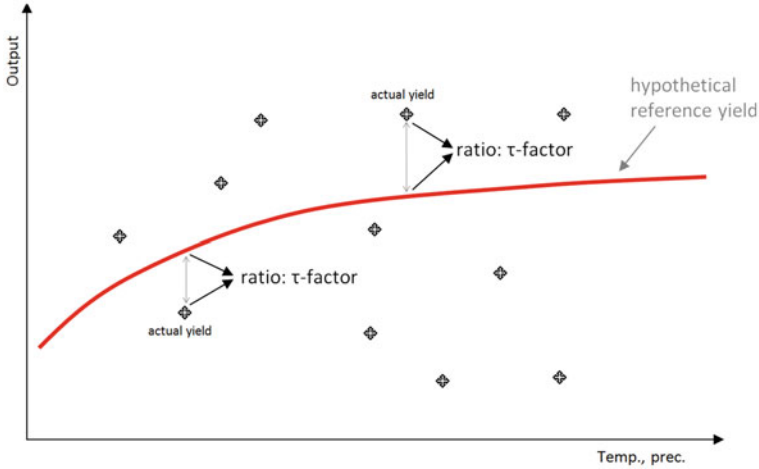


**Fig. 5.2** Schematic representation of the τ-factor approach. The hypothetical yield (*solid red line*) is constructed by setting all management-dependent parameters in the global dynamic vegetation model to a constant level. The τ-factor is the ratio of the actually achieved yield to the reference yield

intensity (the intensity indicator suggested by Boserup) to be undetectable. This is a limitation of this specific calculation rather than a characteristic of the general methodology and can be overcome by using data regarding land-use yields instead of harvest yields. Such data, however, are not readily available at the global level for individual crops (Portmann et al. 2010). Likewise, in its current implementation, the τ-factor is calculated for cropland, but it could be conceptually extended to any land-use class for which a yield can be determined, such as grazing or forestry. For land-use classes such as infrastructure, the τ-factor cannot be derived.

The τ-factor has been used to implement technological change in an economic land-use model (Dietrich 2011). This improved model was applied in several studies related to questions of future agricultural land use (Popp et al. 2011; Schmitz et al. 2012).

### *5.3.3 Human Appropriation of Net Primary Production*

The "human appropriation of net primary production" (HANPP) is an integrated socio-ecological accounting framework that uses a reference value determined only by natural conditions: the productivity of the potential natural vegetation, i.e., the vegetation assumed to exist in the absence of land use. In the HANPP framework, "productivity" is operationalised as net primary production, i.e., the carbon accumulated by green plants through photosynthesis, less the metabolic needs of the plant. HANPP measures changes in trophic energy flows in ecosystems resulting

from all types of land use (infrastructure, cropland, grazing, and forestry) and can as such be regarded as an aggregate indicator of land-use intensity (Erb 2012; Erb et al. 2009b; Haberl et al. 2001, 2007). HANPP encompasses all land-use classes, including cropping (annual and permanent), grazing, forestry and infrastructure, in contrast to the two above-discussed concepts, which only refer to agriculture in their current implementations.

HANPP is defined as the sum of (a) the changes in productivity resulting from land conversion ($\Delta NPP_{LC}$) and (b) the biomass harvested or destroyed during harvest ($NPP_h$; see, e.g., Erb et al. 2009b; Haberl et al. 2007). $\Delta NPP_{LC}$ may result from the replacement of natural vegetation with artificial ecosystems such as settlements, industrial areas, infrastructure or other impervious surfaces. In agro-ecosystems, NPP is also directly influenced by management activities such as irrigation and fertilisation. Hence, the NPP of agro-ecosystems often differs from the NPP of the natural ecosystems they replace. By extracting biomass from ecosystems for socioeconomic purposes, humans alter the amount of NPP remaining in ecosystems. The total amount of biomass harvested or destroyed (e.g., through human-induced fires) is denoted as $NPP_h$. $NPP_h$ is calculated on the basis of a combination of national yield data with factors that allow for the accounting by-products, destroyed biomass fractions and pre-harvest NPP losses (for details see Haberl et al. 2007; Krausmann et al. 2008), and $NPP_h$ is downscaled to the grid level based on a probability index derived from the $NPP_0$ pattern of the LPJ-DGVM (Bondeau et al. 2007; Gerten et al. 2004; Sitch et al. 2003) Only the biomass remaining in the ecosystem after harvest ($NPP_t$) is available for carbon sequestration or as a food energy source for wild-living heterotrophic organisms. HANPP and its components are measured in the same units as NPP, that is, as flows of dry-matter biomass, carbon or energy.

HANPP accounts can provide spatially explicit information in an overall representation of one central aspect of land-use intensity, i.e., changes in trophic energy flows in ecosystems resulting from land use. The definition presented above (Fig. 5.3) allows for consistent long-term assessments using HANPP (Krausmann et al. 2012) and for spatially explicit HANPP assessments, e.g., Haberl et al. (2001, 2007). Land use sometimes reduces NPP or even prevents it altogether (e.g., soil sealing), but technologies such as irrigation, fertilisation or the use of improved crop varieties may also raise NPP above its natural potential. Such effects are significant and historically variable and should therefore be included in any comprehensive HANPP assessment.

However, HANPP has some weaknesses in determining land-use intensification due to technological improvements on cropland because technological improvements typically result in parallel increases in plant growth (NPPact) and harvest growth (NPPh). In consequence, the HANPP value remains unaltered (Krausmann et al. 2012). Conceptually, separately monitoring the two primary components of HANPP (NPPh and ΔNPPLC) allows the effects of improved technologies to be discerned because the increases of productivity then become visible as increasing NPPh and declining ΔNPPLC. In the current implementation, in which NPPh denotes the entire biomass harvested or killed during harvest (Erb et al. 2009b; Haberl et al. 2007), any yield increased due to NPPact neutral shifts in the harvest index (the fraction of the main product, e.g., grain, to the total plant, including straw; see

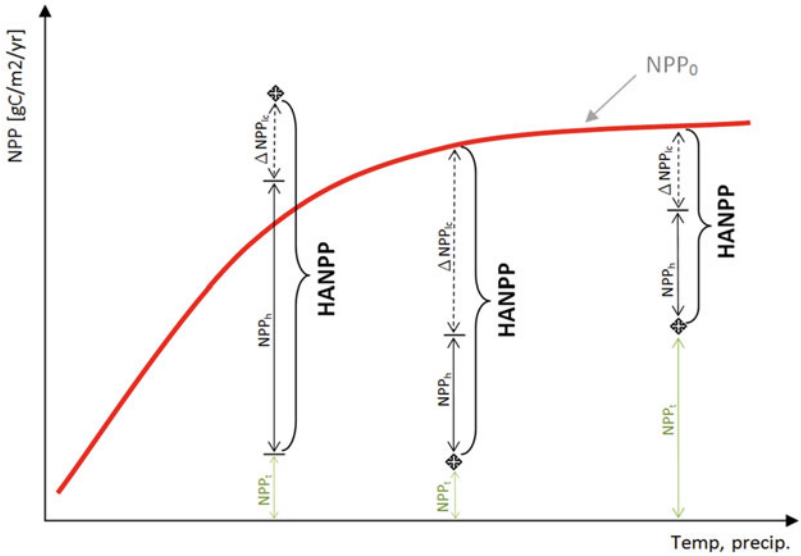


**Fig. 5.3** Schematic representation of the HANPP approach. The HANPP can be defined as (1) the sum of productivity changes induced by land use (ΔNPPLC) and biomass harvest (NPPh) and (2) the difference between the NPP of potential natural vegetation (NPP0) and the fraction of current NPP (NPPact) that remains in the ecosystem after harvest (NPPt). Please note that current NPP (the sum of NPPt and NPPh) can exceed NPP0 due to management (*left* example). For details, see text

Krausmann 2001) cannot be identified. However, as the HANPP frameworks assesses all biomass components separately (Krausmann et al. 2008), such effects would potentially become visible with modified aggregation schemes.

The basis of HANPP calculations is the quantification of the potential ecological energy flow ($NPP_0$). In contrast to the NPP of the currently prevailing vegetation ($NPP_{act}$), which can be quantified using many different methods (Lieth and Whittaker 1975; Roy et al. 2001), $NPP_0$ cannot simply be "measured", as it is a hypothetical point of reference in most regions of the globe. However, numerous models, including so-called Dynamic Global Vegetation Models (DGVMs), are available to calculate $NPP_0$ on a global level (Cramer et al. 1999; Roy et al. 2001) and on regional levels. These models provide spatially explicit information regarding many ecosystem parameters and are built upon basic ecological information from site-specific research (for a compilation of NPP data for forest ecosystems, see, e.g., Cannell 1982) that allows the reconstruction of $NPP_0$. Simpler approaches are available based on empirical algorithms of the interrelation among NPP, mean annual temperature and precipitation (e.g., Lieth's "Miami model"; Lieth 1973; Zaks et al. 2007; see Fig. 5.3). These approaches build upon the finding that the most decisive factors influencing NPP in the absence of human activities are climate (above all, temperature and precipitation) and soil quality. Species composition, for example, plays a much smaller role.

### *5.3.4 Global Patterns of Land-Use Intensity Derived Using the Three Approaches*

Figure 5.4 shows maps of land-use intensity derived using the three above-presented approaches. The maps were drawn based on existing datasets, which were Neumann et al. (2010) in the case of TE, Dietrich et al. (2012) in the case of the τ-factor and Haberl et al. (2007) in the case of HANPP. The TE map (a) displays the efficiency of the most dominant crop type (wheat, rice and maize) in each grid cell. The aggregated τ-factor (b) was calculated as the mean τ-factor for all crops occurring in one grid cell. The HANPP map displays the aggregated values of all land-use classes occurring in a grid cell.

## 5.4 Comparison of the Three Approaches

### *5.4.1 Conceptual Differences*

In this section, we discuss the convergences and discrepancies between the TE approach, the τ-factor and HANPP expressed as per cent of $NPP_0$. Each indicator tells its own story of land-use intensity—the objective of this comparison is to illuminate the issue of the intricacies of measuring land-use intensity.

Table 5.1 and Figs. 5.1, 5.2 and 5.3 give an overview of the conceptual features of the three approaches. All of the indicators are applicable on regional as well as global scales in a spatially explicit manner. However, they show considerable variations in scope: whereas the TE, in its current implementation by Neumann et al. (2010), focuses on the cultivation of selected cereals (maize, wheat and rice), the τ-factor, as implemented by Dietrich et al. (2012), considers a huge variety of cropland products (grouped into 11 crop groups). HANPP encompasses the entire land-use system and is calculated for cropland, grazing land, forest land, and settlement areas (Erb et al. 2009b; Haberl et al. 2007; Vitousek et al. 1986).

The three frameworks differ considerably in how the reference line is constructed, which results in substantial differences in the aspects of the land-use system that are considered. This is important to note when interpreting the results. The TE approach is based on the "frontier yields" (Fig. 5.1), defined as the highest currently achieved yield under the growing conditions of the location studied. Land-use intensity is measured as the ratio of actual yields to frontier yields, i.e., as the deviation of actual yields from the highest currently technologically achievable yields. Low TE (near zero) indicates that the land in a certain region is managed inefficiently; in this case, one may assume that there is a high potential for further yield increases. The τ-factor and HANPP relate observed yield data and data on biomass appropriation to simulated reference lines, calculated by dynamic global vegetation models (Bondeau et al. 2007). The τ-factor refers to modelled hypothetical yields of the same crop (reference yields: under constant land management), whereas HANPP uses natural

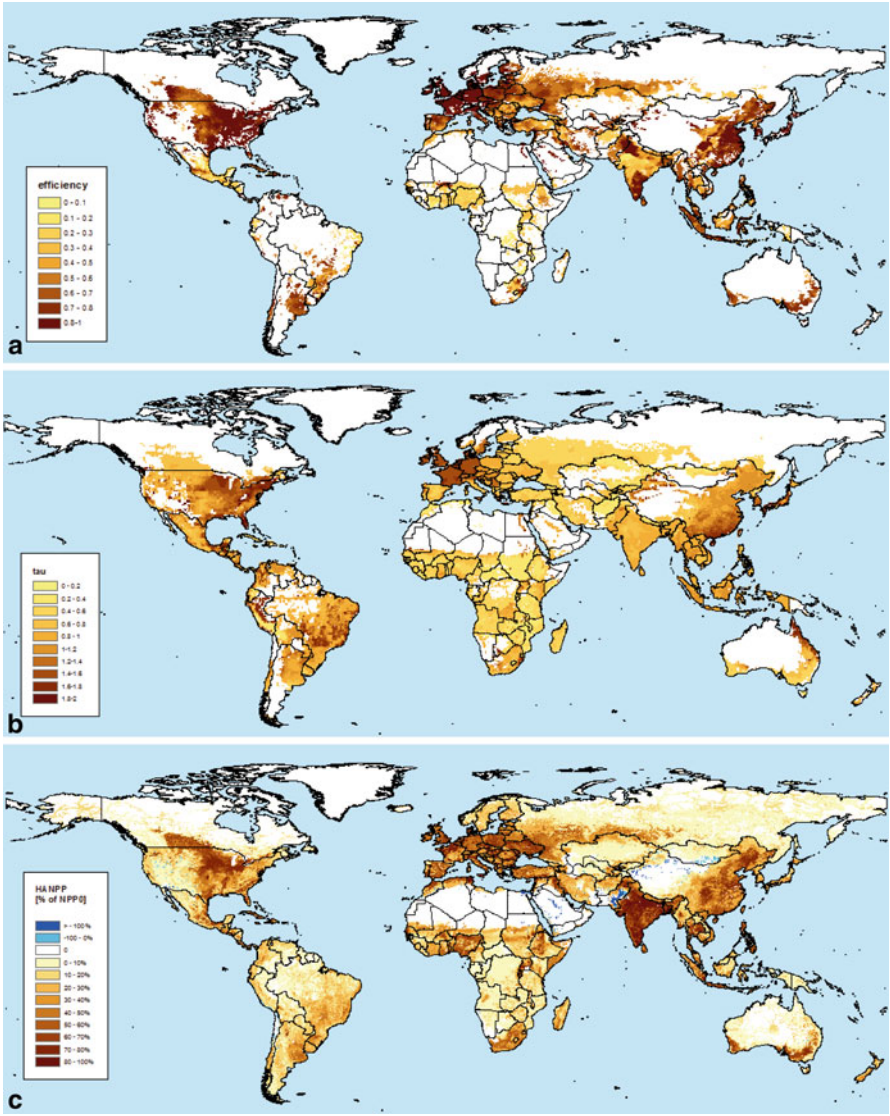


**Fig. 5.4** Aggregated land-use intensity maps based on **a** global TE, **b** the τ-factor, and **c** HANPP. For details see text. (Sources: Based on the following datasets: a: Neumann et al. 2010, b: Dietrich et al. 2012, c: Haberl et al. 2007 (HANPP))

ecosystem conditions ($NPP_0$) as a reference. The τ-factor, calculated as the ratio between actual yields and reference yields, can range from zero to greater than one. For example, a factor of two would indicate that current yields are twice as high as the reference yields. $NPP_0$, the reference for HANPP assessments, denotes the productivity of natural ecosystems (i.e., the ecosystems that would prevail without

**Table 5.1** Comparison of the global TE, the τ-factor and HANPP approaches

| | Technological efficiency | τ factor | HANPP |
|---|---|---|---|
| *Conceptual aspects* | | | |
| 1 *Land-use intensity measure* | Integrates outputs and inputs | Outputs | Integrates outputs and alterations in the natural system |
| 2 *Reference line* | Frontier yield (locally highest achievable yield) | Reference yield (hypothetical yield under constant land management) | Potential (=hypothetically without land use) productivity ($NPP_0$) |
| 3 *Land-use intensity measured as* | Observed yield/frontier yield | Observed yield/reference yield | HANPP $(\Delta NPP_{LC} + NPP_h)/NPP_0$ |
| 4 *Unit of measurement* | Dimensionless (% of frontier yield) | Dimensionless (% of reference yield) | Dimensionless (% of $NPP_0$) |
| 5 *Ranges from* | 0–100 % | 0–∞ | < 0 % to > 100 % of $NPP_0$, Negative in case of strong NPP increases, exceeds 100 % if stocks are depleted |
| 6 *Scale* | Global and regional | Global and regional | Global and regional |
| 7 *Scope* | Cropland (maize, rice and wheat)* | Cropland (14 crops)[a] | Cropland, forest land, grazing land, infrastructure area |
| 8 *Crop specific analyses* | Possible | Possible | Not possible[a] |
| 9 *Yield* | Harvest yield* | Harvest yield[a] | Land-use yield[a] |
| 10 *Data sources* | Global empirical datasets[a] | DGVM-derived reference and actual yields (the latter reconciled with national data)[a] | Global empirical datasets, DGVM-derived data on $NPP_0^a$ |
| *Technological and environmental dynamics related to cropland* | | | |
| a) *Yield increase due to increased plant productivity (e.g. more fertilizer)* | TE depending on applied technologies (see c, d, e) | τ increases | HANPP constant or decreasing |
| b) *Yield increases due to changes in harvest index (larger corn/straw ratio due to plant breeding), same plant productivity* | TE depending on applied technologies (see c, d, e) | τ increases | HANPP increases |
| c) *Yield increases based on existing technologies* | TE increases | τ increases | HANPP behavior depending on effect (see a, b) |

**Table 5.1** (continued)

| | Technological efficiency | τ factor | HANPP |
|---|---|---|---|
| d) *Yield increases based on the introduction of new technologies (adopting farms)* | New frontier yield, TE depends on implementation | τ increases | HANPP behavior depending on effect (see a, b) |
| e) *Constant yields, but availability of new technologies (non-adopting farms)* | TE decreases due to new frontier yield | τ constant | HANPP constant |
| f) *Increased cropping Index* | No change[a] | No change[a] | HANPP Increases |
| g) *Altered bioclimatic conditions* | No change | No change | No change |
| h) *Yield decreases due to soil degradation* | Decreases | τ decreases | HANPP increases<br>harvest/HANPP decreases<br>NPP loss/HANPP increases |

[a] Not conceptually, but in its current implementation by Neumann et al. 2010 (TE), Dietrich et al. 2012 (τ-factor) and Haberl et al. 2007 (HANPP)

human land use), and HANPP can range from negative values below −200 % of $NPP_0$, in cases where actual productivity surpasses $NPP_0$, up to 100 % of $NPP_0$ in regions with very intensive cropland agriculture. When biomass stocks (i.e., accumulated NPP) are exploited to an extent that exceeds the accumulation time (stock depletion, e.g., deforestation), HANPP can exceed 100 % (Erb et al. 2009b).

The τ-factor uses output (yield) alone as a measure of land-use intensity. HANPP accounts combine information on outputs (harvest) with alterations of the natural state, i.e., of the natural productivity of each site, and TE combines information regarding outputs with inputs, analysing factors that influence the inefficient use of production factors. All indicators are dimensionless, with TE ranging between 0 and 100 % and τ having any value > 0. HANPP, in contrast, can become negative or exceed 100 % (see above); however, in most cases, HANPP ranges between 0 and 100 %.

Table 5.1 also lists the response of the three indicator frameworks to altered technological and environmental dynamics related to the cropland system. All three indicators remove the effect of climatic and soil conditions on yield and thus render differences in land management visible. Increases of cropland yields due to increased plant productivity, e.g., through increased use of fertilisers, pesticides, or irrigation, are depicted by both TE and τ. HANPP, in contrast, does not depict this important aspect of land-use intensification. If the increases in yield stem from increases in NPP compared with the previous state, two counteracting effects can be observed: $\Delta NPP_{LC}$ decreases, and $NPP_h$ increases. If the increase in $NPP_{act}$ is greater than the increase in harvest ($NPP_h$), HANPP may even decline as $NPP_h$ grows.

In contrast, among the compared implementations of the different approaches, HANPP has two advantages: (1) it is an indicator of overall land-use intensity that encompasses all land-use classes and is not restricted to cropland or single crops, and (2) on cropland, HANPP is able to detect changes in cropping intensity, that is, in the number of harvests per year. Cropping intensity may be lower than one (fallow) or higher than one (multi-cropping). This aspect of land-use intensity was central to Boserup's definition of land-use intensity. Declining fallow land over time results in increasing HANPP values. The TE and the τ-factor, in their current implementation, however, explicitly focus on harvest yields (i.e., the yields per harvest event); they do not consider the fraction of land lying fallow. However, this difference among HANPP, TE and the τ-factor is only a matter of the current implementation and not a conceptual shortcoming. TE and the τ-factor could also be calculated based on land-use yields (i.e., yields per unit of cropland area including fallow), which would allow the proportion of fallow land to be included in the measurement of land-use intensity. This inclusion would not be straightforward and simple, due to data limitations and conceptual intricacies. TE and the τ-factor are defined for single crops, whereas fallow land is an integral part of crop rotation systems; hence, its integration would require assigning fallow areas consistently to single crops.

The use of advanced crop varieties to increase production, for example, by increasing harvest indices (the ratio of commercial harvest, e.g., grain, to the total crop plant biomass at the time of harvest) can be depicted with the τ-factor as well as with the HANPP concept, even in cases when the overall plant productivity (NPP)

is not altered. In the case of TE, such changes result in complex outcomes. On non-adopting farms, TE is decreased, as this change alters the position of the frontier value (such as any technological change would do). On adopting farms, in contrast, the increased harvest index (HI) would be cancelled out in the TE calculation.

The significance of different reference values becomes particularly apparent in a scenario with increasing yields that result from newly available technologies within a region. As frontier yields in the TE approach are technology-dependent, an innovation would increase the frontier yields. Concurrently, TE on farm units that do not adopt technological change would decrease, indicating a reduction in intensity despite the inputs and outputs of these areas remaining constant. This is a caveat when interpreting TE directly as an indicator of land-use intensity. In contrast, TE is a powerful indicator that can help detecting technology-dependent potentials for closing yield gaps. HANPP reacts differently to technology-driven yield increases, depending on whether such increases are achieved by increasing biomass production, $NPP_{act}$, or decreasing the biomass that remains in the ecosystem, $NPP_t$. Although HANPP does not change in the first case, it increases in the second case (as indicated previously, it would be possible to render this visible in the HANPP framework, but it would require separate analysis of the individual HANPP components). The τ-factor "translates" technology-driven yield increases into increases of their respective indicators.

### *5.4.2 Spatial Patterns of Land-Use Intensity*

Comparing the spatially explicit results of the different approaches is intricate because the differences shown in the global maps (Fig. 5.4) depend not only on the differences in concept and scope but also on data uncertainties (e.g., due to differences in input data or conversion factors). This makes it difficult to separate this noise from the signal. In principle, data regarding agricultural yield are similar for all three approaches. However, for the inter-comparisons of the spatial patterns, not only the datasets per se but also the downscaling techniques play an important role. TE, as calculated by Neumann et al. (2010), for example, uses the census statistic-derived dataset published by Monfreda et al. (2008), available at a 5-min geographic resolution (ca. $10 \times 10$ km at the equator). In contrast, the τ calculation by Dietrich et al. (2012) uses the internal allocation rules of the vegetation model to downscale national harvest yields from FAO to a resolution of 0.5°. The HANPP map not only uses a different allocation technique based on the pattern of $NPP_0$ but also refers to land-use yields rather than harvest yields, as discussed above.

Moreover, TE and the τ-factor were originally developed for crop-specific analyses of land-use intensity (Dietrich et al. 2012; Neumann et al. 2010). Therefore, for the purpose of this study, the results had to be aggregated to display one intensity value per grid cell (see caption of Fig. 5.4). All of these aspects are important for interpreting the spatial patterns and differences. The map in Fig. 5.5 locates the areas of agreement and disagreement of the three approaches: TE, τ and HANPP.

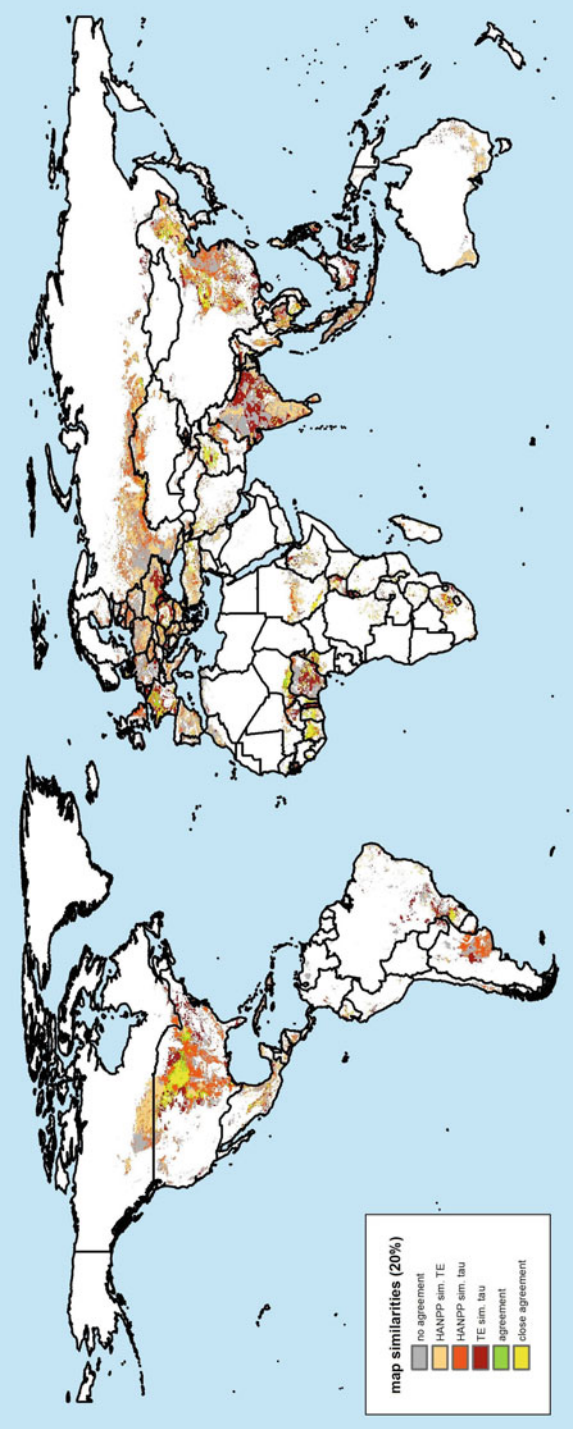


**Fig. 5.5** Comparison of the spatial patterns of TE, τ and HANPP (cropland only): similarity is defined as a difference of less than ± 10 %-points. HANPP sim. TE: HANPP and TE are similar; tau is outside the range; HANPP sim, tau: HANPP and tau are similar; TE is outside the range; TE sim. tau: TE and tau are similar; HANPP is outside this range; agreement: two are similar, all are within ± 20 %-points difference; close agreement: all values are within ± 10 %-points

To discuss the differences in spatial patterns of the respective implementations of the three different approaches, we created an aggregated similarity map, which detects repeating patterns among the indicators (Fig. 5.5). Some adjustments were required for a consistent comparison. All of the values in the three maps were re-scaled to range between zero and one, to allow for consistent intercomparison. Additionally, negative HANPP values were not considered. The final map is restricted to the pixels contained in the TE map, which only covers the cultivation areas of maize, rice or wheat. All other land-use areas were excluded. Yellow regions in the map (close agreement) indicate that all three approaches yield similar results for land-use intensity. This is given if the difference is less than 10 %-points in each pixel.[2] Green regions (agreement) are defined as regions in which two indicators show similar results (percentage-points closer than ± 10 %) and all three indicators lie within 20 % points. It is apparent that green regions tend to be clustered around yellow regions, revealing a gradient from complete agreement to less or eventually no agreement.

**Areas of Agreement** A significant proportion (11 %) of the covered land area shows good (all three indicators within ± 10 %) or moderate agreement (two indicators within ± 10 %, one within ± 20 %). These are the regions with high land-use intensity in the Northern US, along the Mississippi river basin, and the Northern European croplands. These regions are characterised by high crop yields due to advanced agricultural production techniques (in particular, high levels of fertiliser application and irrigation). The TE in these regions approaches its maximum value of 1, indicating that actual yields approach frontier yields here. Additionally the τ-factor ranges up to its maximum level of 2 in these regions, indicating that actual yields are twice as high as their reference yields. Likewise, HANPP shows its highest values here as well, ranging up to greater than 80 % of the total $NPP_0$.

Agreement with moderate intensity (with TE approximately 0.5, τ-factors approximately 1 and HANPP approximately 30–50 % of $NPP_0$) can be found in the cropland regions in North-eastern China, the Philippines, some Eastern European countries (Romania, Bulgaria) and southern Brazil. High agreement among the three indicators can be found in some regions of Sub-Saharan Africa (along the Gulf of Guinea coast and the Sahel zone), and some hotspots are also found in the easternmost parts of Europe (Ukraine), all areas with moderate-to-low intensity. In particular, the Sub-Saharan African countries situated in these regions often suffer from the combined effects of climatic constraints and the lack of agricultural means of production. However, reasons for this intricacy are manifold. In many cases, failed states, political constraints, poverty, and soil degradation pose restrictions to intensive agricultural production. In TE-terms, the distance from actual yields to the yield frontier in these parts of the world is still high, indicating a huge potential for future yield increases if improved management strategies are adopted. To harness these great potentials,

[2] Nota bene—this was calculated by subtraction and not as a ratio. We defined close agreement as when the difference of intensity values is less than 10 %-points (thus, shows a similar "class" of intensity). Such an approach leads to different results than calculating the ratio between two datasets and defining a similarity range (e.g., ± 10 % deviation).

however, will require sensitive strategies to avoid the many possible detrimental social and ecological impacts of land-use intensification (Foley et al. 2011; Friis and Reenberg 2010; Haberl et al. 2010; Lambin and Meyfroidt 2011; Young 1999).

**Areas of Disagreement** For much greater areas, however, the results of the three intensity calculations differ significantly. For 35 % of the covered area, complete disagreement among the three indicators prevails, with hotspots concentrated in Canada, North-western India, Northern Europe, Western Russia, and along the North African Mediterranean coast. For the majority of the covered area (53 %), two indicators are similar to each other but differ significantly from the third. All three possible cases of this type are approximately equal in size: a HANPP similar to τ but dissimilar to TE is found in 20 % of the area, a HANPP similar to TE but dissimilar to τ is found in 17 %, and a TE similar to τ but dissimilar to HANPP in 16 %.

These areas of disagreement are spread evenly throughout the entire global land surface. Several areas in South-eastern Europe, Canada, Southern India, Northern China and South Australia exhibit similar HANPP and TE patterns that are different from τ. Vast parts of China, the US, Southern Brazil and Southern Russia reveal similarities between the HANPP and the τ-factor, whereas TE disagrees. The τ-factor and the TE largely agree but are not line with HANPP for areas in central India, Eastern Europe, Sub-Saharan Africa and South America. Reasons for this are manifold and are often an effect of specific different methodological features of the indicators.

The disagreement can be caused by conceptual differences but also by the differences in scope. Agreement is likely in areas where the sum of maize, wheat and rice dominates cropland (TE similar to τ). Additionally, discrepancies between HANPP and the other two indicators are likely in areas that are not dominated by cropland but are heavily grazed, under forestry, or densely settled. The disagreement of τ and HANPP with TE can occur in areas where, at a large geographic scale, the potential for cultivation is not fully utilised, and the frontier yield is lower in the entire region, e.g., due to social or economic reasons. Major areas in which both TE and τ disagree with HANPP are at least partially due to multiple cropping, which is due to the differences in yield definition: HANPP refers to land-use yields (total annual production per area under cropland use, including fallows), whereas TE and τ refer to harvest yields (production per harvested area and harvest event; fallows are excluded, total annual production is divided by the area times harvest events, i.e., times three in the case of three harvests per year). Under the assumption of the equal inputs (e.g., irrigation), the τ-factor approach on croplands situated in less favourable growth regions is likely to show higher τ-values than in the more humid regions. One reason for this is that reference yields are lower in less favourable climatic regions. As these regions show a greater response to irrigation than do humid regions, actual yields can greatly exceed reference yields under appropriate management. In contrast, regions characterised by more favourable biophysical crop growth conditions (e.g., less water-stress, appropriate temperatures, and rich soils) are characterised by high reference yields. They thus already exhibit high actual yields under lower inputs into the land and hence also show less response to irrigation.

## 5.5 Conclusions

Approximately three quarters of the terrestrial surface are used more or less intensively for, or at least affected by, settlements and infrastructure, cropping, grazing or forestry. The remaining quarter encompasses the remaining primary forests, natural grasslands and dry or cold deserts (Erb et al. 2007). At the same time, a growing and increasingly affluent world population that intends to satisfy its consumption needs and achieve a higher level of renewable energy supply will consume more biomass—even if the potentials for switching towards diets with reduced fraction of animal products in wealthy regions are realised and biomass is used more cautiously and efficiently (Erb et al. 2009a, 2012). Future increases in biomass supply for food, fibre and bioenergy will therefore primarily have to rely on changes in land-use intensity, as humanity struggles to limit the conversion of the last remaining pristine ecosystems (Foley et al. 2011). The search for sustainable options for intensification is therefore of utmost importance for feeding and fuelling the world.

Land-use intensity is a multi-faceted, complex concept. Increased land-use intensity can help reduce land demand and produce more food, fibre or bioenergy from constant or even shrinking land areas (Balmford et al. 2005; Burney et al. 2010; Rudel 2009). In contrast, negative environmental consequences of land-use intensity, such as falling energy return on investment (EROI) (Giampietro and Mayumi 2009; Hall et al. 1986, 2001, 2009; Pimentel 2008), soil degradation, nitrogen leaching, and the toxic effects of pesticides, have become widespread, and concern over these pressures is mounting (IAASTD 2009). Reliable and integrated socio-ecological indicators of land-use intensity are an important component of any effort to reap the benefits of land-use intensification while minimising its negative environmental consequences (Erb 2012).

Inspired by Boserup's seminal writings, this chapter has reviewed three different approaches to measuring land-use intensity: (1) TE, i.e., the distance between current crop yields and the highest possible yields given current technology; (2) the $\tau$-factor, the distance between current crop yields with and model-derived yields standardising technology; and (3) HANPP, the distance between the energy flow in ecosystems after harvest and the (hypothetically) undisturbed energy flow. Although each of these indicators has its specific strengths, none provides an all-encompassing solution to measuring land-use intensity. TE is best suited to identify "yield gaps", i.e., potential to improve crop yields by using the best available technologies. The $\tau$-factor is best suited to compare land-use intensity on cropland across time and space without having to use a time-dependent reference line such as "best currently available technology". Both measures are currently only defined for cropland and have difficulties in dealing with fallow land and multi-cropping, the aspect of land-use intensity that was the primary focus of Boserup's work. HANPP can help in both of these regards: it can measure land-use intensity across land-use classes, can address multi-cropping and fallow, and uses a natural science based, technology-independent reference line. However, compared with the other approaches, it does not capture the dominant effect of agricultural intensification on cropland, which occurs when

technological improvements result in a parallel increase in primary production and harvests, see Krausmann et al. (2012).

We conclude that the search for integrated socio-ecological indicators of land-use intensity is an important topic of future land-change and sustainability science. Ester Boserup's seminal work will continue to provide an important source of inspiration for this highly topical area of research.

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# Chapter 6
# Malthusian Assumptions, Boserupian Response in Transition to Agriculture Models

**Carsten Lemmen**

**Keywords** Sociometabolic transition · Population pressure · Innovation · Development framework

## 6.1 Transitions to Agriculture

The relationship between humans and their environment underwent a radical change during the last 10,000 years: from mobile and small groups of foragers to sedentary extensive cultivators and on to high-density intensive agriculture-based modern society; these transitions fundamentally transformed the formerly predominantly passive human user of the environment into an active component of the Earth system. The most striking impacts of these global transitions have only become visible and measurable during the last 150 years (Crutzen 2002; Crutzen and Stoermer 2000). Prior to this time frame, the use of forest resources for metal smelting in early Roman times and the extensive medieval agricultural system had already changed the landscape (Barker 2011; Kaplan et al. 2009); the global climate effects of these early extensive cultivation and harvesting practices are still under debate (Kaplan et al. 2011; Lemmen 2010; Ruddiman 2003; Stocker et al. 2011).

Transitions to agriculture occurred in almost every region of the world, with the earliest instances occurring in China and the Near East over 9,000 years ago (Kuijt and Goring-Morris 2002; Londo et al. 2006). More recent transitions occurred several 100 years ago in Australia and Oceania with the arrival of Polynesian and European immigrants (Diamond and Bellwood 2003). While each local transition can be considered revolutionary, the many diverse mechanisms, environments, and cultural contexts of each agricultural transition make it difficult to speak of one 'Neolithic revolution', as the transition to farming and herding was termed by V. G. Childe almost a century ago (Childe 1925). The transitions from foraging to farming were not simply one big step, but may have consisted of intermediary stages. Bogaard (2005) examines such transitions in terms of the land use system: she classifies the

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progression as comprising inadvertent cultivation, horticulture, simple agriculture, and then advanced agriculture. Boserup (1965), however, classifies these stages by management practice: forest, bush, short fallow, annual cropping, and multi cropping.

In contemporary hunting-gathering societies, much less time is devoted to procuring food from hunting and gathering as compared to agriculture and herding (e.g., Sahlins 1972). In addition, less labour is required for long fallow systems compared to intensive multi-cropping agriculture (Boserup 1965). These phenomena raise the question: Why farm? Different explanations from archaeology (Barker 2011), demography (Turchin and Nefedov 2009), historical economy (Weisdorf 2005), and ecosystem modelling (Wirtz and Lemmen 2003), suggest that the answer lies in processes such as social reorganisation, the value of leisure, changing resources, and coevolutionary thresholds.

Malthus (1798) proposed what is arguably the simplest relationship, namely that more production sustains larger populations. With larger populations, more production is possible, thereby constituting a positive feedback loop, which ideally results in ever-increasing (geometric) growth and productivity. This ideal increase does not apply in a world with finite resources, as expressed by Malthus (1798, p. 4), who stated that: "Population, when unchecked, increases at a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison with the second". Malthus identifies the need for positive and preventive checks to balance population increases with a limited capacity of resources.

It is important to note the reasons for productivity increases. First, the input of more labour increases productivity (Malthus 1798, p. 11), subject to the constraints of finite resources and diminishing returns. However, whereas Malthus focuses on extensive productivity increases, Boserup (1965) highlights the intensification component of productivity increases. Investments in a more intensive production system require significant additional labour, and the benefits of such investments are often small. To stimulate an investment in more intensive agriculture, Boserup requires population pressure.

Both Malthus (1798, 1826) and Boserup (1965, 1981) concentrate on the role of labour (and, later, division of labour and social/family organisation) and innovations that increase area productivity (such as storage or tools, requiring relatively more labour for harvesting, building, and tool processing). Both authors neglect the role of labour-independent innovation, or innovations that increase both area and labour productivity. These are innovations in the resources themselves, such as cultivation of higher-yielding grains or imported high yield varieties, or types of management such as water rights. Although this distinction may be ambiguous for certain innovations, it is used here conceptually. Labour-independent innovation can be stimulated by population diversity and density, both of which are positively related to population size. Darwin (1859, p. 156) wrote "The more diversified [. . .], by so much will they be better enabled to seize on many and widely diversified places in the polity of nature". Translated into the realm of innovation, Darwin's "seizing of places", or niche occupation, would be the realisation of technical and scientific opportunities.

Regarding density as a stimulus of innovation, aggregation is understood to constitute a vehicle for technological and cultural change (Boyd and Richerson 1995; Smith 1776)[1].

## 6.2 Models of Population, Production, and Innovation

In 1996, Ester Boserup reflected on the problems arising from the differences in terminology and methodology when comparing different models of development theories (Boserup 1996). She suggested a common framework to facilitate interdisciplinary cooperation based on six structures: Environment *(E)*, Population *(P)*, technology, occupational structure, family structure and culture. In this framework, she then interpreted the major works of Adam Smith, Thomas Malthus, Max Weber, Karl Marx, David Ricardo, and Neomalthusian thinking, as well as her own perspective on different stages of the developmental process.

For many of the theories and models discussed by Boserup in this framework, the partitioning into six structures can be simplified by (a) aggregating technology and occupational structure into a single entity technology *(T)*, and by (b) aggregating culture and family structure into a single entity culture *(C)*. Aggregating technology and occupational structure means that I assume here that changes in technology are equivalent to changes in organisation and that the location of technological change is the occupational sector. By aggregating family structure and culture, I assume that values and social conventions penetrate from the society into the family and are governed by similar dynamics. The reduced framework then consists of the following compartments: population, environment, technology, and culture (PETC, Fig. 6.1).

In this PETC framework, the model referring to Malthus (1798) involves only population and environment. Population growth exerts pressure on the environment, and failure to provide adequate resources from the environment acts as a positive check on population through higher mortality (Fig. 6.1a). Technology does not play a role in this simplest Malthusian model[2]. Culture in the form of preventive checks—such as birth control—acts on population only in later versions of his theory (Malthus 1826). At its core remains "the dependent role he assigns to population growth" (Marquette 1997). D. Ricardo (1821) proposed that the incentive to intensify and develop technologies comes from a stimulus in population pressure. The demand for more land *(E)*, however, leads to declining marginal benefits of and negative feedback on innovation *(T)* due to the high costs of renting the land (Fig. 6.1b). In Ricardo's work, population is the independent variable, and technology and environment are the dependent variables.

[1] This does not, however, explain the reason for a particular choice of one innovation over another (Sober 1992).

[2] Malthus considered the increase of carrying capacity by autonomously occurring inventions (Lee 1986), however, this was not discussed by Boserup (1996) in her model intercomparison.

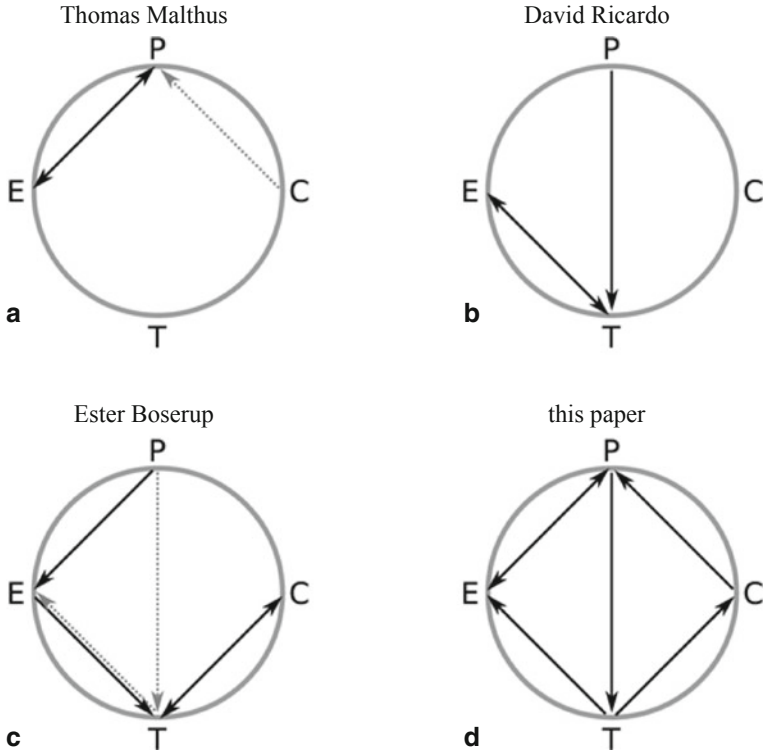


**Fig. 6.1** Four compartment framework for the interrelationship between population, environment, technology, and culture. Four economic theories are contrasted: the essays on the principles of population by T. Malthus (1798, 1826) (**a**), *dotted line* indicates the revised essay including culture change; D. Ricardo (1821)'s principles of economy (**b**), E. Boserup's (1965, 1981) theories for five transitions explained in Boserup (1996) (**c**), 1981 refinements shown as dotted lines; and the ecological model proposed in this chapter (**d**). The framework is a simplification of the six-compartment framework originally proposed by Boserup (1996)

Population is also the driving factor in Boserup's (1965, 1981) works. Of the six transitions considered by Boserup (1996), five transitions can be accommodated within my PETC framework as a succession of population, environment, technology, and culture: foraging to crop production, village development, Eastern hemisphere pastoralism, urbanisation, and industrialisation (Fig. 6.1c)[3]. In all of these transitions, population growth leads to pressure that derives from the limited environmental resources, which in turn stimulates technological and organisational change, and later results in cultural changes that are evident in cults, social hierarchies, women's

[3] The sixth transition—western European fertility decline—follows a different path as a succession of technology, environment, culture, and last population; it is not considered here.

status, and status symbols. Within this group of five transitions, Boserup's model of village development, in addition, has a direct population–technology link and allows for feedback regarding the land resources on occupational structure (dotted lines in Fig. 6.1c). Furthermore, her model of the foraging to farming transition includes a feedback from culture to organisational structure (not shown).

## 6.3 A Combined Model and "Real" World Application

Here, I suggest a different model of population development that considers the foraging to farming transition as an example (Fig. 6.1d). This model is a reduced form of the Global Land Use and technological Evolution Simulator (GLUES, described below), which has been operationally applied to a number of problems in archaeology and climate research (Kaplan et al. 2011; Lemmen and Wirtz 2010, 2012; Lemmen et al. 2011). The reduced model shares the functional characteristics of the full model, but it is not spatially explicit and the biogeographic and climate background is considered to be constant (see Appendix for equations).

Regarding the PETC framework, the dynamics between population, environment, technology and culture include the following (Fig. 6.1d, cmp. Boserup 1996, p. 509):

1. $P \rightarrow T \rightarrow P$ Population growth stimulates innovation by aggregation and diversity. Innovations in, e.g., health care, increase population;
2. $P \rightarrow E \rightarrow P$ Higher population uses increasingly more land for hunting and exerts pressure on the game stock, higher population densities damage the environment, and food shortage leads to reduced fertility (preventive check) or higher mortality (positive check). The rising capacity of the environment supports larger populations;
3. $T \rightarrow E$ More intensive foraging or farming strategies damage the environment, while efficiency gains lead to higher environmental capacity;
4. $T \rightarrow C$ Adoption of novel technologies induces changes in social structure where specialists and leaders or cults emerge;
5. $C \rightarrow P$ Family and social structure change reproduction rates.

Richerson and Boyd (1998) claim that basically all models that are rooted in ecology are Neomalthusian in essence, i.e., they can be characterised by a $P \rightarrow T \rightarrow E$ loop in Boserup's (1996) framework. This loop can be detected in my model, as well; in fact, historically, the model developed from ecosystem models of tree stands or algal communities (Wirtz and Eckhardt 1996). Unlike many other models, however, GLUES is based on coevolutionary dynamics of technologies and population and has no a priori information on whether there is an (Malthusian) "invention-pull view of population history" (Lee 1986, p. 98), or whether population is the (Boserupian) driver of development[4]. Applications of GLUES show an emergent emancipation of population development from the environment with increasing population and innovation (Lemmen and Wirtz 2010, 2012; Lemmen et al. 2011).

[4] See also Simon (1993) for a detailed discussion.

GLUES mathematically resolves the dynamics of population density and three population-averaged characteristic sociocultural traits: technology *($T_A$)*, share of agropastoral activities *(C)*, and economic diversity *($T_B$)*. These traits are defined for preindustrial societies as follows:

1. Technology *($T_A$)* is a trait that describes the efficiency of food procurement—related to both foraging and farming—and improvements in health care. In particular, technology as a model describes the availability of tools, weapons, and transport or storage facilities. It aggregates over various relevant characteristics of early societies and also represents social aspects related to work organisation and knowledge management. It quantifies improved efficiency of subsistence, which is often connected to social and technological modifications that run in parallel. An example of *($T_A$)* is the technical and societal skill of writing as a means for cultural storage and administration, with the latter acting as organisational lubricant for food procurement and its optimal allocation in space and among social groups. *($T_A$)* is labour-dependent.
2. A second model variable, *C*, represents the share of farming and herding activities, encompassing both animal husbandry and plant cultivation. It describes the allocation of energy, time, or manpower to agropastoralism with respect to the total food sector.
3. Economic diversity *($T_B$)* resolves the number of different agropastoral economies available to a regional population. This trait is in the full model closely tied to regional vegetation resources and climate constraints; in this reduced model, it denotes a labour-independent technology. A larger economic diversity offering different niches for agricultural or pastoral practices enhances the reliability of subsistence and the efficacy in exploiting heterogeneous landscapes.

The temporal change of each of these characteristic traits follows the direction of increased benefit for success (i.e., growth) of its associated population (Appendix Eq. 6.1).; this concept had been derived for genetic traits in the works of Fisher (1930) and was recently more stringently formulated by Metz and colleagues (Kisdi and Geritz 2010; Metz et al. 1992) as adaptive dynamics (AD). In AD, the population-averaged value of a trait changes at a rate that is proportional to the gradient of the fitness function evaluated at the mean trait value. The AD approach was extended to functional traits of ecological communities (Merico et al. 2009; Wirtz and Eckhardt 1996) and was first applied to cultural traits of human communities by Wirtz and Lemmen (2003).

The adaptive coevolution of the food production system $\{T_A, T_B, C\}$ and population *P* (Appendix Eqs. 6.1–6.4), which is at the heart of this model's implementation, was also found empirically by Boserup (1981, p. 15): "The close relationship which exists today between population density and food production system is the result of two long-existing processes of adaptation. On the one hand, population density has adapted to the natural conditions for food production [. . .]; on the other hand, food supply systems have adapted to changes in population density."

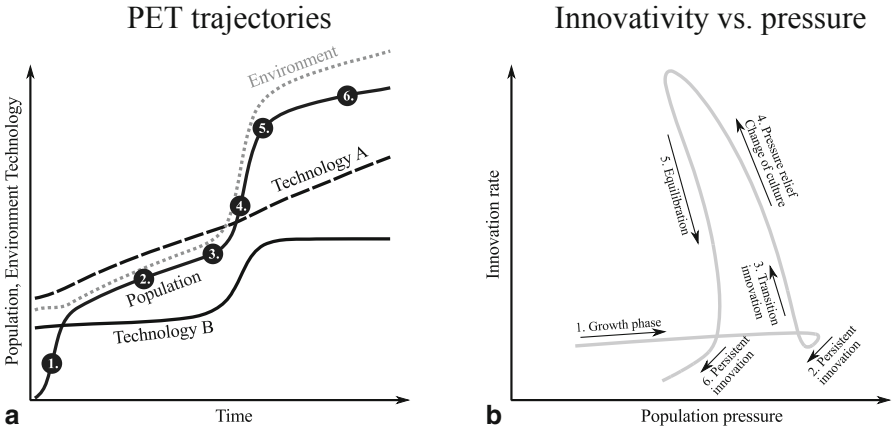


**Fig. 6.2** Trajectories of population $P$, environment $E$, and technologies $T_A$, $T_B$ (**a**) and phase diagram of innovation rate versus population pressure, (**b**) from a simulation with a simplified version of the Global Land Use and technological Evolution Simulator. The trajectories describe the temporal evolution of population density, capacity denoted as environment, a labour-dependent technology $T_A$, and a labour-independent technology $T_B$. Numbers identify the different stages of development in the both diagrams. In the phase diagram **b**, the innovation rate, derived as the cumulative change in $T_A + T_B$, is shown in relation to population pressure, calculated as $1 - E + P$

## 6.4 Innovation in Transitions to Agriculture

The outcome of the coevolutionary model simulation with the reduced GLUES is shown in Fig. 6.2. I divided both the trajectories (temporal evolution of state variables, panel a) and the phase space (panel b) into six stages:

1. Growth phase: Beginning from a Malthusian perspective, and examining only population and environment (quantified here as the ecosystem capacity, i.e., the ratio of birth over mortality terms in the growth rate Eq. 6.3), population grows towards its capacity with diminishing returns as $P$ approaches $E$; this first phase spans only a short period of time but covers a large area in phase space;
2. Persistent innovation in technology $T_A$ and associated investments in tool making and administration allow sustained slow growth of population $P$ and alleviate the built-up population pressure; in contrast to the growth phase, the phase space coverage is very small, while the temporal extent of this phase is large.
3. Transition phase: rapid innovation in a labour-independent technology $T_B$ (e.g., domestication successes) leading to
4. Pressure relief, but this relief also induces also a cultural change (not shown);
5. Equilibration: Innovation slows but has led to a wider gap between $P$ and $E$ because of the investments made in manufacturing and organisation during the transition: accordingly, population pressure increases more slowly and up to a lower value than in the growth phase (1.);
6. Persistent innovation: corresponds to phase (2.) and is again characterised by persistent innovation in technology $T_A$ and a slow population pressure relief.

Figure 6.2 provides key insight. What can be learned about the relationship between population pressure and innovation? (i) Innovation is greatest at high population pressure. (ii) In this model, innovation always occurs; at no time, the technology change is negative. (iii) The relationship between innovation and population pressure changes profoundly during the foraging-farming transition; three different regimes can be identified: (i) a positive relationship where acceleration of innovation corresponds to population pressure increases (phases 1, 2, 6), (ii) a negative relationship with pressure relief during accelerating innovation (phase 3, 4), and (iii) a negative relationship with deceleration of innovation at increasing pressure (phase 5).

A superficial analysis would find that population pressure is the motor of innovation in this example: population increases seemingly precede the stepwise technological change (Fig. 6.2a). Only a detailed examination of the phase space (Fig. 6.2b)—especially at the transition phases 2 and 3—shows that innovation decelerates at very high population pressure and that the largest innovation occurs slightly below the highest population pressure. In fact, the driver in the transition depicted here is not population, but technology[5]. Only the different coevolutionary time scales of population growth (fast) and innovation (slow) yield the seemingly Boserupian, i.e., population driven, response.

The same mathematical model—plus spatial and biogeographic aspects—have been used to successfully simulate the many transitions to agriculture in Neolithic Europe (Lemmen et al. 2011), in good agreement with the radiocarbon record. Additionally, the transitions appear to be Boserupian with critical innovations occurring at high population pressure. If the numerical analysis had not been available (and proved that this phenomenon is in fact technology driven), as shown in the discretely sampled data from observations of technological change, one might erroneously conclude that this type of innovation was population driven.

## 6.5 Conclusion

I presented a reduced version of the Global Land Use and technological Evolution Simulator—a numerical model that is capable of realistically simulating regional foraging-farming transitions worldwide. The simulated—and possibly also observed—transitions are seemingly Boserupian, i.e., population driven: innovation is greatest when population pressure is high. Analytical examination of the model, however, shows that technological change is the driver of these phenomena and that, in the context of a simplified version of Boserup's (1996) framework in development theory, the model should be classified as Neomalthusian. I thus demonstrated that Boserupian appearance may be based on Malthusian assumptions; I caution not to infer too quickly a Boserupian mechanism for an observed real world system when its dynamics appears to be driven by population pressure.

[5] There would be no evolution of $T$ without $P$ due to the coevolutionary definition of the system. The dynamics of $T$, however, leads the dynamics of $P$ at the foraging-farming transition.

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## Appendix: The Reduced GLUES Model

A coevolutionary system of population $P$ and characteristic traits $X \in \{T_A, T_B, C\}$ is defined by the evolution equations

$$\frac{dP}{dt} = P \cdot r, \tag{6.1}$$

$$\frac{dX}{dt} = \delta_X \cdot \frac{\partial r}{\partial X}, \tag{6.2}$$

where $r$ denotes the specific growth rate of population $P$, and the $\delta_X$ are variability measures for each $X$. Growth rate $r$ is defined as

$$r = \mu \cdot (1 - \omega T_A) \cdot \left(1 - \gamma \sqrt{T_A} P\right) \cdot SI - \rho \cdot T_A^{-1} \cdot P, \tag{6.3}$$

with coefficients $\mu$, $\rho$, $\omega$, and $\gamma$. In this formulation, the positive term including food production $SI$ is modulated by labour loss for administration $(-\omega T_A)$ and by overexploitation of the environment $\left(-\gamma \sqrt{T_A} P\right)$. Food production depends on the cultural system $C$ and available technologies as follows:

$$SI = (1 - C) \cdot \sqrt{T_A} + C \cdot T_A \cdot T_B, \tag{6.4}$$

where the left summand denotes foraging activities and the right summand agropastoral practice. To produce the results for Fig. 6.2, I assumed the following parameter values: $\mu = \rho = 0.004$, $\omega = 0.04$, $\gamma = 0.12$, $\delta_{T_A} = 0.025$, $\delta_{T_B} = 0.9$, a variable $\delta_C = C \cdot (1 - C)$, and initial values $P_0 = 0.01$, $T_{A,0} = 1.0$, $T_{B,0} = 0.8$, and $C_0 = 0.04$.



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# Chapter 7
# Reconciling Boserup with Malthus: Agrarian Change and Soil Degradation in Olive Orchards in Spain (1750–2000)

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**Keywords** Long-term socio-ecological research · Southern Spain · Agricultural change

## 7.1 Introduction

Soil degradation is one of the consequences of farming activity that has had the greatest impact on the capacity of agro-ecosystems to produce food and offer environmental services.[1] This risk is threatening the Mediterranean basin as one of the principal factors of non-sustainability (Kirkby et al. 2004). Unintended, long-term consequences of different land use practices are some of the primary drivers of

[1] According to the FAO (1995, p. 6): "The concept of land degradation refers to the deterioration or total loss of the productive capacity of the soils for present and future use (. . .). Such loss occurs mainly because of various forms of erosion (by wind and water) and of chemical and physical deterioration."

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socio-ecological change for Mediterranean soils, rooted in the process of productive intensification that agro-ecosystems have been undergoing for several centuries (McNeill 1992). In recent decades, the expansion of olive growing has exacerbated the problem in the Mediterranean region (Beaufoy 2001; Gómez et al. 2008). Although the natural phenomena responsible for the process of soil degradation seem clear, debate remains regarding its social causes (FAO 1995). The centenary of the birth of Ester Boserup—and the debate that has grown regarding her work—offers a good opportunity to examine this issue further.

The primary objective of this chapter, based on the evidence of severe degradation of Mediterranean soils, is to analyse its historic dimension through a case study performed in a mountainous area of southern Spain (Montefrío, Granada), in which to identify the causes and thereby contribute to the on-going debate regarding management approaches and soil degradation on a global scale, where the work of Boserup has been so influential.

Our case study, which spans two and a half centuries (1750-present day), examines whether population growth was among the primary factors in the transformation from pre-industrialised to industrialised agriculture, with its consequent environmental impacts. In the light of the transition towards sustainable agriculture, understanding the vital role played by population size and dynamics is crucial, especially if approached on a global scale (Haberl et al. 2011), given that the population of the planet is constantly growing (United Nations 2007).

In the text, we first present our case study in its environmental and social context. Then, we continue explaining the character of agrarian change in the southern Spain and our local case study focusing on both social and material aspects to contextualise the causes of soil degradation through a historical perspective. We then provide data and context regarding the problem of soil degradation in our case study. Finally, we conclude by discussing the impacts of agrarian change on soil degradation from the middle of the eighteenth century to the present by quantifying soil erosion in olive orchards and nutrient balances.

## 7.2 Case Study in the Mountains of Southern Spain

Our case study is situated in the Mediterranean mountains of southern Spain, in the province of Granada. The 25.5-km$^2$ study area is part of the Baetic Cordillera chain; the average gradient is 10 %, representing a typical example of mid-height mountain agriculture. The climate in this area is Mediterranean-Continental, with average annual rainfall of 550 mm, an average annual temperature of 15.2° and potential evapotranspiration (PET) of 760 mm. The soil type is primarily Calcic Cambisol according to the FAO classification. Montefrío, our case study, is a town with a long olive-growing tradition, and its geographical and soil and climatic characteristics are similar to those of the agricultural interior of Andalusia. Until well into the twentieth century, it was fairly isolated because of the characteristics of its relief; hence, its processes of change are an attractive field of study.

This location was specifically chosen for its territorial representativeness and the availability and quality of its historic documentation. Furthermore, some of the authors of this paper have conducted previous research regarding Montefrío, which has proved immensely useful. This research has provided information needed to ascertain the agrarian evolution of the town and of olive-growing in particular (Infante-Amate 2011), the balance of nutrients (González de Molina et al. 2010) and erosion over time from a historical perspective (Vanwalleghem et al. 2011).

## 7.3 From a Pastoral System to a Specialisation in Olive Production

### *7.3.1 Agrarian Change in Preindustrial Agriculture*

In the mid-eighteenth century, Montefrío had 5,108 inhabitants, a scant population in comparison with other territories in northern Spain (23 inhabitants/km$^2$), with high land availability, in excess of 4 ha per inhabitant. Land use was primarily devoted to livestock, offering future possibilities for the agricultural "colonisation" of the town. It was, as Herman Daly said (2005), an "empty" territory where labour, rather than resources, was the main limiting factor.

Land use was organised according to different levels of labour intensity. Land occupation occurred was based on a primary population nucleus and on small population clusters known as *cortijos* scattered throughout the municipality. Cultivation decreased in intensity with distance from these clusters.[2] The land that surrounded the town (*ruedos*) was cultivated intensively because more labour could be applied there. Some areas had access to irrigation and thus were where fruit, vegetables, cereals and leguminous crops were grown. The available manure was dedicated if possible to these lands because of the transport economy and because the costs in labour could be easily borne by the town (for more details, see González de Molina et al. 2010; Infante-Amate 2011) (Table 7.1).

The majority of the cultivated land (28.8 %) where "*al tercio*" (wheat/fallow/fallow) rotation was practised was located adjacent to this area, with fairly modest sowing and harvesting. Finally, grape vines and olive trees, which received low levels of labour during this period, occupied a marginal area (0.7 %), and their products provided subsistence for the locals. The land area dedicated to permanent, natural pasture (51.1 %) reveals that a very significant portion of the agro-ecosystem remained uncultivated, as home to significant livestock numbers (21 LU/km$^2$).

In accordance with the tradition inaugurated by Marshall Sahlins (1972), Montefrío appeared as a kind of "opulent society", which, through high levels of labour productivity, was able to feed a scant population more effectively. Indeed, the available food per capita in 1750 had a higher energy content than in the nineteenth century

[2] In a similar model to that formalised by Von Thünen and, more recently, this has been taken up again by the field of Economic Geography (Fujita et al. 1999).

**Table 7.1** Evolution of the agro-ecosystem in Montefrío, 1750–2000. (Source: González de Molina et al. 2010; Infante-Amate 2011)

| | Unit | 1750 | 1850 | 1900 | 1950 | 2000 |
|---|---|---|---|---|---|---|
| Population | [no.] | 5108 | 7938 | 10404 | 13698 | 6453 |
| Population density | [inhab/km$^2$] | 23.36 | 38.16 | 45.40 | 52 | 27 |
| Cereal | [ha] | 7372 | 12940 | 15245 | 15894 | 2165 |
| *Annual* | [ha] | 0 | 0 | 0 | ? | 2165 |
| *Ruedo*[a] | [ha] | 24 | 1324 | 2934 | ? | 0 |
| *Tercio*[b] | [ha] | 7348 | 11616 | 12311 | ? | 0 |
| Fruit and vegetables | [ha] | 71 | 170 | 97 | 217 | 35 |
| Olives | [ha] | 120 | 442 | 718 | 2320 | 15006 |
| Vines | [ha] | 59 | 196 | 246 | 44 | 4 |
| *Cultivated* | [ha] | *7622* | *13748* | *16306* | *18475* | *17210* |
| Mountain | [ha] | 10100 | 3110 | 3110 | 5920 | 4046 |
| Pasture | [ha] | 3025 | 2840 | 2439 | 712 | 1366 |
| *Utilised agricultural area* | [ha] | *20747* | *19698* | *21855* | *25107* | *22622* |
| Unproductive | [ha] | 1060 | 1060 | 1060 | 1060 | 910 |
| *Total* | [ha] | *21807* | *20758* | *22915* | *26167* | *23532* |
| Livestock for Income[c] | [LU] | *3326* | *880* | *400* | *1830* | *1225* |
| Livestock for Labour[d] | [LU] | 1821 | 1012 | 1187 | 2356 | 200 |
| *Total Livestock* | [LU] | 5147 | 1892 | 1587 | 4187 | 1425 |
| Production harvested | [t d.m.] | 3157 | 7387 | 9470 | | |
| Production harvested | [1752 = 100] | 100 | 234 | 300 | | |
| Production/inhabitants | [kg d.m.] | 618 | 931 | 910 | | |
| Production/inhabitants | [1752 = 100] | 100 | 151 | 147 | | |
| Production/cropland | [kg d.m./ha] | 153 | 537 | 581 | | |
| Production/cropland | [1752 = 100] | 100 | 352 | 380 | | |
| Average farm size | [ha] | 53.09 | 26.70 | 10.75 | 8.95 | 9.50 |

[a] "*Ruedo*" Rotation. Four-year rotation of wheat-beans-wheat-chick peas
[b] "*Al tercio*" Rotation. Three-year rotation with 2 years fallow and one year wheat
[c] Labour livestock. Animals involved in transport and soil management (cows, mules, horses . . .)
[d] Income livestock refers to those primarily devoted to produce food or products such as meat, milk or eggs (i.e., chickens, goats, sheep, or pigs)

(González de Molina et al. 2011). Recent anthropometric studies have shown that the biological standards of living for its inhabitants were among the highest in Spain at that time (Cámara 2007).

During the second half of the eighteenth century, population growth was practically zero; however, in barely a century, it nearly doubled to 10,101 inhabitants in 1877.[3] Following the fall of the *Ancien Régime*, new liberal policies facilitated access to land to a great number of landless peasants. Over the course of the nineteenth century, there were as many as three land distributions in Montefrío, which attracted significant population numbers (Martínez 1995). Other liberal measures, such as land seizure and the redemption of tithe rent charges, also facilitated access to land ownership. The availability of labour for more intensive management of

[3] It was primarily due to immigration and growing birth rates. More details in Cámara (2007, p. 214–220).

**Table 7.2** Distribution of registered land ownership, 1852–1901. (Based on Martínez 1995)

| | 1852 | | 1901 | |
|---|---|---|---|---|
| | *Owners* | *%* | *Owners* | *%* |
| 0–5 | 533 | 69.31 | 1490 | 74.31 |
| 5–10 | 64 | 8.32 | 220 | 10.97 |
| 10–50 | 90 | 11.70 | 211 | 10.52 |
| 50–100 | 30 | 3.90 | 42 | 2.09 |
| 100–500 | 49 | 6.37 | 37 | 1.85 |
| Over 500 | 3 | 0.39 | 5 | 0.25 |
| Total | 769 | 100 | 2005 | 100 |
| | *Ha* | *%* | *Ha* | *%* |
| 0–5 | 890.18 | 4.50 | 2260.04 | 10.48 |
| 5–10 | 486.29 | 2.46 | 1539 | 7.14 |
| 10–50 | 2157.51 | 10.92 | 4537 | 21.05 |
| 50–100 | 2183.98 | 11.05 | 2872 | 13.32 |
| 100–500 | 10464.68 | 52.95 | 6599 | 30.61 |
| Over 500 | 3579.85 | 18.11 | 3750 | 17.4 |
| Total | 19762.49 | 100 | 21557 | 100 |

the agro-ecosystem was greater and consequently so were the feeding requirements, which in turn spurred further reclamation and crop intensification.[4]

Analysing the structure of ownership and agrarian exploitation in Montefrío demonstrates that the number of small landowners increased as the number of large landowners decreased. Farms between 0 and 10 hectares in 1752 accounted for less than 3 % of the land area registered on the cadastral register. One century later, this figure had increased to 7 %. In contrast, in the mid-eighteenth century, farms over 500 ha accounted for over 40 % of all lands, whereas in 1850 this figure had fallen to 18 % (see Table 7.2). A large group of peasant farmers were able to access land ownership (Martínez 1995, p. 163).

However, the population growth and the consequent increased pressure on resources were beginning to decline by the end of the nineteenth century. Indeed, the number of small landowners continued to increase through the liberal measures outlined above, and as a result of the opportunities for clearing and intensifying production, they were favoured by the egalitarian legacy characteristic of Spanish legislation. Relatively isolated from the main commercial points of the region, the town was by necessity self-sufficient. By the beginning of the twentieth century, Montefrío had over two thousand landowners. Approximately 90 % of them, 40 % of the registered plots of land, had fewer than 50 ha. The greatest demographic increase was recorded among landowners with insufficient land; the number of peasant farmers

[4] The first distribution was performed using wasteland and land from the Royal Patrimony in 1799, grounded in the seizures of wasteland by Charles III in 1769. This distribution was performed on a ground-rent basis, payable to the town hall, among 440 residents, in lots of between 1 and 10 ha. A second occurred at the end of the 1830s (1839), following another failed attempt during the Constitutional Triennium, this time, on the basis of ownership. The population increased from 6,357 inhabitants in 1819 to 7,903 in 1842. The increasing cropland occupied former pastureland or forestland that was not previously cultivated due to low population pressure.

who owned fewer than 5 ha rose from 192 in 1752 to 533 in 1852 and had reached 1,490 by 1901, representing an approximately eight-fold increase. The average area of land owned by this segment also decreased, from 1.67 ha per owner in 1852 to 1.51 in 1901 (see Table 7.2). Certainly, the number of landowners increased at a much greater rate than did the population as a whole, but this occurred under increasingly precarious conditions because of the scarce provision of land and because the productive possibilities of this land were being exhausted. This meant increasingly difficult access to labour and to income livestock and fewer opportunities for work, which stagnated in availability. The composition of their diet also deteriorated (González de Molina et al. 2011), and anthropometric studies display a sharp decline in biological standards of living, also accompanied by waves of emigration (Cámara 2007) and increasing development of social conflict (Cruz 1994).

At the end of the nineteenth century, the amount of land dedicated to agriculture had increased to levels never before observed, and more intensive rotations occupied more space than ever before. The only way of fulfilling the dietary needs of the town was to replace livestock farming, which could only be sustainable under low population densities, with another form of agriculture based on cereal crops. This change seems to support the classic strategy described by Boserup (1965, 1981), whereby territories that begin to become densely populated intensify their rotations and increase production to adapt to the limitation. However, focusing solely on population dynamics ignores the manifest importance of the institutional dimension of change, which in this case encouraged population increases or immigration into the town and also governed the way in which the rural community was able to colonise the territory or intensify its management.

The increasingly precarious situation of the peasantry of Montefrío, given the imbalance between population and resources, explains here and elsewhere the increasingly intensive use of the land to guarantee subsistence, which led to processes of soil degradation (Blaikie and Brookfield 1987; FAO 1983).

### *7.3.2 Specialisation in Olive Growing and the Major Transformation of the twentieth Century*

Olive growing is the best metaphor for the changes that have occurred in the Spanish Mediterranean in the past two centuries. It encapsulates the intensive progression of agro-ecosystems in the nineteenth century, and its level of expansion in recent years has meant that the area of land dedicated to this activity in certain territories such as Montefrío occupies the total utilised agricultural area.

In the mid-eighteenth century, olive trees were scattered in Montefrío, integrated with other uses and subject to fairly non-intensive management. Olive production barely exceeded 100 kg per ha, whereas production was greater than 500 kg by 1900. Although the production as total biomass of the tree remained relatively stable (including the use of pruned material and ground cover plants), there were increased efforts to improve olive production, which is the most valuable part of the crop.

Human labour increased from 11 days/ha in 1750 to 28 days in 1900, and animal labour increased from 4.39 *obradas*/ha to 10.65 *obradas*/ha. Although higher olive yields were obtained, total crop productivity, measured as total biomass, decreased. In spite of this, olive orchards were a good solution for peasants with insufficient land.[5] In addition to olives, they provided wood and timber from pruning for domestic fuel, leaves to feed goats, ground cover plants to feed sheep, and pomace to feed livestock. In terms of energy, these products represent between 80 and 90 % of the total usage (Infante-Amate 2011, 2012), and these products were decisively important for these peasant economies.

Therefore, olive orchards charted a transition from an "empty" (Daly 2005) and "opulent" (Sahlins 1972) world towards more intensive cultivation, partially linked to the market, which required more intensive labour despite the costs in productivity (Boserup 1965). This is a similar story to what the changes in land use throughout Montefrío: increased agricultural intensity based on a loss of labour productivity.

However, the major transformation of agriculture in Montefrío, as in the rest of the country, came in the second half of the twentieth century and was characterised by the industrialisation of the sector and the full expansion of olive growing. Spain joined the European Common Market in the 1980s and its agricultural policy in the early 90s while also achieving high levels of industrialisation and consolidating its integration into the global economy. The importation of great quantities of energy and materials has allowed the cultivated land area to occupy essentially the entire utilised agricultural area (Guzmán and González de Molina 2009). This socio-ecological transition in Spanish agriculture eventually isolated the processes of food production and consumption from the territory, as has also occurred in other countries (Erb et al. 2009; Würtenberger et al. 2006).[6] Because of the mass importation of grain, meat consumption levels have returned to those last observed in the eighteenth century (Infante-Amate and González de Molina 2013), and land has become available for other uses. Production specialisation was accompanied by the expansion of olive growing, primarily because of the ecological advantages of this tree for development in Mediterranean climates (Angles 1999) and also because of the public subsidies of the Common Agricultural Policy (De Graaf and Eppink 1999).

Today, there are approximately 10 Mha under olive cultivation in the world, over 80 % of which are in the Mediterranean basin (FAO 2013), primarily because towns such as Montefrío have focused their agrarian activity fully on the production of olive oil; approximately 90 % of cultivated land is allocated to this crop, which is largely managed industrially. This latest leap towards agricultural intensification has substantially improved labour productivity (see Table 7.3). As recently discussed by

[5] During this period, small peasant farmers were behind the expansion of the olive orchard in southern Spain and in Montefrío in particular (see Infante-Amate 2011).

[6] New economic processes have gradually developed between production and consumption: transportation, packaging, processing, preservation, distribution and consumption. The gap between the concept of "agrarian product", understood as the output derived from the production of the agrarian sector, and the concept of "food product", understood as the final product resulting from the transformation of agrarian products and the addition of diverse uses, has continued to grow in recent decades.

**Table 7.3** Indicators showing the evolution of the olive orchard in Montefrío, 1750–2000. (Source: Infante-Amate 2011)

| | Unit | 1750 | 1850 | 1900 | 1950 | 2000 |
|---|---|---|---|---|---|---|
| Land area olive orchards | [ha] | 120 | 442 | 718 | 2320 | 15006 |
| Land area olive orchards/utilised agricultural area | [%] | 0.58 | 2.24 | 3.29 | 9.24 | 66.33 |
| Olive production | [kg d.m./ha] | 108.72 | 543.61 | 534.21 | 801.49 | 1339.18 |
| Pruning production | | 675.90 | 887.50 | 710.00 | 852.00 | 710.00 |
| Plant cover production | | 381.20 | 381.20 | 381.20 | 1997.71 | 0 |
| Total biomass production | | 1165.82 | 1812.31 | 1625.41 | 2851.2 | 2049.18 |
| Productivity olive labour | [day/kg] | 9.87 | 15.61 | 19.00 | 10.35 | 72.58 |
| Productivity Total labour | [day/kg] | 105.89 | 52.05 | 57.82 | 36.83 | 111.07 |
| Human labour | [day/ha] | 11.01 | 34.82 | 28.11 | 77.41 | 18.45 |
| Animal labour | [*obrada*/ha] | 4.39 | 10.57 | 10.65 | 15.26 | 6.84 |
| Input energy (1) | [Gj/ha] | 3.99 | 9.62 | 7.88 | 22.55 | 26.51 |
| Total output (2) | [Gj/ha] | 21.98 | 31.81 | 27.95 | 46.39 | 31.52 |
| Efficiency (2/1) | [Gj/ha] | 5.51 | 3.31 | 3.55 | 2.06 | 1.19 |

Fischer-Kowalski et al. (2010), the productivity of labour could once again increase in an unprecedented way because of the application of substantial amounts of energy, largely from fossil fuels.

The model of agrarian growth that accompanied the industrialisation of Spanish agriculture was based on the forced transfer through the markets of a portion of agrarian incomes (González de Molina and Guzmán 2006). This resulted from the on-going deterioration in the exchange relationship between the agrarian sector and the urban industrial and services sector. In comparison with other sectors, agrarian income suffered a significant decline in real terms. Between 1990 and 1999, income in the province of Granada—to which Montefrío belongs—had fallen by 15 % (Analistas Económicos de Andalucía 2000).

Furthermore, the process by which the subsidies of Common Agricultural Policy incentivised productivity through the intensification of cultivation and through savings in labour costs is well known (De Graaf and Eppink 1999). Much of the technological package integrated into the management of olive orchards responds to the new olive-growing reality of the region, including part-time agriculture, an ageing population and a loss of profitability[7], factors that are separate from the dynamics of population pressure.

[7] In addition to this decline in agricultural income, over the last 10 years, the group of farm owners who have another principal economic activity has increased by 30 %, and over the past 20 years, the percentage of farm owners aged over 64 has increased from 11.7 to 20.2 % (IEA 2011).

## 7.4 The Impacts of Agrarian Change: The Problems of Soil Erosion and Soil Fertility

### *7.4.1 Managing Land Fertility*

The expansion of the amount of land used to produce food for human consumption was achieved at the expense of space used to grow feed for livestock (Table 7.1). Livestock numbers declined between 1752 and 1854, a trend that continued until the end of the nineteenth century. Livestock density was reduced to a third of its previous size. The expansion of cultivated land and the net increase in demand for animal traction explain why the decrease in working animals was not as marked. However, the decline was most obvious in income livestock, which were fed on products of the agro-ecosystem that could not be exploited to grow food for humans or labour livestock. By 1901, this type of livestock had fallen to just over 12 % of the figure registered in 1752.

One consequence of this process was a 54 % net reduction in the fertilisation capacity of livestock. The imbalance between cultivated lands and those dedicated to animal feed, at a time when significant transportation of grain, straw or manure was limited (González de Molina 2010; Sieferle 2001), diminished fertilisation capacity. In truth, the possibilities of agrarian growth in Montefrío had reached their practical limit in the final decades of the nineteenth century. The possibilities for increasing the amount of cultivated land were very limited. In general terms, yields had begun to level off and, in some cases, even to decline. The decrease in production per inhabitant shown in Table 7.1 is explained by this fact. However, harvested biomass continued to grow during this period. How was the global increase in production between 1852 and 1901 possible, therefore? It was achieved at the expense of the nutrient reserves in the soil. The decline observed in the amount of manure applied per cultivated hectare confirms this: it was reduced to a fifth of the former levels.

In previous articles (García-Ruiz et al. 2012; González de Molina et al. 2010), we have examined the balance of nutrients on an aggregate scale and for the main types of crops. Table 7.4 provides a summary of our primary findings in this regard, showing that the extraction of nutrients exceeded inputs as crops became more intensive. In the mid-eighteenth century, the nutrient balance for crop rotations and on an aggregate scale was positive, with the exception of a few losses in potassium that were not significant because of its abundance in the soil. By the mid-nineteenth century, the balance of potassium had become even more negative, and the phosphorus balance became negative for the first time. Something similar occurred at the end of the century with perhaps the most important macronutrient in preindustrial agriculture: nitrogen (Allen 2008; Cunfer and Krausmann 2009). This was yet another symptom of the difficulties facing the agro-ecosystems of Montefrío in the final few decades of the nineteenth century: the progressive exhaustion of the possibilities for intensifying production, the mining of nutrients (González de Molina et al. 2010), the declining biological standards of living, and emigration (Cámara 2007). These processes may have spread to other areas in southern Spain (Infante-Amate 2011).

**Table 7.4** Balance of nutrients in Montefrío, 1750–1900. (Source: García-Ruiz et al. 2012; González de Molina et al. 2010)

| | The whole town | Fruit and vegetables | *Ruedos* | *Tercio* | Vineyards | Olive orchards | Years[a] |
|---|---|---|---|---|---|---|---|
| *1750* | | | | | | | |
| N | 9.3 | – 13.6 | – 3.6 | 0.7 | – 3.7 | 15.2 | – |
| P | 16.7 | – 3.1 | 0.8 | – 0.6 | – 1.1 | – 1.2 | 668 |
| K | – 148.5 | 9.1 | – 5.3 | – 12.1 | – 23.2 | – 27.8 | 551 |
| *1850* | | | | | | | |
| N | 3.5 | – 6.0 | 6.2 | 5.0 | – 8.9 | 5.5 | – |
| P | – 16.2 | – 1.2 | – 0.2 | – 1.5 | – 3.4 | – 2.7 | 293 |
| K | – 274.0 | 13.0 | – 7.4 | – 17.2 | – 53.4 | – 53.2 | 452 |
| *1900* | | | | | | | |
| N | – 13.4 | 6.1 | 2.1 | 0.1 | – 8.9 | 4.3 | – |
| P | – 22.4 | 3.6 | – 0.4 | – 1.4 | – 3.5 | – 2.9 | 271 |
| K | – 332.2 | 29.9 | – 12.8 | – 17.2 | – 53.4 | – 54.1 | 277 |

[a] Years when olive growing would deplete soil reserves

Earlier, we associated the increasingly precarious situation of the peasantry in the late nineteenth century with the greater intensity in farming. According to our data, this association led to a process of soil degradation, which revealed itself in higher rates of erosion in the most expansive crop grown in southern Spain, olive orchards, and also in widespread nutrient mining that limited productive capacity.[8]

The negative balance registered in olive orchards continued to increase until the late nineteenth century. Although the balance of nitrogen was always positive, the mining of phosphorus and, to a greater extent, potassium increased. Although reserves of phosphorus and potassium were very high in the soil, the continued losses led to a long-term decline. According to García-Ruiz et al. (2012), the intensive levels of extraction practised in the late nineteenth century would have affected the production capacity of the olive orchards in a few decades.

In the final decades of the twentieth century, the availability of inexpensive synthetic fertilisers has spurred their uncontrolled use, especially for nitrogenous fertilisers. Over 60 % of the nitrogen applied is not absorbed by the plant (Hermosín et al. 2009), and that nitrogen consequently causes significant water and soil contamination (Beaufoy 2001; Tombesi et al. 1996). In addition, this same management approach is responsible for the loss of ground cover plants and, therefore, the increased erosional processes in olive orchards (see following section).

### *7.4.2 Soil Erosion in Olive Orchards: A Long-Term Perspective*

During previous research (see Vanwalleghem et al. 2011), we reconstructed soil losses in the olive orchards of Montefrío from 1750 until the present. This quant-

[8] We have documented elsewhere how this process has even caused a decline in yield (González de Molina et al. 2010).

**Table 7.5** Average soil losses (in t/ha/year) from the olive orchards of Montefrío for different periods, 1750–2000. A distinction is drawn between losses caused by tillage and water erosion. (Based on Vanwalleghem et al. 2011; Infante-Amate et al. 2013)

| | Tillage | Water | Total |
|---|---|---|---|
| 1752–1856 | 2.00 | 21.00 | 23.00 |
| 1856–1888 | 7.71 | 39.77 | 47.48 |
| 1888–1896 | 23.47 | 40.69 | 64.16 |
| 1896–1935 | 20.12 | 30.48 | 50.60 |
| 1935–1950 | 20.12 | 15.57 | 35.68 |
| 1950–1970 | 10.06 | 15.57 | 25.62 |
| 1970–1990 | 28.16 | 61.36 | 89.52 |
| 1990–2000 | 6.50 | 84.26 | 90.76 |
| Average | 11.35 | 29.65 | 41 |

ification was performed using measurements taken in three plots of land located within the town, following the methodology defined by Vanwalleghem et al. (2010).[9]

Table 7.5 shows the primary results, reflecting the average values for the three plots of land studied.[10] The average soil losses (just over 40 t/ha/year) significantly exceeded the natural rate of soil regeneration (Montgomery 2007), but different values were observed over the course of the period studied. A clear upwards trend is observed from the lowest losses in the mid-eighteenth century to the present highest losses, with the exception of the mid-twentieth century when the losses declined.

Because the level of rainfall, the gradient, and soil type remained relatively stable throughout the period studied, the soil losses must be directly linked to changes in soil management.[11]

[9] This methodology allows us to the analyse changes in the soil height between the bases of tree trunks and the centres of the furrows between olive trees that are caused by water erosion and labour. Subsequently, soil losses caused by water erosion were estimated using RUSLE (Renard et al. 1997), adapted for olive orchards using the methodology proposed by Gómez et al. (2003); soil losses caused by labour were also estimated, applying the basic equations of this diffusive process (Van Oost et al. 2006) and considering the different olive orchard management approaches used over time. Thus, we have been able to differentiate between the soil losses linked to different processes for each plot of land studied. The experimental data obtained were used to calibrate the results of the model (for further details, see Vanwalleghem et al. 2011).

[10] See Fig. 7.1. The study sites correspond with the three places in the town where historic olive trees could be found, enabling application of the methodology of Vanwalleghem et al. (2010).

[11] Rainfall, slope gradient and soil type remained relatively stable throughout the studied period. Vanwalleghem et al. (2011) reconstructed rainfall trends for the study period based on a combination of instrumental and documentary records and concluded that there were no significant changes. Field observation of the soil profiles showed that, although approximately a third of the original soil thickness was lost, this did not yet affect productivity owing to the relatively thick original soils. Therefore, it can be safely concluded that soil type did not change drastically during the study period. Slope gradient has also remained more or less constant over time. Although small changes due to erosion and deposition are not to be excluded locally in areas of convex-concave catenas, most olive orchards are characterised by long, straight slope profiles, which are expected to have changed little in gradient.

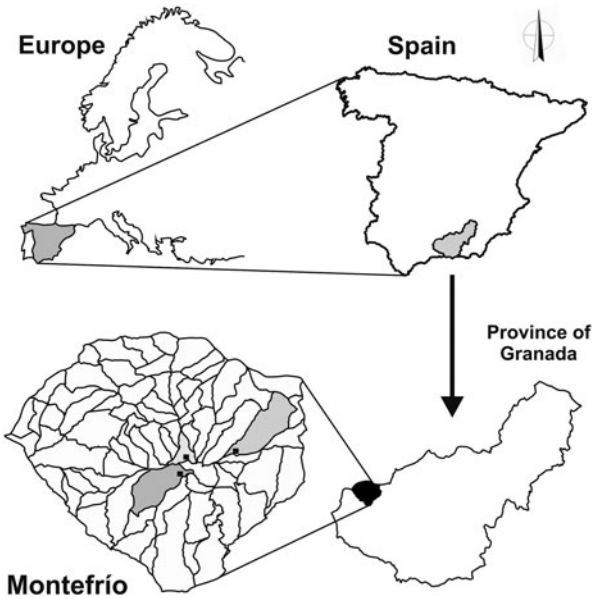


**Fig. 7.1** Location of Montefrío in relation to larger regional towns and the location of the three studied plots of land (shaded *grey* on the map of the town)

In the eighteenth century[12], the olive orchards of Montefrío were barely tilled once a year, using a few people and animals. From the mid-nineteenth century onwards, with the new liberal reforms[13] and subsequent demographic expansion, olive cultivation began to increase in the town. The sources describe greater intensity in soil management: the soil was tilled twice a year, between April and May, the bases of the olive tree trunks were dug out and, during the summer, manual reaping was replaced by very superficial tilling using harrow passes. In the late nineteenth century, the soil continued to be tilled at least twice a year, using more human and animal labour; hence, the soil remained bare for longer, and the risk of erosion consequently increased. This period also saw the introduction of the mouldboard plough. This technology penetrated the land even deeper, considerably increasing the risk of erosion.

From 1936 to 1975, the management of olive orchards changed radically. The autarchic policies implemented during Franco's regime discouraged the production

[12] The historical sources used to reconstruct these tasks were fiscal, cadastral and oral. Information for the second half of the twentieth century was obtained through interviews. All of the details of these sources and descriptions of the management approaches can be found in Infante-Amate (2011) and Vanwalleghem et al. (2011). A general description of olive management and its relation to soil erosion can be found in Infante-Amate et al. (2013).

[13] This primarily involved dismantling the Ancien Regime through the suppression of privileges for the nobility and the clergy, the liberalisation of the land and labour market, repopulation policies and the suppression of monopolies. All of these changes entailed a major advance towards mercantile production and encouraged the rotation of lands through new owners and the promotion of crops such as olive trees.

of olive oil (Tió 1982) and incentivised cereal crops (Christiansen 2002). Throughout the country, farmers sowed cereal crops between their rows of olive trees to alleviate these years of shortage, known as the "years of hunger". Therefore, paradoxically, soil losses under Francoism fell to historically low levels by increasing the amount of plant ground cover between olive trees.

The major change came in the early 1970s, when the use of tractors increased, replacing animal labour. The greater efficiency of mechanical traction enabled farmers to significantly increase tillage. At the beginning of the 1990s, another important change took place. Mouldboard ploughing, which was used during the spring to eliminate spontaneous ground cover, was replaced with the application of weed killers.

Comparing the soil loss in the olive orchards of Montefrío with the changing number of inhabitants of the town, we see that these two trends have not been parallel over the past two centuries. The common history of soil degradation and land use practices indicates that agriculture in Montefrío intensified as the population increased during the nineteenth century until significant soil losses occurred. In other words, in the context of pre-industrial production, there was a high correlation between population growth and erosion. This close coupling between population and soil degradation disappeared in the twentieth century. The institutional features of Francoism resulted in a drastic decline in soil erosion, while population size increased further; in the final decades of the twentieth century, soil degradation increased again to high levels because of the fast expansion and industrialisation of olive production at a time when demographic pressure reached historic lows.

Agronomic literature commonly points to soil degradation in olive orchards as one of the main environmental problems in this region (Beaufoy 2001; Gómez et al. 2008; Kirkby et al. 2004). However, in relation to the discussion here, it is worth examining the causes that precipitated this change. Was population pressure responsible? Figure 7.2 reveals that in recent decades, the number of inhabitants has been declining to all-time low figures, whereas soil degradation in olive orchards is achieving maximum levels. Boserupian analysis also proves to be insufficient here to account for the socio-ecological transition towards an industrial metabolic regime that occurred in Montefrío (Sieferle 2001).

## 7.5 Conclusion: A Sociometabolic Approach to Agrarian Intensification and Soil Degradation

Our case study demonstrates that soil degradation was changed over time, manifested with different levels of intensity and that there was no cause-effect relationship between productive intensification, which caused soil degradation, and population density. Intensification is better explained as a result of the "pressure of production on resources" (FAO 1995, p. 40), in other words, as a result of diverse socio-ecological factors. As Blaikie and Brookfield (1987, p. 4) said some time ago, it is "futile to search for a uni-causal model of explanation". Population continues to be one of the

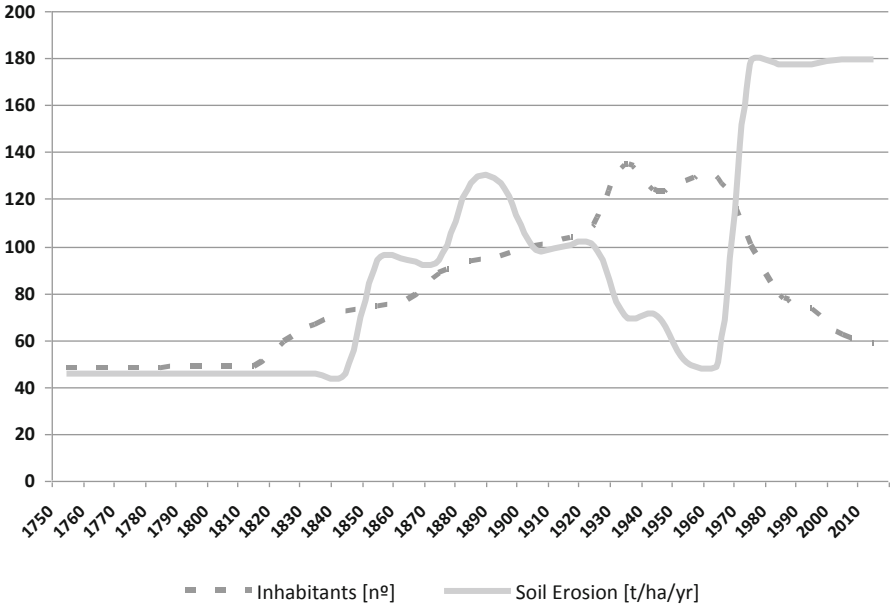


**Fig. 7.2** Evolution of soil erosion rates in the olive orchards in Montefrío and town population (Index 1900 = 100). (Source: Infante-Amate et al. 2013)

core variables affecting the functioning of the social metabolism and, at the same time, one of the factors that drive its transformation; but population growth cannot be considered to be the independent variable that explains the behaviour of the other variables.

Fischer-Kowalski et al. (2010) have indicated that the theory of agrarian change developed by Boserup is linear insofar as it describes a continuous process of development or intensification from a pastoral model to intensive agriculture, ignoring the changes that occur, for example, in the energy base of the society. The aforementioned case study provided by the authors seems better explained by the theory of sociometabolic transition than by the classic Boserupian theory. With the increasing use of fossil fuels in agriculture, the Boserupian link between the declining productivity of labour and the increase in population density is annulled and replaced by the link between the increase in fossil energy and industrial technologies and the increase in labour productivity (Fischer-Kowalski et al. 2010, p. 33).

We agree with these authors that the theoretical proposal of the social metabolism provides the instruments required to adequately explain both the intensification of production and the levels of soil degradation, a metabolic relationship that is configured differently over time in accordance with three major regimes (Sieferle 2001) and different energy bases. In other words, soil degradation must be explained without a specific configuration of the agrarian metabolism or the transition process from one metabolism to another (Haberl et al. 2011, p. 4). This provides a way of reconciling Boserup and Malthus. They both shared the idea that at the very heart

of socio-ecological change lies the relationship between the population and natural resources, although they understood the relationship between the two variables differently. This reconciliation must be founded on the acknowledgement that both the population and the stock of resources are mutually dependent.

The arguments proposed by Boserup should be expanded with two decisive contributions of the Malthusian tradition: on the one hand, the acknowledgement that natural resources are finite and that the possibilities for transformation are limited; and on the other hand, that social systems have not stopped growing since they first appeared. Precisely for that reason, reconciliation would entail assuming a more complex vision of population growth that does not only consider demographic components but also their level of consumption and the ways in which they relate to one another.

Ultimately, the intensification of production can lead to the generalisation of unsustainable management practices and, therefore, to soil degradation. However, this is not a linear process; instead, it responds to the conditions established in each metabolic regime. In this respect, the case study examined here allows us to identify two key phases in this process. The first phase was in the late nineteenth century, when erosion reached high levels, and nutrients were mined, which would have ensured sustainability in the medium term. The second phase was in the final few decades of the twentieth century, when soil losses were greatest and over-fertilisation appeared as one of the most serious environmental problems in the history of agriculture. The first phase was the result of the exhaustion of productive possibilities within a still organic or solar agrarian metabolic regime, which was therefore incapable of meeting the needs of the entire population, especially the poorest peasants. The agrarian liberal reforms favoured access to land for a very large group of peasants, and thus fostered population growth. Both factors, in the context of a solar energy-based economy (Sieferle 2001), forced productive intensity[14] to unsustainable levels. Although the development of a Boserupian strategy can be perceived over the course of the nineteenth century through the intensification of farming land, for example, by reducing fallow, this did not prevent the situation from later bordering on a Malthusian crisis, which resulted in sharp declines in biological standards of living and emigration (Cámara 2007).

In the late twentieth century, in contrast, within the context of an industrial metabolic regime and with a declining population, the pressure on the agro-ecosystem of Montefrío increased to levels hitherto unseen. The current economic situation of the sector, in which farmers are losing purchasing power, has been an incentive to opt for more invasive technologies, which in theory would allow them to multiply yields whilst saving on labour (Beaufoy 2001), following a pattern repeated elsewhere (Ananda and Herath 2003). The lack of adequate compensation for the costs derived from introducing plant cover also explains why the use of weed killers and the overuse of nitrogenous fertilisers continue to occur in spite of the negative effects on the soil.

[14] Understood as increases in management and primary production.

However, there are sharp differences between these two phases. The first was the result of the *exhaustion* of productive possibilities under an organic metabolic regime, and its effects were limited by the capacity for intensification offered by this regime. The second was a *structural* result of the model of agrarian intensification imposed by the industrial metabolic regime, based on continued productive effort. The rate of erosion and the levels of nutrient degradation in the soil were also much higher due to the widespread use of fossil fuels.

In any case, these two critical phases of soil degradation created the conditions for the beginning of a transition towards another metabolic regime. In the first case, pressure on resources in the context of organic production could only be relieved through the transition towards an industrial model. Currently, now that soil degradation in olive orchards is becoming one of the most severe problems for European agriculture (Kirkby et al. 2004), the situation looks ripe for a new transition towards a more sustainable metabolic regime (Haberl et al. 2011).

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# Chapter 8
# Beyond Boserup: The Role of Working Time in Agricultural Development

**Lisa Ringhofer, Simron Jit Singh and Marina Fischer-Kowalski**

**Abstract** This contribution investigates the role of working time in the course of agricultural development. In so doing, we revisit Ester Boserup's (1965, 1981) hypothesis of increasing land productivity at the expense of declining labour productivity as a consequence of agricultural intensification in subsistence communities. We introduce a theoretical framework that centres on human time as a 'limited' biophysical resource and compare the labour burden across gender and age of four subsistence communities, one each from India, Bolivia, Nicaragua, and Laos. While Boserup's claim applies to early stages of agricultural development, we find the dynamics to change with the introduction of fossil fuel based inputs into agriculture, leading to a rise in labour productivity. Despite these improvements, we still find overall labour needs to increase with agricultural intensification. Since household labour remains largely constant during the development process, the labour burden is primarily borne by women.

**Keywords** agricultural change · time use · industrial transformation · land and labour intensity · comparative case studies

## 8.1 Introduction

Many of the world's poor live in rural environments, where their livelihoods depend on smallholder agriculture, foraging or pastoralism.[1] Through regional and national development programmes, local communities increasingly aspire for

[1] According to the UNDP report (2008, p. 90), around three in every four people in the world who live on less than US $ 1/day reside in rural areas.

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modern lifestyles as they integrate their production systems into a global division of labour. In other words, the prevalent development model promotes the integration of remote communities into the market economy through industrial development approaches based on the use of fossil fuels, either directly (through the industrialisation of agricultural production) or indirectly (through specialised machinery). This appears to be the only means of escaping poverty.[2]

The ecological crisis of our current times cannot be understated. The crisis is global: 60 % of our ecosystems have been degraded (MEA 2005; Steffen et al. 2004), and in many respects, we have exceeded the safe operating space of the planet. The distortion of the nitrogen cycle is primarily attributed to industrial agriculture and the use of fertilisers (Rockström et al. 2009). As we head towards the erosion of our own natural resource base on a global level, these current development trends run counter to the increasingly accepted notion of sustainable development. A more sustainable global future therefore requires a broader search for pathways where short- and long-term benefits for people come at the lowest possible environmental cost and the lowest possible burden and stress on individuals in terms of working time (Haberl et al. 2004, 2011).

Guided by this focus on sustainable development, our primary aim is to gain a better understanding of these transition processes "at the periphery" along with the transformative potential and impacts that are generated at the society-nature interface thereof. The conceptual framework of sociometabolic transitions (Fischer-Kowalski and Haberl 2007) is an attempt in this direction. In this context, local rural subsistence communities have been empirically investigated to understand the systemic interrelations between food production systems and the resulting environmental pressures. Comparing and contrasting these cases in terms of their demographic, sociometabolic, and agro-ecological profiles has aided the modelling of development trajectories for larger regions. A variable that is often left out from such analysis is "time use" and its link to sociometabolic transitions. While we have previously illustrated our findings on the environmental pressures triggered by the specific material, energy and land use activities in the different communities (see Fischer-Kowalski et al. 2011), the focus of this chapter is the social pressure on individuals in terms of working time and how the burden of labour changes with agricultural development.

To this end, we revisit Boserup's (1965, 1981) theory of agricultural change in subsistence systems and, in particular, her hypothesis on increasing area productivity at the expense of labour productivity as a consequence of technological intensification in traditional farming systems. Boserup's theory provides a framework for comparing the burden of labour among four contemporary subsistence communities in the global south that are in different stages of agricultural development.

We will first provide a brief overview of Boserup's hypothesis, followed by our sociometabolic concept of human time as a (limited) biophysical resource. What follows is a brief description of the four case studies and methods used for data collection. We then present the main findings and conclude with a brief reassessment of our hypothesis.

[2] These strategies are also reflected in individual countries' Poverty Reduction Strategy Papers (PRSPs) funded and designed by the World Bank.

## 8.2 Theoretical Assumptions, Concepts and Methods

### *8.2.1 Returning to Boserup and Introducing Sociometabolic Concepts*

Boserup's "anti-Malthusian" argument posits that even in traditional agriculture, population growth does not fully translate into an increasing demand for land for food production. Instead, technical improvements and the learning process permit increased food production on the existing land. In effect, population density rises, with the same area sustaining a greater number of individuals. Land use intensifies and returns to prior levels upon unit area increase, resulting in a rising labour input into the land. Boserup envisages a progressive series of fallow reductions driven by population pressure. As intensification progresses, i.e., from long fallow systems to multiple cropping, there is a reduction in agricultural output per man hour that accompanies the vast increase in total output per area. Thus, the higher the output per area, the more hours the farmer must work for the same amount of produce. In other words, as the benefits of fallowing are sacrificed, workloads tend to rise (due to labour-intensive tasks such as weeding, fertilising and irrigating), leading to a decline in the efficiency of labour productivity.[3]

Boserup's hypothesis has also come to be regarded as one of the core elements of the theory of sociometabolic regimes. Further developed by Sieferle (1997, 2001) and other authors (Fischer-Kowalski et al. 1997), the theory claims that certain modes of human production and subsistence can be broadly distinguished. Regardless of the historical timeframe and biogeographical conditions, these modes share certain fundamental systemic characteristics that derive from the way humans interact with nature. These subsistence modes or *sociometabolic regimes* differ according to the source of energy used and the main technologies of energy conversion. The theory distinguishes among hunters & gatherers, the agrarian and the industrial regime.[4] These three different *sociometabolic regimes* exhibit substantially different *metabolic profiles* (i.e., the quantity of materials and energy used per capita and year) and varying usage of land resources. The allocation of human time (as a limited biophysical resource contingent on demographic factors) has been integrated more recently into

[3] Stone (2001) maintains that the key to Boserupian intensification is that the labour costs of intensification are both necessary and sufficient to raise production concentration. They are necessary because higher production requires a proportionate increase in work and sufficient because the proportionate increase in work succeeds in raising output.

[4] Traditional subsistence systems, such as hunters & gatherers and the agrarian, depend almost completely on solar energy. However, while hunters & gatherers are "passive" users of solar energy (insofar as they live on the available resource base in their territory), agrarian regimes mainly rely on an "active" and controlled utilisation of solar energy through the use of biotechnologies and mechanical devices. In other words, peasants try to channel solar energy into a few plant species they wish to produce by changing the land cover, with the cost of an increased human labour requirement that continues to increase with agricultural intensification. The industrial sociometabolic regime, conversely, transcends the limitations of relying on available solar energy by utilising fossil fuels.

this theoretical framework, with the goal of establishing a link between the intensification of land, energy, and material use and how these factors impact the need for increasing working time. Framed differently, having sufficient disposable time for engaging in social and cultural activities is a measure of well-being.

Contrary to Boserup's claim of incremental agricultural development progressing from long fallow systems to multiple cropping, the sociometabolic theory presents a different view of "transitions" between regimes: the shift between energy regimes is instead associated with a major transformation of society (such as the Neolithic and Industrial Revolutions in the past). Sociometabolic regimes are not viewed as static. Instead, they consist of a set of opportunities and constraints within which certain dynamics occur. However, if the dynamics transcend or are pushed out of the boundary conditions of the regime by exogenous forces, turbulence will ensue with an unpredictable outcome anywhere between a collapse of the social system (Leemans and Costanza 2005; Tainter 1988) and a transition into another sociometabolic regime (Fischer-Kowalski and Haberl 2007).

### *8.2.2 Human Time as a Biophysical Resource*

Within our theoretical framework, human time is characterised by the following metabolic characteristics. First, and analogously to the other relevant biophysical resources (materials, energy and land), human time is a limited resource. Each individual has 24 h per day at his/her disposal. All human time has to be used in some manner, and preference for one activity over another is contingent on culturally prescribed means of self-maintenance and reproduction. In addition, each human lifetime hour, whether "productive" or not, requires a certain metabolic input (i.e. matter and energy). Otherwise, social conflict arises, and people starve and die. The time at one's disposal, whether one's own time or that of other individuals, is one critical indicator of freedom and power. How human time is used, therefore, is a crucial variable that determines and is determined by the system's social metabolism and its regime transitions. In some instances, societies have resisted transitions from hunting and gathering to agriculture because they were not prepared to invest the greater amount of labour time required; in contrast, the willingness of other societies to do so paved the way for agricultural transitions (Carlstein 1982; Ellen 1982).

#### 8.2.2.1 Labour Time Studies Revisited

Research on the allocation of human labour time has a long tradition in the social sciences, especially in sociology, anthropology and economics. An underlying assumption of all these studies is that human time is a limited resource that needs to be budgeted.

Early sociological time studies dealt predominantly with exploring the social conditions of the rising working class. In the early 1930s, a whole new era of work/leisure

studies was launched. Within the range of emerging time diary literature, *Time Budgets of Human Behaviour* (Sorokin and Berger 1939) provided one of the most intriguing insights into sociological and psychological stimuli for daily time use. Since the 1950s, the effects of longer working hours have become increasingly analysed through the lens of comparative time use data. Perhaps the most ambitious multi-country time use study was the Multinational Time Use Study directed by Szalai (1972) in the mid-1960s or, more recently, Gershuny's (2000) Multinational Time Budget Data Archive.

In contrast to the sociological tradition of quantifying time use, earlier anthropological studies commonly relied on qualitatively describing the "daily round" of the communities studied (Evans-Pritchard 1940; Malinowski 1935). Generally more theory-driven, notable attempts have been made to test two general theories related to time use. One is the role of "leisure time" in cultural evolution. It has been argued that development in arts and science is only possible once communities can move away from the drudgery of subsistence (Steward 1955). In contrast, Sahlins (1972), Lee (1979), and several others tried to show that leisure time is not a sufficient condition for the development of civilisation. They showed that hunters & gatherers could meet their needs with only approximately 1–3 h of work each day, leaving plenty of time for leisure and idleness. This argument, highly debated by Sahlins' critics (see Bird-David 1998; Johnson 1975; Kaplan and Lancaster 2000), is neatly captured in Sahlins' classic text *Stone Age Economics*, whose first chapter is dedicated to the "original affluent society". The second theory that has received considerable attention in anthropology is Boserup's (1981) thesis of declining labour productivity with agricultural intensification, as previously discussed.[5] While a large number of empirical studies lend support to Boserup's argument (Ellen 1982; Grigg 1974; Netting 1977, 1993; Sahlins 1972), some have rejected the "decline thesis" (Conelly 1992; Harris 1971; Hunt 2000; Padoch et al. 1985).

More recent anthropological publications on working time among horticultural societies include Johnson's (1975, 2003) account on the Matsigenka of Peru and Descola's (1996) study of the Achuar ethnic group in the Ecuadorian Amazon, both of which have substantially contributed to establishing a standard approach to time allocation studies.[6] Some of the questions that these studies address relate to time spent on acquiring protein from hunting and fishing, the efficiency of hunting using traditional and modern weapons, the benefits of development assistance in terms of

[5] A different approach to labour productivity comes from the field of ecological anthropology. Rappaport's (1968) detailed monograph Pigs for the Ancestors, whilst striving to document the interdependence of cultural phenomena and biophysical variables, provides interesting data on energy expenditure during labour processes through the application of time-and-motion studies.

[6] Allen Johnson (1975) is considered a pioneer in terms of activity coding and classification among non-market societies. We adopted his activity coding (1975) for our own studies and restructured, added or eliminated certain activities that were not of particular relevance for our own purposes. He later provided an overview of systematic observation methods (Johnson and Sackett 1998). Gross (1984), one of Johnson's students, conducted interesting research on behavioural approaches in time allocation research, and Baksh (1989, 1990) further refined the methodological approaches for instantaneous spot check sampling.

labour-saving devices, the economic importance of child labour in agrarian societies (see also Cain 1980), and the contribution of women to domestic reproduction (Antonopoulos and Hirway 2010; Gross 1984).

Within the field of economics, Becker (1965) emphasised the value of time at the household level, instigating the so-called "New Household Economics". His approach applies economic analysis to household behaviour and emphasises the importance of time in household production and consumption activities. In recent development literature, the concept of "time poverty" or "time stress" (see Hirway 2010, p. 26) refers to the burden of work on the poor, especially on women, that restricts the choices available to them in selecting activities.[7] In the wider context of sustainability, the consideration of human time as a key resource remains somewhat uncommon (the few exceptions include Giampietro 2003; Pastore et al. 1999; Ringhofer 2007, 2010, 2013; Schandl and Grünbühel 2005).

In our theoretical approach, we consider human time to be a *limited and fairly evenly distributed* resource, whose availability depends on the number of people within a social system and their reproduction rates. In contrast to previous time use traditions, we are primarily interested in human time as a resource on the social system level.[8] At the same time, we perceive the investment of human time as a means to reproduce certain subsystems within a social system. These subsystems allow time invested for one's personal maintenance and development to be distinguished from that of time invested for household or social reproduction. The four time-relevant subsystems of the social system are the person system, the household system, the community system, and the economic system. We allocate the time spent on various activities to the respective functional subsystem that is being reproduced. To ensure comparability, the coding and classification used do not differ substantially from what is commonly found in sociological and anthropological time use studies.[9]

The *person system* functionally serves personal reproduction and includes all those activities that cannot be delegated or "outsourced" to others. It holds all of the physiologically necessary functions for a person's self-reproduction, such as sleeping and eating, and it encompasses functions for extended reproduction, such as studying, leisure activities or idleness.

The *household system* serves as the organisational basis for biological reproduction and fulfils the function of basic day-to-day reproduction as a group, such as child rearing and food preparation. The system also encompasses functions that ensure long-term maintenance of the household, such as repair and maintenance

[7] Within this concept, one important indicator of well-being is leisure, the time spent on rest and relaxation.

[8] From the perspective of ecological economics, Pastore et al. (1999) conducted a land-time budget (LTB) analysis for various villages in rural China, examining demographic variables, land availability and land use, time availability, labour time use and cash flows. The LTB analysis was one of the first approaches treating land and time use as an opportunity or constraint at the social system level.

[9] The time use categories developed for statistical monitoring of the European Union (Eurostat 2001, 2007) have been largely followed in our four cases.

work. The household system is typically organised as an exchange of unpaid labour according to the socio-cultural norms regulating age and gender roles in society.

The *community system* on the next higher functional level contributes to the reproduction of reciprocal relationships and shared beliefs as well as political decision making. In non-industrial societies, the community system may be regarded as a predecessor of more specialised systems, such as politics, religion or the judicial subsystem.

The *economic system* extends beyond the household, even though part of its function consists of supplying households and individuals with life-sustaining commodities (with economic "food provision" sometimes difficult to distinguish from household "food preparation"). The economic system reproduces the society, in a division of labour and functional interdependence beyond the household, and manages most of what was described as social metabolism above. Under modern conditions, the economic system typically functions on the basis of paid labour. Under premodern conditions, economic activities may simply be an additional function of households or communities.

## 8.3 Description of the Cases

### *8.3.1 Introducing Trinket, Campo Bello, Sabawas, and Nalang*

To test Boserup's theory, we classify and position the four cases by—to use Boserup's terminology—their degree of "agricultural intensification". We do this by examining basic demographic data and a few agro-ecological indicators of food production and consumption. If we consider population density to be an indicator of population pressure on land, Trinket has by far the lowest density (0.11 cap/ha) and the lowest rate of population growth. The other three communities, Campo Bello, Sabawas and Nalang, all have similar population densities (approximately 0.40 cap/ha) and fairly high population growth rates (2.5–4 % annually). Food system information also provides insight into the relative position of each of the cases. With respect to food production, we find a gradual increase from Campo Bello to Sabawas to Nalang, with Nalang also having the highest percentage of nutritional energy derived from agriculture. Fishing and foraging contribute to the food intakes in all four communities. While the percentages in Campo Bello, Sabawas, and Nalang range from 7 to 16 %, Trinket derives almost 70 % of its food energy from fishing and foraging. Thus, in terms of food production, Trinket stands out as a community that is predominantly dependent on hunting and gathering as the mode of subsistence. From this analysis, we have provisionally ranked the cases along a "Boserupian axis" from Trinket to Nalang (Table 8.1).

Trinket Island is located in the Nicobar archipelago (India) and had 399 inhabitants in 2001. Because it can only be accessed by canoe or diesel-engine boat at high tide, the island has remained quite isolated, and the people of Trinket continue to live

**Table 8.1** Basic demographic and food production data

| | Trinket<br>Forager-Horticulturalist | Campo Bello<br>Shifting cultivation<br>(Short fallows) | Sabawas<br>Shifting cultivation<br>(Short fallows) | Nalang<br>Intensive rice cultivation<br>& shifting cultivation |
|---|---|---|---|---|
| *Demographic data* | | | | |
| Population (cap) | 399 | 231 | 290 | 702 |
| Community area (ha) | 3,626 | 615 | 652 | 1,630 |
| Population density (cap/ha) | 0.11 | 0.38 | 0.44 | 0.43 |
| Population growth (%/a) | 1.5 | 3.8 | 2.5 | 3.0 |
| Share of population below age 15 (%) | 39 | 61 | 55 | 45 |
| *Food production and consumption* | | | | |
| Food production (GJ/a) | 2,820 | 1,840 | 2,792 | 3,752 |
| Food consumption (GJ/a) | 1,752 | 940 | 1,383 | 3,320 |
| Nutritional energy from agriculture (%) | 30.7 | 84 | 84.5 | 92.6 |
| Nutritional energy from F/H/G (%) | 69.3 | 16 | 15.5 | 7.4 |
| *Staple food production (SFP)* | | | | |
| Area for SFP incl. fallow (ha) | 29 | 200 | 238 | 139 |
| Share of area for SFP (%) | 1 | 33 | 37 | 9 |
| Labour hours for SFP (1,000 h/a) | 25 | 114 | 153 | 213 |
| Fossil energy input per Area (GJ/ha) | 0 | 0 | 0 | 1.2 |

Note: The staple foods are rice, cereals and tubers; in the case of Trinket, the staple food is copra. F/H/G stands for fishing, hunting and gathering

relatively traditional lifestyles. The primary activities of the local population are fishing and gathering, the growing of coconuts and the bartering of *copra* (dehydrated coconuts) in exchange for market commodities. Some families also cultivate food gardens, which they maintain with simple tools, such as sickles, axes, and spades. Despite low agricultural production—the total area for staple food production amounts to only one-third to one-fifth of the areas used in the other communities—fossil energy inputs are by far the highest in Trinket. This is a direct result of a state-induced subsidy programme for transport infrastructure that promotes the sale of cheap diesel and kerosene (Singh 2003; Singh and Grünbühel 2003; Singh and Schandl 2003; Singh et al. 2001).

The indigenous community of Campo Bello (Bolivia) is situated in the Bolivian Amazon plains with 231 inhabitants in 2004. About one-third of the community's total area comprises the agricultural area for staple food production. Rice, maize, and manioc are typically grown using only simple technology, such as machetes, sickles, hoes, and rice seeders for sowing rice. Much of the rice is sold at the market for cash immediately after the rice harvest, while plantains are generally marketed throughout the year. The local diet is complemented by protein sources from fishing and foraging that account for about one-fifth of the total nutritional energy inputs into the system. Still largely secluded and self-contained, the village has witnessed a number of development projects introduced by the local administration and non-governmental agencies (Ringhofer 2007, 2010, 2013).

The remote indigenous community of Sabawas (Nicaragua) with a population of 290 people in 2008 is located in the territory officially named Mayangna Sauni As. In the early 1980s during the Contra War, the whole territory was abandoned, and Sabawas remained uninhabited for almost 10 years until repatriation began in 1994. Almost 40 % of the community's total area is used for staple food production. The agricultural activity includes the farming of upland rice, plantains, banana, maize, and velvet beans with simple machetes, spades, hoes, and axes. Because transport opportunities are limited, the marketing of these crops is erratic, and crop cultivation is largely subsistence based. The importance of farming is reflected by the high nutritional intake from agriculture, at nearly 85 %. The local diet is complemented by proteins from fishing and foraging that account for the remainder of the total nutritional energy inputs into the system (Ringhofer et al. 2010).

The multi-ethnic community of Nalang (Laos) with a population of 702 people in 2001 combines swidden agriculture with permanent paddy rice production. Despite having similarly sized areas for staple food production, the energetic returns in Nalang are twice as high as in Sabawas and almost three times higher than in Campo Bello. This is attributable in part to fossil fuel input in the form of motor-ploughs, accounting for 1.2 GJ/ha. Greater ease of transport following the construction of a road in the 1980s also triggered increased market integration: cucumber was introduced as an important cash crop during the dry season, and traditional buffalo rearing is gradually losing importance. Although buffaloes continue to be reared in Nalang, the arrival of the motor-plough in the mid-1990s has diminished the agricultural need for them. In terms of meat production, buffaloes are gradually being replaced by cattle, largely because of the shorter maturing times of cattle (Mayrhofer-Grünbühel 2004).

### *8.3.2 Methods of Data Collection on Time Use*

The data collection methods vary between the case studies. Meanwhile, a more systematic methodology has been developed containing comparable time use indicators (Ringhofer 2010, Singh et al. 2010), and considerable efforts have been made to transform the time use data from earlier studies into the new scheme.

In the case of Trinket, we used "time-frame" analysis focussing only on certain activities observed repeatedly (a sample size of 3–5 observations for each activity). The duration of these activities and the participants (in terms of gender and age) were recorded. These activities were then weighted according to their annual frequency and used to calculate the average daily hours. Interviews were conducted for the household activities. Time use for the person system was calculated as a residual. As the most recent empirical studies, the time use analyses for the communities of Campo Bello and Sabawas were conducted systematically, with people observed for days during their waking hours. In Campo Bello, the sample consisted of 12 male and 13 female days (each including four children between the ages of 6 and 15). In addition to these samples, a total of 112 spot checks were performed, thereby obtaining two more person days. In Sabawas, the sample consisted of 13 male and 11 female days (including three children between the ages of 6 and 15 and 2 adults over the age of 60) who were "shadowed" at different times of the year, thus covering seasonal differences. Household interviews and direct observation were used for cross-checking. Average time use and standard deviations were calculated for all four subsystems mentioned above. In the case of Nalang, both of the above-mentioned methods were used. The sample size was 23 females and 23 males (including 10 girls and 11 boys). In addition to observation, the context and meaning of the activities performed were validated by interviews in all cases. To obtain system level data, the frequency of these processes across the members of the community and the year was estimated and used for weighing.

## 8.4 Findings

To what extent does Boserup's (1965, 1981) claim still hold and aid our understanding of today's agricultural transitions? And what can we learn about the overall burden and stress in terms of working time across gender and age? Using the ranking of our cases along the "Boserupian axis" discussed in the previous sections, we organise the findings in the following way. First, we examine land and labour productivity and seek to test Boserup's claim of the dynamics of agricultural intensification. Second, we present the labour investments in the economic and household systems along with the resulting social distribution of the labour burden in the different communities.

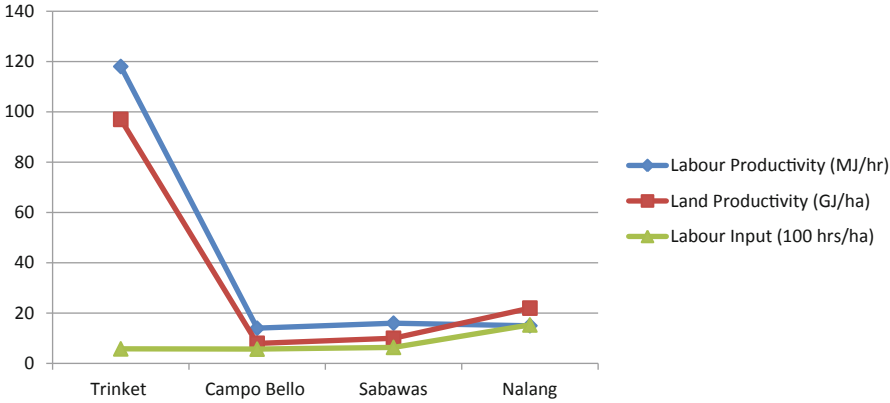


**Fig. 8.1** Labour and land productivity in staple food production

### *8.4.1 Land and Labour Productivity*

Judging from the results shown in Fig. 8.1, our cases do not seem to conform with Boserup's hypothesis of agricultural intensification. As the first example, Trinket is characterised by land and labour productivity conditions that are substantially more favourable than those of the other cases. Both land productivity (how much land is required to produce a certain amount of nutritional energy) and labour productivity (how much work is required to realise this energy harvest) are far higher than in any of the other communities.[10] Considered from another perspective, it appears that no incremental evolutionary pathway of agricultural intensification would lead from a sociometabolic system of hunting and gathering like that of Trinket, however atypical, to a system resembling those of the other communities. With such high productivity levels, it would seem completely irrational to alter course in favour of a more intensive production mode, considering declining returns on land and labour. Thus, a sociometabolic system like that in Trinket will either persist or collapse rather than being gradually transformed into an agrarian system similar to those in the other cases. In effect, the hypothesis of distinct sociometabolic regimes is supported by this example: communities such as Trinket adhere to a sociometabolic regime of hunters & gatherers, however atypical, with no continuous, non-disruptive pathway leading from this regime to an agrarian regime. It takes a major transformation, a "transition", for a community to transcend this mode of subsistence (Fischer-Kowalski et al. 2011, p. 153 f.).

Campo Bello and Sabawas are both "traditional" (Boserup 1981) production systems insofar as fossil fuel-based inputs and animal traction are not used for any of

[10] With the exception of some pig rearing, the inhabitants of Trinket do not engage in agricultural tasks. Instead, they grow coconut palms and exchange dried coconut flesh (copra) for rice on the market. The high land and labour productivity of Trinket therefore reflects the good exchange conditions of copra to rice.

**Table 8.2** Daily time investment per adult for all four subsystems

| | Average Adult 16–60 (h/d) | | | |
|---|---|---|---|---|
| | Trinket | Campo Bello | Sabawas | Nalang |
| Total population size | 399 | 231 | 290 | 702 |
| Population size 16–60 | 244 | 91 | 121 | 356 |
| *Person System (PS)* | *18.45* | *13.21* | *13.00* | *14.34* |
| *Household system (HS)* | *3.23* | *3.79* | *3.70* | *3.68* |
| Care for dependents | 0.00 | 1.59 | 1.50 | 0.46 |
| Food preparation | 1.09 | 1.07 | 1.00 | 0.69 |
| House building | 0.00 | 0.26 | 0.25 | 1.43 |
| Repair/maintenance work | 0.16 | 0.34 | 0.35 | 0.00 |
| Domestic chores | 1.98 | 0.64 | 0.60 | 1.10 |
| *Economic system (ES)* | *1.19* | *4.69* | *4.75* | *5.85* |
| Agriculture/horticulture | 0.07 | 2.32 | 2.25 | 3.06 |
| Hunting | 0.00 | 0.46 | 0.45 | 0.00 |
| Fishing | 0.58 | 0.35 | 0.30 | 0.44 |
| Gathering | 0.00 | 0.17 | 0.20 | 0.15 |
| Trading | 0.39 | 0.43 | 0.45 | 0.00 |
| Wage work | 0.00 | 0.27 | 0.25 | 1.46 |
| House garden | 0.02 | 0.21 | 0.25 | 0.00 |
| Handicraft | 0.00 | 0.41 | 0.40 | 0.13 |
| Animal husbandry | 0.14 | 0.02 | 0.20 | 0.61 |
| *Community system (CS)* | *1.13* | *2.32* | *2.55* | *0.12* |
| Annual labour time ES (h/a) | *434* | *1,711* | *1,733* | *2,135* |
| Daily labour time HS + ES (h/d) | *4.42* | *8.48* | *8.45* | *9.54* |

their agricultural activities. Nalang, however, uses some fossil fuel input (1.2 GJ/ha), in the form of motor-ploughs for rice production. Considering the use of fossil fuels, the relationships among the three communities would most likely comply with the Boserupian hypothesis: with intensifying food production, there is indeed increased yield per unit area, resulting in increased labour input and declining labour productivity. Without fossil fuels, Nalang would likely have a much lower labour productivity than that shown in Fig. 8.1. The use of fossil fuel-based and labour-saving technologies in agriculture, which are not considered in Boserup's theory, reduces the need for human labour and makes human labour hours appear more productive.

### *8.4.2 Overall Labour Time Investment in the Different Communities*

How do these intensification dynamics relate to the overall distribution of working time in the four communities? Alternatively, what conclusions can be drawn regarding the sharing of the labour burden across gender and age? To address these questions, Table 8.2 presents an overview of the daily hours invested in the individual subsystems, i.e., the person system, the household system, the economic system, and the community system.

While the person system draws by far the most time resources, with sleep representing the greatest component, the overall time investments in the community system are relatively low in all four communities.[11] The time resources associated with the economic system steadily increase from the agrarian community of Campo Bello to Sabawas to Nalang. Trinket's labour requirements for the upkeep of the economic system are much lower, amounting to only one-fourth of the relative time investments of Campo Bello and Sabawas and one-fifth of that of Nalang. Trinket's daily working time for the average adult (16–60 years) is slightly over 1 h, accounting for 434 h annually. This is barely more than a quarter of the workload common in OECD countries. As for the "traditional" agrarian cases, 4–6 h are required daily from every adult for the upkeep of the economic system, which amounts to annual economic working times of 1,711 h per adult in Campo Bello, 1,733 h in Sabawas and 2,135 h in Nalang. These values are comparable to the approximately 1,800 annual hours per economically active[12] in the US and Japan and are above the averages for the European Union (Groningen database 2005).

Not surprisingly, we find that agro-horticultural activities represent the predominant component in the fairly similar agrarian communities of Campo Bello, Sabawas and Nalang, accounting for about half of all the time resources invested in the economic system. Trinket's agricultural labour time, however, constitutes a mere 6 % of total labour time inputs. Interestingly, despite Trinket's extremely low time investment in agriculture (the agricultural labour requirements in Campo Bello and Sabawas are approximately 30 times greater than that of Trinket, whereas Nalang's labour requirements are 40 times greater), the local nutritional energy returns from agriculture (Table 8.1) account for a quite substantial 30 %, which is roughly one-third of the agricultural energy harvests of the agrarian communities. Although Trinket and Nalang invest about the same daily time resources for fishing and gathering, Nalang receives less than one-tenth of its nutritional energy from these sources, while Trinket's returns from these activities cover almost 70 % of their total nutritional requirements. Cash-producing activities, e.g., wage work, trading and the production of saleable handicraft, require only about half as much time than agricultural activities in the agrarian cases, while Trinket's investment in trading is about four times higher than in agriculture. Wage work draws more than 2 h of an adult's day in Nalang, while in the other agrarian communities, it is far less significant than other cash-producing activities, such as the production and sale of handicrafts as an additional source of income.

[11] What influences the time investment into the community system, and what differences (in terms of social integration and cohesion, for example) arise from the amount of time spent? Unfortunately, our data on community time investment cannot be used to address these questions because of uncertainties in measurement and classification.

[12] One should be aware of the difference between "average per adult" (which includes all individuals over the age of 14) and "average per economically active", which in OECD countries is about half the adult population over 14 years of age. Therefore, these working hours in subsistence agriculture communities are really very high!

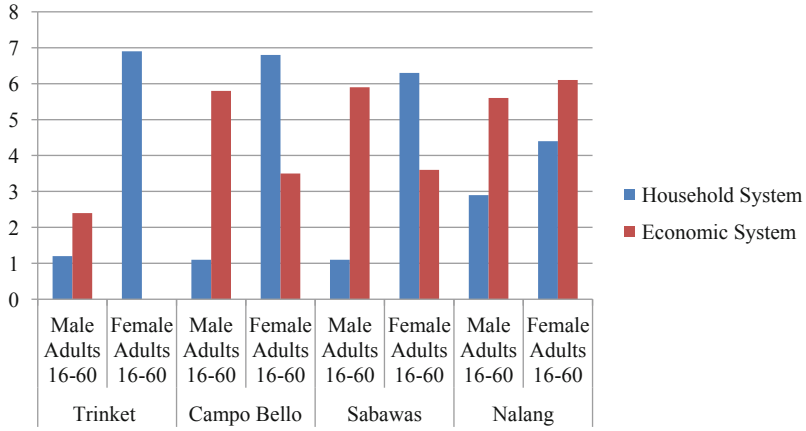


**Fig. 8.2** Gender differences in labour time

One interesting finding is that household labour draws similar time investments in all four cases, accounting for 3.2–3.7 h per average adult.[13] Most of this time is invested in the day-to-day reproduction of the household, including child care, food preparation and domestic chores. As described in the section below, this involves a constantly higher labour burden for women throughout the development trajectory.

#### 8.4.2.1 Gender Differences in Labour Time

With respect to gender, a tentative interpretation of our data shows that the upkeep of the household system predominantly remains in the hands of women throughout "agrarian development". In Trinket, Campo Bello, and Sabawas, household labour draws 6–7 h from an adult woman's daily time resources, while male labour contribution to the household system accounts for little more than 1 h per day. In contrast to the other cases, Nalang's household labour seems to be more evenly distributed between the sexes (Fig. 8.2). In terms of the specific types of tasks, we find a fairly similar division of labour chores between men and women. While female labour largely entails activities for the system's day-to-day reproduction, male labour tends to contribute to the long-term maintenance of the household (e.g., house-building, repair, and maintenance work).

As shown in Table 8.3, overall labour in the economic system increases with "agrarian development", and judging from our data, so does a woman's labour contribution. With the exception of Trinket, where women do not invest any labour in economic activities (and men's work is limited to little more 2 h a day), we find a substantial almost 3-h increase in a woman's workload from the fairly similar agrarian communities of Campo Bello and Sabawas to the more "agriculturally intense" community of Nalang. Though male labour is the predominant component

[13] More detailed data reveal a stagnant 2.1 daily hours per inhabitant.

**Table 8.3** Male and female daily labour time (h/d) in all four communities, incl. the contribution of children in Campo Bello and Sabawas

| | Trinket | | Campo Bello | | | | Sabawas | | | | Nalang | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male adults 16–60 | Female adults 16–60 | Boys 6–15 | Girls 6–15 | Male adults 16–60 | Female adults 16–60 | Boys 6–15 | Girls 6–15 | Male adults 16–60 | Female adults 16–60 | Male adults 16–60 | Female adults 16–60 |
| Household system (HS) | 1.2 | 6.9 | 1.8 | 2.9 | 1.1 | 6.8 | 0.8 | 1.5 | 1.1 | 6.3 | 2.9 | 4.4 |
| Economic system (ES) | 2.4 | 0.0 | 2.6 | 2.6 | 5.8 | 3.5 | 2.7 | 2.4 | 5.9 | 3.6 | 5.6 | 6.1 |
| *Daily labour time HS + ES* | *3.6* | *6.9* | *4.4* | *5.5* | *6.9* | *10.3* | *3.5* | *3.9* | *7.0* | *9.9* | *8.5* | *10.5* |

in agriculture in Campo Bello and Sabawas, the role of women in agriculture is important and highly valued. Women contribute about two-thirds of their overall economic labour time to agro-horticultural tasks. The small remainder is invested in subsistence fishing and gathering (hunting is solely ascribed to men in all of the communities) and market involvement (through the production of saleable handicraft, trading and wage work). In Nalang, the only community that uses fossil fuel-driven technology for agricultural production (i.e., motor-plough), a woman's contribution to the daily economic labour time is slightly higher than that of her male counterpart. This finding illustrates that the labour-saving motor-plough may have alleviated the workload of men in rice production, while many other labour-intensive agricultural tasks continue to be performed by women.[14]

If we define the daily working time as the total amount of time invested in the household and economic system, a steady increase of working time for both sexes would be expected for "agricultural intensification". In all of these stages, however, we find women working longer hours than men. For men, the low daily work burden of 3.6 h in Trinket cannot be sustained by agrarian production systems. In the more "traditional" (Boserup 1981) production systems embodied by Campo Bello and Sabawas (insofar as fossil fuel-based inputs and animal traction are not used), the daily male labour requirement nearly doubles. The use of agricultural technologies may relieve a man's economic work burden in Nalang; his contribution to the long-term maintenance of the household, however, increases. Similarly for women, a 7-h workday (Trinket) cannot be sustained with increased agricultural production when her contribution levels off at approximately 10 h a day. When women continuously work longer hours, they have less time available to spend for personal reproduction activities, such as studying, leisure, or idleness. Detailed data from Campo Bello show that adult women get less sleep than men, which may contribute to illness and premature death in the long run.

One interesting, albeit tentative, finding is that even communities with a relatively low labour burden per individual (such as Trinket) tend to display the same pattern of labour allocation by gender as more labour-intensive agrarian communities. However low the economic labour burden may be for men, a woman's share in household labour is fairly consistent throughout "agricultural development".

#### 8.4.2.2 The Contribution of Children to Labour Time

Finally, we examine the contribution of child labour in the different communities.[15] Table 8.4 shows that the children's share in the overall time budget of the communities

[14] A similar situation is observed in Campo Bello, where the application of rice seeders, as opposed to traditional rice planting, saves up to 12 days of labour in annual rice production. These technologies, however, are solely handled by men, while women continue to engage in laborious traditional planting, weeding and harvesting (Ringhofer 2010).

[15] Child labour in Trinket was observed but not systematically registered. Therefore, the contribution of children to labour processes is based on estimations. Additionally, this section focuses instead on the cases of Campo Bello and Sabawas, where child labour contribution was most systematically observed.

**Table 8.4** Children's share in community working time

| | Trinket | Campo Bello | Sabawas | Nalang |
|---|---|---|---|---|
| Population size | 399 | 231 | 290 | 702 |
| Population growth (cap/a) | 1.5 | 3.8 | 2.5 | 3 |
| Number of children below 15 | 155 | 137 | 159 | 318 |
| Share of population below 15 (%) | 39 | 59 | 55 | 45 |
| Children's share in the total community labour time investment (%) | *39* | *61* | *51* | *45* |

**Table 8.5** Children's daily investment of household and economic labour in Campo Bello and Sabawas (h/d)

| | Campo Bello | | Sabawas | |
|---|---|---|---|---|
| | Boys 6–15 | Girls 6–15 | Boys 6–15 | Girls 6–15 |
| *Household system (HS)* | *1.8* | *2.9* | *0.8* | *1.5* |
| Care for dependents | 0.5 | 1.5 | 0.2 | 0.6 |
| Food preparation | 0.2 | 0.5 | 0.0 | 0.3 |
| House building | 0.0 | 0.0 | 0.1 | 0.0 |
| Repair/maintainance work | 0.2 | 0.2 | 0.2 | 0.2 |
| Domestic chores | 0.9 | 0.7 | 0.3 | 0.4 |
| *Economic system (ES)* | *2.6* | *2.6* | *2.7* | *2.4* |
| Agriculture/horticulture | 0.8 | 0.2 | 0.8 | 0.3 |
| Hunting, fishing and gathering | 1.1 | 1.5 | 1.2 | 1.6 |
| Trading | 0.0 | 0.3 | 0.0 | 0.0 |
| Handicraft | 0.6 | 0.4 | 0.5 | 0.3 |
| Animal husbandry | 0.1 | 0.2 | 0.2 | 0.2 |
| *Daily labour time HS + ES* | *4.4* | *5.5* | *3.5* | *3.9* |

is 61 % in Campo Bello, 51 % in Sabawas, 45 % in Nalang and 39 % in Trinket. Thus, in terms of available "live" hours, children below the age of 15 play a major role in all four communities.

We find the highest ratio of child labour in Campo Bello (61 %), in which the percentage of the population under 15 years of age is also highest. More detailed data reveal that about one-third of the community's total labour invested in the household system is contributed by children aged 6–15 years. This is more than double the contribution of children to household labour in Sabawas, where the percentage of the population under 15 years of age is almost as high as in Campo Bello. It should be noted that in Campo Bello, children of both sexes engage in reproductive household labour such as child care and food preparation until about the age of 10, when they gradually become socialised into their gender-assigned roles. This pattern is less prevalent in Sabawas, where reproductive household tasks are mostly carried out by girls and female adults. Girls in Sabawas invest twice as much time as boys in the daily reproduction of the household system (Table 8.5).

The economic system draws similar time resources from boys and girls in Campo Bello and Sabawas. Agricultural activities appear to be a predominantly male domain in both villages. In Campo Bello, a boy starts to cultivate his own fields at around 12 years of age, even if it seems to be more of an educational activity. In Sabawas, a boy's

contribution to agriculture tends to involve assistance tasks, such as the transport of plantains or the fetching of seeds (see Ringhofer 2010). Hunting and fishing is carried out in a more playful manner.[16] For girls, fishing and gathering represents the predominant component of their time investment in the economic system.

Clearly, children do lighter work and may do it less efficiently than adults. Nevertheless, approximately one-third of the total labour hours in Campo Bello and Sabawas are contributed by children. As documented by Fischer-Kowalski et al. (2010), children in Campo Bello also spend approximately the same fraction of their day working as the average inhabitant.

In addition to making up a smaller percentage of the populations of Nalang and Trinket, children in these communities also appear to have a lower labour burden. Due to their substantially lower share in household and economic work, they have the opportunity to spend the remainder of their day on person system activities, such as studying and personal recreation.

These results, however selective, lend support to Cain's (1981) argument that agricultural communities with higher demographic proportions of children place a high labour burden on them. Framed differently, communities in which children are considered of high use value in terms of labour contribution (either for technological or cultural reasons) tend to have more children. We find that the community with the highest percentage of the population under 15 years of age (61 %) also has the highest share of child labour (Campo Bello). Sabawas, the community with the second highest child population (55 %), also places a relatively high labour burden on their children. Nalang's children, in contrast, are less burdened with labour, particularly household labour. Finally, Trinket has the lowest demographic reproduction rate and the lowest share of child labour.

## 8.5 Conclusions

Rural development and poverty alleviation programmes worldwide have succumbed to the ideology of agricultural change through the deliverance of technology. While this has indeed helped maintain larger populations by boosting food production per area, this has not come without ecological and social costs. Boserup's hypothesis of declining labour productivity is indeed supported up to a certain point in agricultural development. As such, increasing workloads on rural communities in which women and children are subject to ever higher exploitation is evident. However, the dynamics change with the introduction of fossil fuel-based technology, thereby countering Boserup's linear claim. With the introduction of fossil fuel-based technology, a reverse trend of increasing labour productivity is observed. However, this does not mean that the overall burden of work for the community is reduced or more evenly

[16] Children's play (e.g., play hunting or play food processing) in traditional subsistence societies is widely documented (Bock 2002; Caro 1988; Fagen 1981) as a safe strategy that imparts more skills that will increase productivity in the future compared to time spent performing directly productive tasks.

distributed across gender and age. Fossil fuel-based agricultural technologies (such as tractors, tillers, and threshers) are used by men and reduce their workload, while other labour-intensive tasks (such as sowing, weeding, and spreading manure) continue to be performed by women and children (see also Gooch, Chap. 10 in this volume).

We have seen that the change in the energy system causes a transition from one sociometabolic regime to another. This is evident not only in energy use per capita but also in the overall working time of a community. Trinket's time investment in the economic system is only a quarter of the time investment of the others. The leisure experienced by hunting and gathering modes of production is hardly comparable to the toil of the agrarian system, with its severe consequences on the female and child populations. The difference in time use across the four cases arises from the changing workload in the economic/subsistence sector, and this workload, as Boserup posits, increases with agricultural intensification-but only up to the point where fossil fuels come into play. The labour invested in household chores remains more or less constant across agricultural intensification and across sociometabolic regimes. Thus, the cost of the additional burden is actually a trade-off on personal reproduction and care primarily borne by women (and to some extent, also by children).

Development trajectories are not simply a matter of economic well-being. Ecological and social sustainability for present and future generations ought to include a broader view of the quality of life. To this end, we need to have a better understanding of the dynamic and systemic relationship between key biophysical resources, for which time is indeed a crucial variable along with its equitable distribution across gender and age.



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# Part III
# Population and Gender

# Chapter 9
# Following Boserup's Traces: From Invisibility to Informalisation of Women's Economy to Engendering Development in Translocal Spaces

**Gudrun Lachenmann**

**Keywords** Interdisciplinarity Gender relations · Social spaces · Informalisation · Knowledge interfaces · Embeddedness · Engendering development

## 9.1 Introduction: Reconceptualisations

The merit of Ester Boserup (1965, 1970) in showing the neglect, or "invisibility", of women's work and the gendered differences in agricultural systems and transformation processes lies in having eyes opened to a completely new perspective in many areas of development. It also originated inter- and transdisciplinary debates between (agricultural) economists and social scientists and between liberal, feminist or structuralist approaches. Regardless of her various critics, I think that she has influenced future debates about what can be analysed as the gendered "structuration" (Giddens 1984) of rural economic production and society, which is rarely done in any other work. My guess is that many different approaches to rural development have, in some way, reacted to her hypotheses or developed contrasting concepts, even if this was not explicitly the case. In my view, these debates can be complemented and driven further by the thesis of the on-going informalisation of various gendered social and rural institutions, especially in Africa.[1]

I have previously postulated that through the "invisibilisation of women in the process of modernisation, there occurred a loss of significance of institutions relevant for women" (Lachenmann 1996, p. 232 f.), starting from structural adjustment programmes, where women were marginally considered, as well as in processes of democratisation and the decentralisation of services. In conceptualisations of (good) governance, women and gender do not turn up. In poverty reduction programmes (PRSP), they are only regarded as "vulnerable" groups, not as agents of

[1] This thesis is exacerbated by recent new approaches to take up the classical issue of informal institutions (Meagher 2007). James Ferguson (2006) talks in an even broader sense of "global shadows", referring to extended fields of irregular economy and governance.

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transformation and their links to the formal, liberalising mainstream economy are not established. Political scientists have shown (Chazan 1989) how women's activities, whether called "popular female modes of political action", or subsistence, marginal, informal economy, have generally taken place at the margins of the political or economic systems.

In this paper, I aim to show how the legacy and main ideas of Ester Boserup can lead to further conceptualisations that overcome these basic gaps. This will also be shown in terms of development issues (especially in cross-sector, cross-productive and reproductive spheres, such as food and social security) and in general gender orders of different spheres.

Institutions tend to be conceptualised in the "development world" in very formalistic and modernistic ways, distinguishing between formal and informal institutions and sectors as well as social security, public and private, traditional and modern forms of governance, civil society and the state. However, the main development problems are conceived as issues such as poverty, social cohesion of society, and bad governance (including corruption). These phenomena have been characterised as blurring boundaries and causing a lack of autonomy between the spheres of the state, economy, family and the public.

My endeavour is to show how the consideration and conceptualisation of the links between "female economy" and "spaces" and other fields, as well as of the gendered structuration of different spheres can be achieved. I want to examine the spheres and sectors that are empirically interesting cases of interfaces (Long 2001) and crosscutting issues, where the institutionalisation processes are proceeding uncaptured by development policies and research.[2] I want to investigate how frontiers are drawn and (re)negotiated, and I also aim to analyse the linkages that I assume exist, though they are often hidden, but which constitute social spaces where disruptions and continuities occur through "knowledgeable actors" (Giddens 1984). These interfaces will be studied through the social embeddedness of institutions, entitlements, and identities, as well as gendered structuration and the transfer of knowledge and resources. I will also evaluate crosscutting issues such as care economy, translocal relations and the flexibility of structures and agency.

After considering the lessons learned from Boserup and beyond, this paper will concentrate on accounting for the special characteristics of a (ideal type of) socially embedded and translocally related female economy in the form of the production of social security and livelihoods. Crosscutting issues will be captured using a relational approach. Through conceptualising translocality, it can be determined how knowledge that does not include gender knowledge is produced. Additionally, how this situation is to a certain extent being overcome with global gender policies and women's movements negotiating development in translocal spaces and restructuring the public sphere can be shown. In this way, structure and agency are brought together and middle level concepts such as social spaces and institutions are conceived. At the same time, the mainstream concepts of "impact" and "target groups"

[2] See e.g. "Institutions for sustainable development", World Development Report 2003, supposed to "coordinate human behaviour" (World Bank 2003).

are challenged and contrasted with all forms of interaction with the negotiation of meaning, concepts, gender relations, interfaces, examining links, and connectivity.

There are female social spaces organised where negotiation takes place on a local and intermediary level regarding gender constructs and relations at the interface of state, translocal and transnational networks. However, as far as links are produced with national public debates, the classical "women in development" and "status of women", as well as "vulnerability" approaches, do prevail in all countries instead of a societal concept of gender and gender order. In principle, this concept would correspond to the translocality represented by a cosmopolitan epistemic community (e.g. reports on Beijing plus 5 resp. 10, such as Molyneux and Razavi 2005).

## 9.2 Following Ester Boserup's Traces

I think the basic gender differentiating perspective of Ester Boserup has been very fruitful for various pathways of engendering farming systems in addition to what can be called "female economy" or "the economy as a gendered structure" (Cagatay et al. 1995). However, many arguments that refer to the "evolutionary" or factor-oriented analytical approach in addition to the lack of analysis of structural and power relations have been raised. The main critique of Boserup's approach in the early 1980s (Benería and Sen 1981) was directed at the neoclassical foundations as they lacked theoretical considerations and a foundation from a feminist and social science point of view. My view is that all of the debates resulted in very productive advancement in theoretical, empirical and activist work.

The term "invisible woman", which showed the marginalisation of women's activities in modernisation processes (commercialisation/market integration), was introduced by the first gender adviser of the World Bank (see Scott 1979) following Boserup's work. This position was created in 1977 and was the starting point of transnational gender development policies (Lachenmann 1996) that have likely led to "mainstreaming gender", which is seen as requisite condition in development agencies and programmes. However, it has given transnational women's and feminist movements the opportunity to enter the transnational public sphere and pursue political and methodological struggles about "engendering development" (Lachenmann 2008a). The appropriation of respective terms shows the loss of the meaning of the "empowerment of women", a term that was introduced by DAWN Development Alternatives for Women for a New Era. The classical "Women in Development" and the later marginalised "Gender approach" have not led to fundamental changes (Molyneux and Razavi 2005). However, they have allowed for the engendering of debates and policies about gender orders, relations, constructs. Thereby, Boserup's seemingly static concept of "women's role in development", which is often still used without taking into account power relations and only looking at a quasi-natural division of labour, has been overcome. The first concept of "strengthening women's role in development" perpetuated this "system of ignorance". The scapegoat of feminism

loomed, but the main arguments of this debate were clearly taken up by policy analysts (e.g. the Indian World Bank expert on African agriculture, Lele 1986). Also, many theoretically complex and empirically rich studies performed in the 1980s and 1990s all referred to Boserup but considered rural development in a critical developmental manner (Kandiyoti 1990) or from a socio-anthropological perspective, in contrast to structural approaches. Jane Guyer used the title of "women's role in development" for a chapter (Chap. 14, 1986) and contributed very rich studies on "the multiplication of labor" by applying "historical methods in the study of gender and agricultural change in modern Africa" (Guyer 1988, pp. 247 ff.). One of her interesting points, similar to the sociological approach presented here, was to "help to illuminate the interaction of local systems with the wider political and economic context" (Guyer 1988, p. 258), including women's "local organizations."

Paul Richards's book, *Indigenous agricultural revolution* (1985) had a "revolutionary" influence on the concepts of agricultural/local knowledge (Lachenmann 2004) as well as of transformation applied within developmental sociology (Bierschenk and Elwert 1993) and social anthropology but without a specific gender focus. The author (Richards 1985, pp. 51 ff.) quoted Boserup (1965, 1981, 1982) primarily for her systems approach, considering it fitting to suggest change by intensifying production. However, the argument of gendered farming systems and the lack of attention was attributed in his book (p. 116 f.) to Jennie Dey (1981, p. 122), whereas women's "invisibility of food crop producers (is) compounded by male bias" (p. 115 f.) is attributed to Barbara Rogers (1980). Boserup (1970, p. 116) had written "that in the supposedly immutable communities of primitive agriculture profound changes are in fact occurring".

It is probably true that Boserup's work supported the simple approach of "integrating women in development", which was criticised with the argument that women were already integrated through their unpaid labour and submitted to "housewifization" (Mies et al. 1991; Wichterich 1987). Nevertheless, it is also true that all of the debates have shown how approaches to agricultural development and other sectors were targeting the wrong actors and do not take the gendered structure into account, especially with regard to the interface between subsistence and market and that between the reproductive and productive sectors. This has not changed much until recently, as shown by the poverty and food crises. Kandiyoti (1990; Lachenmann 1992) noted that developmental politics were not interested in these arguments but instrumentalised them for utilising the "potential" of women for economic growth (i.a., World Bank 1994). In contrast, women were (and are) labelled as "vulnerable" and were only considered as actors in the poverty reduction policies within the "informal sector" (mostly without a link to mainstream economic policies).

Social economist Sen (1985) refers to Boserup's work (1970, p. 16), saying that she rightly criticised Margaret Mead (1950, p. 190) for having made too strong generalisations when she wrote: "The home shared by a man . . . , into which men bring the food and women prepare it, is the basic common picture the world over". Sen's concept of entitlement used at that time (1985, p. 15 ff.) is still valid regarding the informalisation of institutions. However, like Boserup who previously makes the argument of access to technology, land and labour, he views the "household" as

an entity and does not examine structures of embeddedness and translocal relations (see the previous debate in Joekes and Kabeer 1991). We know that in most African countries, men and women maintain separate budgets. However, women cannot always control their own monetary income and are required to use it more often for general family needs. As there is no uniform household welfare, women rely on extra-household cooperation and transfers (Laaser 2005; Wanzala 2001). It is important to consider special arrangements of how production and consumption units overlap and transcend the domestic unit. This is the case in polygynous families, for example, in which the economic relationships can be rather diverse.

In most African countries, policies are still handling gender according to the classical "Women in Development" (WID) approach that looks at the "role of women" and views them as housewives instead of producers. Thus, many opportunities and efficient economic policies are lost, including not only the typical "access to xyz" approaches that ignore the typical link between the reproductive and productive sectors but also "income generating activities", which seek to assist all women by means of microcredit schemes. The proponents of these projects stress that women are better when it comes to repayment. It can be assumed that one of the main economic problems in Africa continues to be how to overcome the disruption of the embedded economy caused by "modern" approaches (this corresponds to the Boserupian preoccupation).

The term "women's issues" might represent important gender specificities and concerns, but this makes us follow a dual instead of relational gender approach. Relations or interface/interaction between the subsistence-market, the reproductive-productive sector, and the inter-household relations (apart from gendered intra-household relations), in short, the meso level, are needed to link micro and macro and understand the gendered fields of economic activity.

The challenge is how to analyse all development fields in a dynamic, gendered way. When using an interface approach, attention is paid to interactions between different fields, groups, institutions, co-operation arrangements (e.g. in the field of technology), brokers, and the flexible organisation of work, as well as analyses of the concrete risks of market integration. This is true even if the markets are socially organised and follow very diverse logic (see e.g. women traders in Sudanese markets, Nageeb 2001; buyem sellem, the female vendors of food staff in Cameroon, Batana 2007). The social organisation of resource management and the allocation of resources in different sectors (in programmes and projects in the sphere of agriculture) are also interesting. In these sectors, women are often excluded but develop hidden strategies that then enable them to edge in and make use of new economic opportunities, such as collective forms of land tenure and collateral when taking credit (see irrigation schemes in Ghana, Becher 2001).

Therefore, one can envision an approach starting from *Woman's Role in Development* (Boserup 1970) to gender analysis to engendering development. Boserup considered the dynamics of transformation (Boserup 1965, 1981, 1982). This approach would be transformative with regard to examining processes and development policies (Kabeer 1994). The negotiation of underlying gender order(s) is studied in respect to changing gender constructs and relations, such as empowerment, in translocal arenas by various societal forces.

## 9.3 Processes of Gendered Structuration and Informalisation

The main analytical argument of this paper refers to the informalisation processes of predominantly female institutions, even and precisely during the formalisation of crosscutting issues, such as social and food security, livelihood, and even decentralisation and democratisation at the local level (Lachenmann 2006). Therefore, the prevailing dualistic concepts are overcome, which led to relations being ignored, as is the case between the market and domestic economies, which is constituted by embeddedness (Lachenmann 1999; Lachenmann and Dannecker 2001). This is also true of translocal relations and social spaces constituted by female (and peasant) groups, thereby delegitimising forms of mutual help and services. The concept of the informal sector introduced by Keith Hart in the 1970s (Hart 2008; Meagher 2007) has become a "black box" that is used without further analysis, usually with the (often implicit) understanding that modernisation and development would eventually cause it to disappear. However, many poverty studies recognise that it guarantees more and more livelihoods. It is also noted that women are its key actors, implying that economic efficiency is much lower and that the policies do not make sense. Neither the constitutive character of this field for the general economy nor the special interaction between the formal and informal sectors, which I suggest addressing here, are the subject of serious examination. Furthermore, the processes of informalisation are not viewed as a part of the on-going transformations. Hart (2008, p. 4) highlights the "dialectic of formal and informal economy in the context of "development" discourse over the last four decades" and refers to the effects of structural adjustment programmes (SAPs) as having an "informalising" effect on the economy. Meagher (2007) states that there is an apparent decrease in the knowledge about the present day reality of the informal sector; however, there is also growing interest and an "expansion of informality".

These debates can be connected to our approach of considering locally negotiated concepts of development. Development is conceived in a very broad sense, as social change and transformation are brought about by political action, civil society, and purposeful policy intervention. By using an interface approach, we can examine different levels of societal structuration and interaction at arenas where new gender relations are negotiated. I prefer this approach to a dualistic one of distinguishing between practical and strategic gender needs (as does Caroline Moser 1993). Empowerment, the concept forwarded in transnational women's policy, corresponds mainly to the economic autonomy of women, despite being co-opted by development bureaucracies, and their capacity to act in civil society (Grosz-Ngaté and Kolole 1997).

The gendered structuration might be conceptualised as economic relations between formal and informal sectors (e.g. finance) which cross the boundaries of formal institutions, formally employed persons, and distances that create innovative forms of interacting. These include social networks, livelihoods, the cooperation between genders regarding the exchange of resources and labour, and the crossing of boundaries between different logics of economic agency (such as in the areas of reproduction and production). These are not taken into account when conceiving and combating

poverty, business women interacting with men who work in formal organisations and vice versa, and borders drawn as a result of recent development policies between local governance institutions and civil society organisations. They can be analysed by studying the social spaces of negotiating public issues or conceiving formal institutions (such as social forestry) or informal institutions, such as the rehabilitation of irrigation schemes (which are structured according to gender), religious, male and female groups and organisations that constitute crosscutting spaces.

In general, development theory and policies do not consider these new interactions and spheres, and these relations are not addressed at all when studying the "impacts" or new development and social policies. The relevant interactions are not taken account of in a modernist view on the one side and a paternalistic, antipoverty perspective on the other. Transnational relations in migration, new forms of shadow economy in formerly socialist regimes, cross-sector livelihoods, and interfaces between all informal forms of economy and politics have only recently been discovered.

Thereby, the interaction of subsistence and market economies needs to be studied in detail, specifically regarding the female economy as one field of agency interacting with others. This corresponds to the call of critical macro economists (such as Cagatay et al. 1995), specifically the relationship between the reproductive economy and the productive sector, and also considers the role of markets in assuring livelihoods, the necessities of subsistence economy, markets that are sometimes segregated by gender and region, and the entitlements and institutions related to economic resources, such as land, as well as the forms of organisation of market actors. This would mean overcoming the old distinctions between formal and informal sectors, the upgrading of typically female economic fields, and a realistic consideration of opportunities. The possibilities of liberalisation and the reduction of bureaucratic and authoritarian modes of state governance and patrimonial structures of patron-client relations and privileges will also need to be considered.

Theorisation of development and transformation must be based specifically on localisation processes. This does not mean that we should study "the impact" of liberalisation or globalisation processes or of certain global governance policies, economic policies, as is often done by scholars and women's organisations criticising and constructing "Neo-Liberalism" as a global anti-force. We should also avoid studying survival strategies (never included in the economic mainstream) without analysing the contexts and solutions to problems of the respective situations. At the same time, we must challenge the concepts of "target groups", which only represent a one-way perspective, in favour of interaction and agency.

An important feature of engendering (Lachenmann 2008b) is overcoming the micro-macro divide, mainly by bringing structure and agency together. Therefore, we need a dynamic, process-oriented, relational approach. This approach should start from the perspective of social actors and social and cultural meaning, elaborate on processes of the construction and structuring of gender, consider changes and conceive middle level concepts, such as space, institutions, links, interfaces, and room for manoeuvring.

## 9.4 Gendered Embeddedness of the Economy

The gendered embeddedness of the economy within society (Granovetter 1985) includes economic relations beyond the household level. This concept shows the gendered access and control of (natural) resources, including labour, property rights, and environmental knowledge. There are links involving resource access and use between different levels: household and family/community of women's origin. Additionally, there are social institutions of translocal resource access, reciprocity, structures of co-operation, alliances and collective access. Markets are socially organised, including with regard to trading and modes of accumulation.

Women have often concentrated either on the parallel economy outside of the state or on the "endogenous" economy (McGaffey and Windsperger 1990). It is very important to examine what is happening to these female "modes of accumulation" (Geschiere and Konings 1993) with the onset of liberalisation, deregulation, and re-regulation. The typical interface and co-operation between the "informal" and "formal"' sectors often represented by women are not taken into account to upgrade economic activities. This involves numerous exchanges between the genders regarding activities and resources (such as credit). Examples of such an exchange would be between men working as state employees and their wives trading with their colleagues (Laaser 2005) or men using credit from the informal sources of their wives to obtain business loans from banks, as seen in Cameroon.

It appears there are no new opportunities, as old channels are being used on a large scale by new speculative male ventures. The opportunities, which were previously offered by the Social Dimension of Adjustment Programmes and are now offered by current employment programmes, such as anti-poverty programmes for "vulnerable" women, are generally directed towards dynamic and young urban men. As a result, women are crowded out of their "traditional" economic fields. Examples of this exclusion include vegetable gardens maintained by young men instead of women, cereal trade run by male co-operatives instead of women, or the marketing of women-grown products and training through development cooperation. The same effects can result from the dissolution of parastatals and marketing boards, as well as from the breakdown of cash-crop production for world markets (such as coffee and cocoa), which is accompanied by the entry of men into food crop market production (Cameroon, Batana 2007) following the introduction of new technologies. There is no upgrading of women's self-employment structures. A link to regional economics, the management of natural resources, and other fields is not being created.

The typical participation of women in a low-earning and precarious informal sector while still balancing both domestic and external economic activities is often recognised. However, in terms of the World Bank's (1994) approach to highlighting women's economic potential (contrary to empowerment goals), some have rightly noted that women "play a major role in both food production and marketing" (this is still an afterthought of Boserup's ideas). However, they have failed to mention the risk of women losing this important position in the economy when men start to enter into food crop production and marketing or by upscaling business. These observers

do not seem to discern the methodological consequences and fail to seriously extend their data collection to the inter-household and inter-community levels. However, women can be shown to negotiate their entry into markets, even though the public sphere is marked by strict segregation, as in Sudan (Nageeb 2001, 2004).

## 9.5 Food and Social Security, Natural Resource Entitlements

Food security as a global field of governance and livelihoods/entitlements as concepts of a "social economy" are very relevant in Africa and can be considered to be crosscutting issues (as are gender and environment). Livelihoods are very often constructed not only by private and public means but are also constructed through translocal systems of social and gender relations. Social security is a system made of gifts and distribution (upheld to a large extent by women) in a manner that links formal and informal institutions (Lachenmann 1997; Tanzania, Steinwachs 2006). Migrants created new and gendered translocal livelihood systems. In the past, only remittances were examined and critics made about the mere "consumption" finality. Typically, money from young male migrants is sent to their mothers (the older women) instead of to the fathers (as I observed in Senegal). However, in some cases, migrants enter into agreements with local traders to avoid conflict within the family. In many cases, there are groups and associations that assist at the sending end in locations such as Paris or New York.

A typical case is the shared responsibility for education and health services between different family and social networks, with links to kin living in towns and/or working in the formal sector. Consider the case of translocal gendered relations between two (ex) co-wives in Senegal. One woman takes care of all of their children as a housewife in the reproductive sphere with the support of a formally employed husband who has corresponding connections to state institutions, such as schools and hospitals. The other wife works in a semi-formal job in the peasant movement and takes care of matters in the nation's capital, such as accommodation and university access for their children. She performs a variety of "self-help jobs". Her compensations and per-diems amount to a salary of sorts, and she establishes connections to formal state-authority structures and policies by means of her former work in the community development sector (she lost this job as a result of structural adjustment) (empirical case study by the author).

Therefore "gendered social security" (social security in the widest sense of the term) or formal/informal connectivity are very important dimensions of embeddedness (Risseeuw and Ganesh 1998). Alternatively, problems of "insecurity" and sustainable livelihoods should also be considered. Women should be regarded as active providers/producers instead of passive recipients of social security. Furthermore, it

is important to examine changing social institutions and their meanings in terms of social security (such as bride price, reciprocity etc.), the institutionalisation of patterns and strategies in their "quest for security" (Elwert et al. 1983), and the interaction between subsistence-market economies, urban-rural spaces, networks, social relations, and alliances that provide both social security and shifting solidarities.

The local economy is characterised by a 'subsistence logic', with women making livelihoods (including household energy and water and other natural resources, such as collecting wood and gathering other products) as a priority and perspective. These resources are now subject to new regulations at the decentralised level and a certain blockade as their shifting from the social to the public level takes place (Ngo Youmba-Batana 2007).

Since the start of structural adjustment programmes (SAP), it can be observed that community and women's resources are siphoned off by the formalisation of social security and cost recovery. A lot of fund raising has already taken place on the local level in traditional (e.g. for baptisms) or 'neo-traditional' forms, such as Roscas (rotating saving and credit systems). However, it has been primarily women who collect this money and who do the voluntary or self-help work involved in providing basic services. Therefore, the cost recovery and the formalisation of basic services provision becomes problematic. In Senegal, I observed that a rural community was taught how to make a health centre viable by increasing fees, without discussing problems of access or how to formalise the employment of local female midwives.

The gendered construction of environment can be directly linked to concepts of livelihood, as well as to rural and local development. There is a clear relationship between environmental relations and gender order in society regarding access, entitlements, institutions, division of labour, and environmental knowledge. Changes in gender relations are very relevant for modes of environmental change (Joekes et al. 1995).

During environmental and socio-economic changes, women tend to be marginalised regarding political organisation, property rights and new regulations. Often, access to land and natural resources passes through relations of marriage and alliances that are translocal and go beyond territorialities. As soon as local services (water supply, grain mills etc.) are formalised or monetised (such as wood and gathering products), the source of the finances is no longer taken into account (e.g. for labour-saving devices), as the husbands see it purely as a women's concern. Modern institutions lead to the invisibility of these links and entitlements, which lose validity, and do not contribute to new opportunities. Gendered labour is very important for resource protection and control of new or protected resources.

In the case of Senegal, activities and organisational forms were developed in times when self-help projects were promoted by village workers which contradicted the new formal decentralised political regime. Contrary to all of the praise of "civil society", local initiatives were delegitimised. This was typical of the health committees that had been established on a voluntary basis.

Additionally, the management of collective economic resources by women, such as rice fields in Senegal, did not appear to be included in development planning within the local administration. A female president was responsible for a rehabilitation programme for rice fields funded by external cooperation. However, there were at least two "competing" women representing "the women" in the village or district town. These kinds of (very important) efforts were not included in the village development plan. The plan also did not include such features as grain mills and cereal banks, because private economic endeavours were not accounted for. Additionally, these women's groups are not politically represented in the local council where they could participate in the consideration of new regulations. There is no arena where women's movements and groups can enter into a serious debate concerning transformation within the framework of decentralisation (case study, Lachenmann 2006).

While it might be interesting for women to not be forced into male roles, communal and state control, groups and cooperatives primarily made up of male members tend to be formal(ised) as economic, whereas women's groups tend to be informal(ised) as social or developmental (Rosander 1997). The latter are influenced by traditional experiences, community development and home economics coming from the established channels. These channels are dependent on ministries of social affairs (and not of agriculture), and lost their support after a democratic change of government. In any case, their economic level of activity is being suppressed by this "small trade" and "sharing approach" of credit. Not many of these female savings and credit groups are yet integrated in the formalising schemes of Mutual Saving and Credit Banks.

## 9.6 Producing Knowledge and Negotiating Development in Translocal Gendered Spaces

Regarding development knowledge, women are excluded or not encouraged by extension services to participate in activities dealing with new modes of access and the management of natural resources, increasing agricultural productivity, and new economic opportunities in the local economy (such as upgrading transformation of agricultural products). However, state entities are introduced at the national level to promote (formal) female entrepreneurs. This is also true in the spheres of activities where women are normally active, usually within a complex structure of gender cooperation and exchange. This is also the case when it comes to women's social and political activities. As a counterforce, women establish transnational networks for knowledge exchange (Mueller 2005).

This is clearly shown in the form of the innovations. As described in a study from Northern Ghana (Padmanabhan 2002), an absolute gender-blindness prevails. The type of innovations that are adopted are ignored, as women have to contribute labour for men when innovations for cash crops are being introduced. In certain circumstances, however, they introduce innovations in their own fields, thereby enlarging their room for manoeuvring and entering market production. The study clearly shows

that there is a female line of learning, such as transmitting information and knowledge about new seeds.

There is little gender-specialised knowledge that is applied by state organisations and bureaucracies, despite the fact that much information has been accumulated in many spheres and organisations (Goetz 1995; Lachenmann 2009, in (agricultural) policies and new forms of resource management schemes (social forestry, irrigation etc.)). The relational approach should be valid for rural and agricultural activities and the market integration of the informal sector but also with regard to formal employment. The translocality of economic relations has been shown (Dannecker 2002), because textile workers, the typical globalised feminised workers, are acting between social conditions including family, migration and societal gender images; they are also creating room for manoeuvring within the factory in Bangladesh.

In general, the analysis of multiple economic fields of activity illustrates their complex character in the areas located between reproduction and transnational trade. There are networks that move agricultural and other products to the capital and abroad (Batana 2007). There are new and multiple forms of gendered and ethnic trading arrangements, including the well-established transcontinental trade carried out by Ghanaian female traders (Amponsem 1996). Women are normally less conspicuous as they can marry and move from the rural areas into urban settings and other ethnic communities (Cameroon, van Santen 1993; Kenya, Achieng' 2012), and thus, they are much less likely to be distrusted as strangers. However, they often complain about being strangers in patriarchal settings in regard to (formal) entitlements.

**A transnational study** (Lachenmann and Dannecker 2008) has shown that knowledge negotiated in gendered spaces leads to the restructuring of the public sphere. As a result, global (development and) human rights concepts are used through local and global networking through international women's movements. The meaning of these concepts is locally negotiated by activists in the crosscutting spheres of scientific research, political action and everyday life.

The Convention on the Elimination of all forms of Discrimination against Women (CEDAW) has often been referred to as valid argumentation in "shadow reports" by women's groups (Malaysia, Spiegel 2010), even more so in combination with the "Beijing process" which was widely followed in Africa in the form of regional debates. This led to the Platform of Action of the Beijing Conference for Women in 1995, as well as its (less well) established "post-Beijing" process (Molyneux and Razavi 2005).

While negotiating development concepts, women are seeking alternative approaches to women and gender issues based on agency instead of victimisation, and on rights instead of vulnerability (Senegal, Sieveking 2008a, b). Therefore, global concepts of rights have become increasingly differentiated according to the multiple experiences coming from the local level (for other countries, see Elson 2002; Grosz-Ngaté and Kolole 1997; Molyneux and Razavi 2002).

The concept of the "vulnerability" of women underlying the construction of women as weak subjects is found everywhere: global development discourse regarding women in development policies and in poverty alleviation and good governance, as well as in Islamic and culturalist discourses where women are constructed as requiring protection. As a result, women are denied agency with regard to actively

influencing their life-world and are instrumentalised as inferior human beings, even if the complementarity of genders is claimed.

Changes in discourse and policy concepts show the social transformation occurring through the active involvement of women's organisations in development policies and the gender order of society.

The "rights approach" can be analytically combined with the concepts of entitlement, gender order and gender justice and, in development policy, with the appropriation and negotiation of global concepts based mainly on CEDAW.

## 9.7 Conclusion: From Women's Roles to Engendering Development

The argument conveyed in this article about conceptualisations developed following the suggestions and perspectives introduced by Ester Boserup, mainly regarding societal expansion through gender relations and livelihoods, led us to suggest several fields that need further attention in analysis and policy, based on the methodological concepts of informalisation, intersecting gendered spaces and embeddedness.

Approaches to subsistence production should be further developed with regard to the security of livelihoods, the regionalisation of the economy, and the formalisation of new forms of shadow economy. This can be accomplished by bringing these aspects together with the new ideas of "domestic economy", "caring economy", taking into account the interface of reproductive and productive sectors and natural resource management. The consequences of modernisation in general, structural adjustments and policies of poverty reduction, food aid and the introduction of new forms of security systems need to be analysed, not only regarding the immediate impact but also broader and long lasting dynamics.

When doing so, relevant fields to study are how these fields overlap through the different flows of resources, e.g., urban/rural and subsistence/markets, and different combinations with resource usage.

The original highly flexible gendered organisation of work needs to be maintained, and at the same time, the concrete risks of market integration must be considered. The gendered translocal access to resources and their allocation in different sectors must be maintained in programmes and projects in the sphere of agriculture, where women are often excluded but where they find hidden strategies enabling them to participate and obtain access to new economic opportunities. Collective forms of formalised land tenure and collateral when taking credit should be possible, as in the case involving modes of finance that are established for labour-saving devices and appropriate technology.

This would mean engendering appropriate forms of social banking, because social security is achieved by developing soft forms of formalising, including contributions by migrants and connecting to experiences of self-help, women's groups, associative sector, food security, and cereal banks, to name a few.

The level of supporting community/self-help through the care economy or community management should be considered and included in development plans and budgets of local government.

The logic of sharing, solidarity, reciprocity, and moral economy according to gendered social relations should enter the economic sector, so that confrontations with the modern economy (household, farming system, enterprise) take place. Existing alternative modes of accumulation and accommodating formal and informal distribution (sometimes corruption) must be legalised.

With regard to enhancing (social) security, typical female solidarity can be formalised as an alternative to individual interest, which often leads to a lack of accumulation or hiding wealth. Women are addressed by economic policy either as groups, doing work "collectively", such as on fields of the second best quality without permanent title deeds. Or they are seen as independent entrepreneurs, sometimes considered to be rich by illegal means (like Mama Benz in West Africa), but often discriminated against because of a lack of formal credentials and forced to enter the shadow economy of corruption and even sexual dependency.

There are already transnational networks developing approaches to social economy/économie solidaire that elaborate new forms of saving and credit, new forms of collective social security, and new formalised group/collective forms of women engaging economic activities, thereby regularising institutions of access to land, irrigation and the production of handicrafts.

Regarding engendering social and economic policies, appropriate forms of formal solidarity are to be negotiated in the public sphere at the state level, the third sector, or the family/individual. As a result, the common good will be newly negotiated and defined in a gendered manner, including public policies and social services. Responsibility and burden sharing (cost recovery) must be reformed. Not only should state or private suppliers of services be considered, but the third sector (NGO) should also be consolidated. Engendering economic and social dynamic transformation means supporting new creative approaches that may already exist, including the pluralism of solutions and intermediary structures. The question is whether we want to formalise all fields or if we can safeguard a strong communal and translocal care economy, which would be based on gender relations and justice.



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# Chapter 10
# Daughters of the Hills: Gendered Agricultural Production, Modernisation, and Declining Child Sex Ratios in the Indian Central Himalayas

**Pernille Gooch**

**Keywords** India · Womens role in agricultural production · Gendered division of labour · Crop production

In her seminal findings on female neglect in rural North India, based on the census from 1961 and literature studies, the anthropologist Barbara Miller detected a strong correlation between neglect of daughters, agricultural production and the cost of marriage (Miller 1981). She also found significant regional and social variations between the South and the North. In examining studies from throughout India, she observed a pattern in which exceedingly high cost of marriages of daughters among upper social groups in the North corresponded with son preference and high female juvenile mortality, whereas the figures for the South indicated much more equal conditions. With agricultural production and the demand for female labour as the motivating factor, she observed a North/South dichotomy, expressed as "masculinism" in the North, with dry-field plough cultivation and a low demand for female labour, and "feminism" in the South where swidden and wet rice cultivation accompanied a high demand for female labour (Miller 1981, p. 27 f.). Ester Boserup discovered a similar pattern dividing the subcontinent in female participation in farming, with much higher female participation in the South than in the North (Boserup 1970, p. 59 f.). Miller further found that the Himalayan region of Northern India did not fit the geographical dichotomy between the North and the South. Her study showed that, although geographically belonging to the North, the mountainous region was in some cultural ways more akin to the South, including a high participation of women of cultivator families in agricultural work in the Himalayan area (Miller 1981, p. 108; cf. Agarwal 1994, p. 358).

Miller hoped that by using the 1961 census data to expose the "strong effects of culture not only on female roles and status but also on female survival itself" her results could assist in raising female status (Miller 1981, p. 15). However, 40 years later, and after a decade of rapid economic growth, the 2001 Census of India

"Do not abort me. I have a worth. I can be useful." Indian advertisement advocating the worth of the female foetus

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data indicated an even bleaker scenario for daughters in India. The Indian census counts "missing girls", not "surplus boys", and according to census results, the sex ratio of the 0–6 age group had declined at a highly disturbing pace since 1991, from 945 girls for 1,000 boys in 1991 to 927 girls for 1,000 boys in 2001, although the overall sex ratio had increased slightly. Thus, contrary to expectations, we find that, despite heightened consciousness regarding the problem, what had occurred was not the raising of female status and the normalising of juvenile sex ratios but rather quite the contrary. These results revealed marked declines in areas and social groups that earlier showed more equal conditions, with the signs of modernisation, such as urbanisation and female literacy, having a strong negative correlation to the Child Sex Ratio (CSR).

Much has been written regarding gender, patriarchy and unbalanced CSRs in Northern India; however, this discussion is usually restricted to the northern plain area. Here, we will examine more closely the state of Uttarakhand in the Himalayan region of Northern India, where, as mentioned above, declining juvenile sex ratios are a relatively recent phenomenon. This should provide opportunities for studying an old phenomenon in a modern context. The Census of 2001 showed an alarming decline in the CSR in Uttarakhand, down from 948 in 1991 to 906 in 2001. In this northern mountain state, rapidly declining juvenile sex ratios are a phenomenon of the 1990s, which also have wide regional variation. Using the CSR as an indicator, the question is as follows: how can we understand these disturbing figures, and to what extent can the work of Ester Boserup aid us in the task?

## 10.1 Contrasting Case Studies

The study was conducted through contrasting case studies in rural Uttarakhand between 2004 and 2009. Beginning at the tehsil level (an administrative subdivision of a district), we first selected the tehsil with the lowest CSR (low number of girls to 1,000 boys) and then, for comparison, also the tehsil with the highest CSR (high number of girls to 1,000 boys). The tehsils thus selected were Pithoragarh tehsil in the eastern part of Uttarakhand, with only 855 girls for 1,000 boys, and Puraula tehsil in the northwest, chosen for contrast, which had an even number of boys and girls, 1,000/1,000. Detailed surveys of 25 households having at least one child between the age of zero and six were then performed in each tehsil. This was followed by several field visits during which agro-ecological conditions were also studied.

Within Puraula tehsil, which is very large and thinly populated, both the survey and the case study were performed in villages in Mori Block (subdivision of the tehsil), one of the most marginalised parts of the region. Mori, stretching all the way from the middle mountains to the glaciers, is characterised by small terraced villages with very high CSR, many with more than a thousand girls to a thousand boys. In Pithoragarh tehsil, situated in the middle ranges, the study was performed in one of the large rural villages in Bin Block, here called "Bin Village", situated just outside the town of Pithoragarh (the district headquarters) and thus in the most central part

of the tehsil. The selection of "Bin Village", with a CSR that is below the average of the tehsil as a whole, added further contrast to the study.

Although the indicator was the CSR, what we found were two areas at different stages of modernisation and of agrarian transition. By choosing the rural extremes within the tehsils for further study, we could thus follow the process of modernisation from the areas closest to urban Pithoragarh in rural Bin Block in the hilly south-eastern part of the state to the villages closest to the glaciers in Mori Block in the north-western part. Bin Village is apparently "modern" in regard to integration into the market, infrastructure, and new possibilities of employment, whereas Mori appears to be "traditional", marginalised with poor infrastructure, and still completely dependent on mixed agriculture. Although Mori is characterised by intensification and expansion of agriculture, primarily based on female labour, we also found that women in Bin work in cultivation, quite in accordance with the pattern for the mountains; here, however, female labour occurs simultaneously with land abandonment and male out-migration.

A question posed is whether the difference in the CSR figures could be just due to the distance from facilities for pre-natal diagnostic and sex-selective abortion. Although new medical technology is important, the underlying picture is not so simple. Our findings indicate that behind the differences in CSRs we find a much more complex picture of the changing social, economic, and cultural contexts through which gender is constructed, contexts that guide whether to raise a daughter.

## 10.2 Uttarakhand—Dominated by Female Farming Systems

In 2000, after many years of agitation, the central part of the Indian Himalayas, formerly known as the UP hills, severed its ties with Uttar Pradesh—India's largest state, situated in the densely populated upper Gangetic plain region—and was constituted as Uttarakhand, the 27th state of the Indian Republic. Although there are some large towns in the areas closest to the plains, the economy of the state is still predominantly agrarian, and more than 75 % of the population is rural. Until the year 2000, this was the most marginalised part of Uttar Pradesh, and a place primarily forgotten by politicians and agricultural developers.

Traditionally, the North/South dichotomy of agricultural production and the demand for female labour divided the state of Uttar Pradesh, characterised by the masculinisation of labour in the plain areas below and feminisation in the hill districts. Boserup (1970, p. 63) describes Uttar Pradesh as one of the Indian states with a most restrictive attitude towards work by women outside of the domestic sphere. She also found it to have one of the lowest rates of participation of female family labour in their own fields. According to Miller, Uttar Pradesh was typical also in another respect—as one of the northern states with a high prevalence of son preference and where the use of female infanticide was common among upper castes. She further found that also in this respect a dichotomy existed between the plain area and the UP hills, in which the latter appeared to be exempt from the

practice (Miller 1981, p. 54). We thus find that *Pahari* (mountain) women have had a much stronger position in society than women in the plains area below. Today, Uttarakhand is still dominated by female farming systems where, contrary to the situation in Uttar Pradesh below, essentially all work is performed by female labour. The contribution of men in agriculture is generally reduced to walking behind the bullocks when ploughing the fields and marketing the produce.

In Uttarakhand, policies for the development of farming have primarily emerged following separation in 2000. The backbone of economic activity in the hills has traditionally been mixed small-scale agricultural ventures depending primarily on local input and producing for subsistence rather than for the market. Characteristic of the agricultural systems in the mountains has also been a system of mixed millet farming with a high degree of domesticated biodiversity of both plants and livestock and dependence on forest resources. This scenario is now changing with, on one hand, the commercialisation of agriculture and, on the other, migration and diversification of occupations in which agriculture loses its importance to salaried employment outside of the village. This is complemented by a "Money order economy" fuelled by large-scale migration of younger men to the plains for jobs in the armed forces, government or the private sector. Development in the state appears to affect women—and especially female children—negatively. Although the overall sex ratio in Uttarakhand increased from 936 to 964 between 1991 and 2001, the CSR, as we observed above, fell drastically. However, as we will discuss further below, there are still great regional differences.

## 10.3 Low CSR—Bin Block, Pithoragarh Tehsil

Although Pithoragarh tehsil has the lowest sex ratio in Uttarakhand in the 0–6 years range, with an average of 855 girls to 1,000 boys, there is a clear rural/urban divide, with a rural CSR of 867 and an urban CSR of only 819. The tehsil is dominated by Pithoragarh, the largest town of the district, situated in the Soar valley and surrounded by hills. Today, Pithoragarh is a modern town with good infrastructure including easy access to medical facilities, good teaching institutions and a well-connected transport network. Bordering Nepal, it is also an important trade centre. This has provided new opportunities for work outside of agriculture, especially for males. For Pithoragarh tehsil, the most modernised portion of the district, this influx of funds from outside has caused a decline in the importance of agricultural production, which is now marginalised, based on female labour and mainly conducted for subsistence. With greater exposure to "modern" lifestyles, new values have also been accepted, leading to reduced fertility and family size. As more children now survive, two children have become the norm for the young generation of parents. In Bin Village, respondents stated that they could only afford a small family. Although the ideal family is one son and one daughter, in practice, at least one son is a must, whereas a daughter is optional. In our survey, this is generalisable to a preference for either one child of each sex or for two sons. Although all individuals interviewed denied that they themselves

used ultrasound technology to abort girl foetuses, which is strictly forbidden, they all knew that the technology existed and said that they were sure that many families in the area used it.

Generally, the preference for a son was articulated in statements from women such as "We must have at least one boy", or "we cannot afford more than one daughter due to high marriage expenses". They also said "a daughter will be the wealth of another home", or "our in-laws are the biggest problem, they are the ones who want the boys most". In the study, we found no difference in son preference between high and low caste respondents in the village.

Meena, a 26 year old mother belonging to the Scheduled Caste, with two daughters and one son, strongly expressed the seriousness of discrimination against girls:

> Girls have to suffer everywhere: They can't do anything freely. They are killed or burned by in-laws for not bringing dowry. Only if we give her a good dowry will she get a good home. If something happens where will girls go, to whom will they ask for help? Daughters should be educated. If the husband forces her out of the house she should have some weapon [the possibility of a job] in her so she may fill the stomach of herself and children.

She articulated a view of the horrendous fate of women that appeared to be shared by most of the women in the village. Many expressed that the life of a woman was hard, especially following marriage. They told of cases of dowry deaths, and a group of women went so far as to express that "marriage is barbaric". Young girls spoke of wedlock as their inevitable, but frightening, destiny. This was even more terrifying, as girls were generally married in their late teens or early twenties by arranged marriage into extended families far away from their home village. This entails, as stated by Meena above, that in case of problems with in-laws, the girl must face it alone without support from her own kin. The hope for this mother, as for many others, consisted in attempting to provide a good dowry and education for her daughters. There appeared to be no differences in money spent (or planned) for the education of sons or daughters.

The education of girls did not seem to result in working careers for women. Although many young wives in the village were educated—many as much as their husbands—most women, young and old, spent their days with domestic and agricultural work. Many parents stated that they would like to educate their daughters so they could obtain a government or office job. However, in our study of young rural families, only two women, both teachers with teaching husbands, had work outside the own farmstead. Other young mothers with high school exams or bachelor degrees worked as cultivators like the rest. Although unmarried girls act as farm labour at home, neither high nor low caste families would allow their daughters to do labour outside the family. A son may go out to work anywhere to support the family. For a girl, this is not possible. Doing labour outside the home was not considered secure for females. In Bin Village, security for daughters was a major issue and, as articulated by Meena above, girls were not permitted to act freely. As a rule, neither girls nor women are allowed to go out alone anywhere. Women stated that they could not freely go to the market in Pithoragarh only a couple of kilometres away. If they wanted to purchase anything for the household, they had to ask a male member of

the family. From the age of 15, girls are strictly supervised, whereas their brothers are free to move around. Kamla, an educated high caste mother of two young sons, articulated it thus:

> Girls in the cities can do many things. However, the society in the village is very backward. If a girl behaves as a boy, then she is seen as the worst girl of the village. Dowry and security are the two main things in India for daughters.

A mother with two daughters and one son articulated her concern thus:

> Daughters cannot be left alone. They need security. One guardian should always be there with them. If something happens to them the whole image of the family will be merged in mud. People want a chance to speak bad about girls. They can't go alone to cut grass because of fear of bad and drunken boys. They go in groups. If they are seen alone nobody will marry them. If she marries on her own she will be sent out of the village and her parents will cut off all relations with her.

Another educated mother with one daughter and two sons stated that "girls need more care. The parents' image depends on them." However, she also suggested change and new possibilities for girls: "Today girls can do anything that boys do. If they are well mannered and strict in their character they can go higher than boys." What most respondents expressed, though, was that "daughters are difficult" and that "security and dowry" are the primary issues concerning daughters. Parents thus must keep their daughters safe in an increasingly insecure and changing world until they can pass them on to a new family together with a dowry, the gift that, hopefully, will ensure that they married into a good family who will treat them well. To pay dowry, they explained: "If we do not have the money, we will sell a field, we will take a loan, we will do anything to pay it".

Although most of the women stated "cultivator" as their primary occupation, farming here has lost its economic importance to a great extent. Agriculture is primarily for subsistence, and there is hardly any surplus to sell. For many families, the produce does not even cover the needs of the household, and supplements must be bought in the market. One man went so far as to say that continuing to cultivate is counterproductive. He stated that they only continue because they had always done so; it was part of their tradition to grow crops and keep a cow, but in reality, it would save both time and money to stop farming. High caste men do not work in cultivation. Male tasks, such as ploughing, were performed by men from the Scheduled Caste. However, even in the low caste portion of the village, all cultivation apart from ploughing is done by women and girls. Agriculture is performed in the valley, whereas many terraces on the hillsides are now abandoned. Formerly, there were fruit orchards, more crops and higher yields. Farming is now less intensive, and landholdings are small and fragmented. The main crops are wheat, rice and pulses, but yields are low as the land is stony and not irrigated. Women herd livestock, such as sheep, goats, buffaloes and cows, in the scrub forest surrounding the village. Fewer animals are kept now because of the labour involved. No capital is returned to farming.

As we observed, women have access to land; however, the land does not generate any cash, and they do not have the economic means for new technology or input into agriculture, such as high yielding seeds and fertilisers. This is a scenario that very well

fits into Boserup's feminisation of agriculture (1970, p. 44). Keeping fewer animals also has the consequence that there is less manure for the fields and not so much to harvest. This is a break with the traditional farming system with a high degree of cultivated biodiversity, built on livestock, kept in forests and on fallows, producing fertilisers for the fields. Women said that they work less in agriculture now than they did earlier and spend more time on domestic work. This is quite in accordance with a comment by Mendhapurkar: "The better the economy, the greater the domestication of women and the lesser their role in direct economic activities" (Rajalakshmi 2005, p. 3). What we found in Bin Village was that women still cultivate, but their work has lost economic importance. A male student from a household with two sons and no daughters bluntly expressed that the contribution of women to the household is no longer considered important: "We cannot afford girls because girls are not productive".

However, this has not been the historic status of women in the Himalayas. People stated that dowry is a recent phenomenon, introduced as part of a general modernisation process. Traditionally, a young bride would just bring a box of household items to her new home. This is well expressed by a middle-aged woman: "Earlier a girl was *given* household items in order to start her new life, now the in-laws *demand* consumer items such as refrigerator or TV as well as cash". So the development has gone, from a gift to a daughter leaving home, to a demand for expensive commodities, not for the daughter, but for her in-laws. Elderly Brahmins in the area said that in former times they used to pay for a bride. As stated by Srinivas, bride price, otherwise recognised in the North as a practice only of poor and low caste communities, was widespread in the Himalayas, including among Brahmins, until World War II (Srinivas 1984, p. 18). Previously, farming was vital for the economic survival of the household. Although women have always performed most of the labour, both sexes were actively engaged in agriculture.

However, what is examined here is the extreme: a farming village on the outskirts of the town of Pithoragarh. In the villages of the tehsil that are situated further away from urban Pithoragarh, farming is still economically important, and there you will still find mixed farming systems, both for the market and for subsistence, along with higher CSR. As stated previously, Pithoragarh tehsil had a rural CSR of 867 and an urban CSR of only 819. The CSR of 821 in Bin Village was thus much more similar to that of the urban area.

For comparison and contrast, we now turn to the opposite corner of Uttarakhand, an area of the state where agriculture is still the most important economic venture and where the attitude towards daughters—and women in general—is very different.

## 10.4 High CSR—Mori Block, Puraula Tehsil

Using the CSR as the indicator, Puraula tehsil in Uttarkashi District stands at the opposite end of the spectrum from Pithoragarh tehsil, with an equal number of girls and boys (1,000/1,000), the highest ratio at the tehsil level in the state. The two

tehsils also stand in contrast with respect to female literacy, with Pithoragarh at the top with a female literacy rate of 72.5, whereas Puraula is at the bottom with a female literacy rate of only 38.5, approximately half of the male literacy rate, which is 73.7. This further demonstrates that development in the form of education and reduction of the gender gap in literacy does not automatically lead to more equal conditions for women and girls.

Puraula tehsil, which is purely rural, constitutes the north-western part of Uttarkashi district. Mori Block is the most inaccessible area of the tehsil. Although families are generally larger than in Bin, today, the two children norm has reached also this remote corner of the state. In addition, most parents here viewed an ideal family as having one child of each sex. The difference was that here we did not find the extreme son preference so prevalent in Bin. Parents in Mori expressed that an ideal family must have at least one daughter and one son. They formulated it by saying "Both girls and boys are necessary for a good family", and many mothers went so far as to say "We are happy for daughters. Daughters help us with our work. Boys are careless. They do not help". Fathers also expressed sentiments such as "Daughters are closer to parents than sons".

Although Pithoragarh today is a busy infrastructural centre, the small township of Mori is literally at the end of the road. The landscape is mountainous, dotted with tiny hamlets with terraced fields, and many villages in the area can only be reached by a strenuous walk along narrow mountain paths. This means that most transport is still by human bearers or by pony or mule. Pithoragarh, close to Bin Village, has a whole range of modern medical and educational facilities, whereas Mori only has a small government hospital and no education after class twelve. Many villages and hamlets are also without modern conveniences such as electricity and telephone. In the outermost parts of the region, schools are only recently introduced, and many places have a high rate of female illiteracy. However, although Mori has a low rate of literacy for women, we found no present differences in education between daughters and sons. Most parents stated that they planned to educate both sons and daughters as "far as possible". Fathers and mothers expressed that they wanted their daughters to obtain a good education and "go into service" to find a better life. Although most grown women in our study in this area had no or only a few years of education, we did find that the three women with higher education in our survey all had qualified outside jobs, two as teachers and one as a social activist for a Non-Governmental Organisation (NGO). In Mori, we also met women leaders, something we did not do in Bin. What we found was that although men in Bin have left farming for other occupations, agriculture is still the most important work for both sexes in Mori.

In this remote part of the state, new job opportunities have not appeared; although young men do migrate to jobs in the plains, these are primarily low paid menial jobs due to the lack of educational facilities for higher studies. Modernisation in the region is expressed as intensification and an increasing dependence on market powers within agriculture, husbandry and horticulture. Fruit growing has been economically important in neighbouring Himachal Pradesh for several decades, but here it is part of the new agricultural developments introduced after Uttarakhand attained statehood. Although crops produced for the markets in the plains below are replacing traditional

crops produced to sustain the household, women from cultivator families—and their daughters—do most of the farm work. What has changed is that men have taken over the new task of marketing the produce, which gives them control over the cash portion of the family economy. However, as the following incident demonstrates, women still manage subsistence farming for food security, and they still have a strong position in decision-making.

We were sitting with a group of villagers, mostly women, in one of the small mountain villages outside of Mori. The women, of all ages, were active in a local women's self-help group, and they were discussing the agricultural situation in the village. During the discussion, which became very heated, it was obvious that there was a clear difference in opinion between women and men on which agricultural strategy to follow. The primary concern of the women was securing foodstuffs to cook for the family meal, and they were of the opinion that this need was best met by sticking to long-established farming practices with high agro-biodiversity, using traditional crops. The men, in contrast, wanted irrigation so that they could grow marketable crops, such as potatoes, soybeans or new hybrids of wheat and rice, or the new variety of plum trees, supposed to give a bumper crop. Such a scene, in which men have contact with extension services and press for the introduction of modern methods, is quite in accordance with the findings of Boserup (1970, p. 45 f.). The result should be that women gradually lose out. Here, however, the women were still strong enough to maintain their position as the main agriculturists. For the time being, a compromise was struck in which the women grew food crops on the land surrounding the village using local seeds and natural fertilisers, thus securing most of the needs of the household. New crops from improved varieties of seeds were grown on forestland with chemical fertilisers for sale at the market. This forest was previously used as an integrated part of a more extensive cultivation practice including both the cultivation of crops and animal husbandry. Again, we can use Boserup to understand that land used for intensification was earlier used in more extensive systems (Boserup 1965).

Intensification of agriculture increases the work burden of women as they perform most of the added labour. Women grow food for the household and crops for the market as well as doing domestic work, the latter including strenuous and time consuming chores such as fetching water, collecting firewood and gathering fodder from the forest. Men plough, using bullocks, and sell the produce. However, even here, the negative influence of modernisation can be detected. The further one moves away from the single road connecting the area with the outside world, the more males, both men and boys, one will find doing farm work and helping with domestic work. Although men living close to Mori will gather there during the day playing cards and talking, men living further away can be found in the villages caring for young children or doing other domestic chores, while the women work in the fields. Older men, who were still active in farming, also confirmed that "idle men and boys" is a recent phenomenon. We also found more dependence on the market in the villages close to the road, with whole villages concentrating on a single crop, such as growing potatoes for the urban markets on the plains, and more dependence on subsistence further away, with more mixed millet farming, preserved biodiversity and traditional

cropping patterns with annual periods of fallow. Periods of fallow have traditionally been times where women were relatively free from cultivation work. In addition, this changes as agriculture intensifies with modernisation and more crops are raised, quite in accordance with the findings of Boserup in *The Conditions of Agricultural Growth*. Women now must work longer hours, and their work becomes harder.

The fact that agriculture is essential to economic survival and that women perform most of the labour has added to the economic value of keeping daughters. As an elder man in one of the villages said "Earlier girls were married at a young age and sent to their in-laws for whom they worked. Now they are married later and they contribute with important labour at home before they leave". Thus, in former times girls were valuable because the in-laws, who would obtain a worker, paid a bride price to the family of the girl. Today, a daughter is valued as she gives part of her work capacity to her natal family before going to her in-laws. However, Mori differs from Bin in other ways than the economic importance of daughters and of women in general. Women and girls are generally seen as not only hardworking but also as industrious and doing well at their studies, whereas boys are seen to a greater degree as idle and careless in their work capacity and studies. As expressed by Chandri, a 23-year-old mother of two sons but without a daughter, "Boys are careless. They don't obey their parents. They help in ploughing but not much else. If I got a daughter, I would be happy. She would help me in my work." In Mori, most parents also viewed their daughters as more caring than their sons. Surendri, a 21-year-old pregnant mother with one son and one daughter said both she and her husband wanted another daughter because "girls are more caring and close to their parents". Brijmala, an older woman, reported that she felt emotionally closest to her daughter and continued: "Daughters are so much help, also after they go to their in-laws' house". As daughters are often married within walking distance, they can come back and help their own family in times of need. This works both ways; although parents in Bin felt powerless if a daughter was treated badly by her husband and in-laws, a young woman in Mori under similar conditions could rely on support from her natal family. As in Bin, neither low nor high caste respondents would allow their daughters to do menial labour for others, but they expressed support for educated daughters wanting to move away for a job elsewhere. Ashok, a 30-year-old Rajput man with one daughter and one son, expressed the concern for his daughter thus: "Daughters are closer to us than boys. We will provide everything for our daughter. I will educate her as well as my son and send her to a job wherever she wants". During fieldwork, we met cultivator families with educated, unmarried daughters who still supported their natal family economically after having migrated to jobs elsewhere. Rekha, a young Scheduled Caste woman with one daughter and two sons, expressed the concern of many parents: "We want to educate our daughter as far as possible. She will be able to stand on her own feet. She will not be like us".

The primary issues concerning daughters in Bin, "security" and "dowry", did not have the same significance in Mori. Although parents in Bin felt that unmarried girls should be under surveillance at all times in order to not give the family a bad name, parents in Mori said that they would not mind sending an educated daughter to a job somewhere else, even if she had to live alone. Although women from Bin Village

did not go alone to the market in Pithoragarh a couple of kilometres away, women of all ages in the Mori area could be seen moving around alone anywhere: on a mountain path, in the forest, going to the temple or on the way to market, always moving, always busy. In Bin the family, and especially the mother, was blamed if a girl did not follow the social norms set for her behaviour. In those cases, the mother was seen as the real culprit as she could not control her daughter. We discussed this with a woman leader in Mori and asked her whether a mother would be blamed if a young girl ran away with her lover. She answered surprised: "How can you blame the mother? The girl did it of her own free will." According to respondents in Mori, dowry was not yet an important issue. Most respondents reported that it was usually neither demanded nor given. Beela, a 40-year-old Rajput woman with two sons and five daughters, had this to say about dowry: "Dowry has been introduced very recently. However, only those families that have money give dowry to their daughters. It is not demanded". In many other places in India, having five daughters and thus having to pay dowry for them would be considered a horrible fate, but that is not so here. In Mori, parents still present to a daughter the things needed in her new life: a bed, a water pot, and a box of household utensils. Although the dowry of consumer goods in Bin was for the in-laws, what they give here is a gift for the daughter—as it was in Bin previously. In Bin, dowry is demanded by in-laws; in Mori, it is still an offering from parents who can afford it. However, a change can also be observed here with modernisation and proximity to mainstream society. In the southern and more "developed" part of the region, we did meet parents worrying about how to pay dowry for their daughters.

When we first came to Mori, we were told that paying for a bride was a thing of the past, something that they, as modern people, had eliminated. However, as we went higher into the mountains and came closer to the glaciers, we found that bride price was still a cherished institution in outlying villages. In Mori, we also found several examples of love marriages in which parents eventually accepted the relationship and slaughtered a goat to sanction it. In discussions, women stated that a girl who was badly treated in the home of her in-laws could return to her natal home, and her parents would remarry her somewhere else; however, they also said that this practice was declining, as somebody "who was educated would surely not marry such a girl." Again, we observe a negative impact on women's rights from education and modernisation. We also asked women if they felt that they have power in their households and in their communities. In Mori, women generally claimed that they had power, whereas we observed that many women in Bin felt powerless.

## 10.5 Discussion and Conclusion

Many social scientists have argued that, with increasing welfare, education of women and economic development, the importance of factors such as son preference would decline. However, we found that "son preference" and its resultant "missing girls" had actually increased alongside signs of modernisation such as lower fertility and

**Table 10.1** CSR (Child sex ratio) and female literacy in Pithoragarh and Puraula tehsils. (Source: Indian Census 2001)

| Tehsil | CSR (0–6) | Total SR | Female literacy | Male literacy |
|---|---|---|---|---|
| *Puraula* | 1000 | 947 | 38.5 | 73.7 |
| | *Highest CSR* | | *Lowest female literacy* | |
| *Pithoragarh* | 855 | 985 | 73.3 | 94.4 |
| | *Lowest CSR* | | *High female literacy* | |

increasing economic and social welfare (Larsen et al. 2010). Increasing demands for dowry combined with modern techniques of ultrasonography and amniocentesis, resulting in female foeticide, are often cited as the primary reasons for declining CSRs in modern India. However, as stated by Agnihotri (2001, p. 79): "Sex ratio patterns in India are complex and diverse. Their analyses have to be sensitive to this diversity in its spatial, social, cultural and economic aspects".

Although many reports of CSR in India draw their results from aggregates of literature studies, in this study, we examined the diversity of "spatial, social, economic and cultural aspects" in the hills of Uttarakhand through surveys combined with field visits over a 5-year period. Using the CSR as the primary indicator, we have compared two areas in the state of Uttarakhand in the Central Himalayas. Beginning at the tehsil level, we found a strong negative correlation between CSR and female literacy. Pithoragarh tehsil has one of the highest rates of female literacy in the state together with the lowest CSR, whereas Puraula has the highest CSR together with the lowest female literacy (see Table 10.1).

These results substantiate the findings of the 2001 Census that development in the form of education and shortening of the gender gap in literacy does not automatically lead to more equal conditions for women and girls; it may lead to the opposite, resulting in fewer girls being born. However, knowing that it occurs does not really explain why it occurs.

Following Barbara Miller and Ester Boserup, we then looked for the correlations between the "worth" of females and their participation in production. Miller (1981) related the worth of females to their importance in agricultural production as well as to cultural understandings and the cost of marriage. From her material from throughout India, she drew generalisations regarding the co-variation between Juvenile Sex Ratio (JSR) and Female Labour Participation (FLP). Her conclusion was that, where FLP is high, there will always be high preservation of female life, whereas where FLP is low, female children may or may not be preserved. Uttarakhand has traditionally been known for a high rate of FLP in agriculture, which is clearly discernible in Table 10.2, illustrating our case studies at the block level.

We found a high rate of feminisation of labour within cultivation in both areas. This is quite in accordance with what can be expected from rural areas in the hills of Uttarakhand. The figures yet again in themselves provided no real answers to the differences in CPS; instead, answers came from our comparative fieldwork.

We found that differences in the economic importance of agrarian production and the economic worth of women's labour, rather than the FLP as such, appear to

**Table 10.2** FLP (Female labour participation) in Bin block (rural) in Pithoragarh tehsil and Mori block in Puraula tehsil. (Source: Indian Census 2001)

| Block | Total workers Female | Cultivators Male | Cultivators Female | Other workers (not cultivator or household industries) Female |
|---|---|---|---|---|
| Mori Block (Puraula tehsil) | 46.8 | 71.5 | 88.9 | 3.5 |
| Bin Block (Pithoragarh tehsil) | 42.6 | 50.6 | 92.7 | 4.5 |

influence the CSR. In both cases from Uttarakhand, we have agricultural systems dominated by household female labour, with the difference being that in Mori, farming is still essential for the economic survival of the household, both for subsistence and for the market, whereas in Bin, its importance is giving way to incomes from wage employment by the men of the household. Women work in both agriculture and domestic work, and they work hard. However, in Mori, women—and girls—are the backbone of economic survival for their communities. They are seen as industrious, and their efforts are also valued by men. In the villages outside Pithoragarh, the work of women in agriculture is given a low value by members of the community.

Using the CSR from 2001 as the indicator, we have thus compared two rural areas in Uttarakhand and found them to be at the two extremes in regard to the CSR and also at different positions of agricultural transition. At one end, we have the most remote parts of Mori, where we find cultivation with a high degree of biodiversity and dependence on natural resources, primarily for subsistence and still vital for the survival of the household; we then observe how farming for the market increases in importance with the intensification of agriculture, although subsistence farming continues, and finally how market farming takes over in the most central and well-connected area of Mori block. Moving to Bin, we have observed how an earlier farming system, similar to the combined subsistence and market system emerging in Mori, now in the most central part, close to urban Pithoragarh, has given way to a low yielding, extensive subsistence system, now completely feminised, which has lost economic importance.

From the outskirts of urban Pithoragarh to the remotest part of Mori, we may also track the penetration of capital, consumerism and modern development. Pithoragarh is considered to be modern and progressive, whereas the remote area of Mori is seen as traditional and backwards. However, along the same journey, we may examine other phenomenon such as "son preference", "dowry", the "worth of a daughter", or "freedom of women" and find that here modernisation is related to son preference and discrimination against daughters, rising dowries demanded by in-laws, and hardened attitudes towards control of women. In contrast, backwardness and tradition relate to wanting and valuing daughters, dowry as a simple gift to a daughter and more freedom for women. This paints a picture of women as the losers in development—at least at this stage of transition.

Already in 1970, Ester Boserup drew attention to the fact that, in spite of the importance of women in agriculture, development processes and policies have been

biased against females (Kanji et al. 2011). She recognised how sex roles were polarised by modern development "with men at the progressive end and women at the traditional end" (Boserup 1970, p. 44). We observe a final step in such a process in Bin Village, where men have opted out of agriculture for other employment and left the women with a low yielding production of food crops for household consumption. As explained by Boserup (Boserup 1970, p. 44): ". . . women who produce food crops for family use have no cash income for improving their farming techniques" with the result that "the female sector continued with traditional low-productivity methods". However, in Mori, we might detect the signs of modern agricultural development as detrimental to women. As we observed, men control the cultivation of cash crops, although completely dependent on female labour, whereas women control the cultivation of food for family consumption. Therefore, men can invest in market farming, whereas women continue to rely on input from natural resources, such as forest and meadows. We observe that "modernisation" has moved up the Himalayas from the plains below, following new transport networks, and it has now reached the middle hills.

Boserup has been criticised for looking positively at development and for seeing a linear progression in economic development (Kanji et al. 2011, p. vi). Today, we have lost much of the optimistic belief in progress. We have encountered the dark sides of modern growth, and the picture of possible future developments now emerging is much more complex. We are no longer certain of the answers regarding where we are going and what the future might bring. Negative effects of development include valuing everything in economic worth, even a daughter, together with the threat of natural catastrophes, such as climate change, erosion, flash rains, loss of biodiversity and deforestation. Positive effects include new interests in sustainability, in enhancing food security and in organic and holistic farming systems. However, the situation for the girl child in India still looks bleak. As expressed by Mazumdar and Sharma (2001, p. 24 f.) from the Centre for Women's Development Studies, we must recognise "the subordination of women as an advancing rather than a disappearing phenomenon to which the globalisation of economic activities has contributed enormously, undoing in the process much of the hard earned benefits offered by other aspects of modernisation". Their pessimistic view is corroborated by the Indian Census of 2011. Those data reveal that, in spite of a blooming Indian economy and a rising level of education, the outlook is worse for the girl child. Although there were 927 girls per 1,000 boys in India in 2001, that ratio has declined to an all-time-low on the national level of only 914 in 2011. For Uttarakhand, it is even worse, with a nearly 20-digit slump down to only 886 girls for 1,000 boys. That is close to the figures for Pithoragarh, the tehsil with the lowest CSR in 2001. Uttarakhand as a whole is also following Pithoragarh in rising female literacy from 63.36 % in 2001 to 70.7 % in 2011. It thus appears that the development in the state continues to go the way of modern Pithoragarh. However, as this study shows, discrimination against female children is not an absolute given; it differs greatly even within the same region, and thus it may be changed. We can only hope for a future for the "daughters of the hills" that maintains the tradition in Uttarakhand of strong and free women and a wish for daughters, such as we still observe in the remotest part Mori.

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# Chapter 11
# Revisiting Boserup's Hypotheses in the Context of Africa

**Ngozi M. Nwakeze and Anke Schaffartzik**

**Keywords** Human development · Gender gap index · Status of women · Total fertility rate

## 11.1 Introduction

The role of African women in the community and national development process cannot be overemphasised, and it was the work of Ester Boserup on women and development (Boserup 1970) that pioneered this perspective. Until today, women remain the pillars of the household during times of economic hardship and crisis. They are often the ones who devise strategies to sustain their families and who work the extra hours it takes to put these plans into practice. In addition to their informal work, African women are also involved in formal employment and play a particularly prominent role in the agricultural sector. Boserup (1970) referred to Africa as the region of female farming "par excellance". In 1980, 44 % of the population economically active in the agricultural sector were female, increasing to 48 % by 2009—a proportion noticeably higher than women's general share in employment (38 % in 1980 and 41 % in 2009, all data: FAOSTAT 2012). However, this high share in employment does not translate into an equal standing of women workers in agriculture compared to their male counterparts. The International Labour Organization (ILO) notes that women are generally faced with more vulnerable forms of employment, own less than 1 % of the land, have limited access to technology, and often earn significantly less than male agricultural workers (ILO 2009).

The following chapter highlights the relevance of Ester Boserup's hypotheses for women's empowerment in Africa, reassessing the status of African women today. We attempt to answer the following questions: Does gender inequality in ownership

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and control over means of production (such as land and technology) persist, and, if so, are the factors sustaining the inequality the same as those identified by Boserup? Since Boserup first published her theories on woman's role in economic development in 1970, we have seen strong international progress in the field of gender policies. To take these changes into account, we also examine the level of progress achieved for women through development policies in Africa. We have structured our deliberation in three phases: (1) the pre-colonial, (2) the colonial, and (3) the post-colonial era. The latter is also the period in which various initiatives and policies aimed at improving the status of women in Africa gained momentum and the possible adverse implications of macroeconomic policies, such as the structural adjustment programmes (SAP), gained recognition. Our comparative analysis of selected countries in Africa is undertaken based on the Human Development Index (HDI), the Gender Gap Index (GGI), and the Total Fertility Rate (TFR). The chapter concludes by suggesting ways of applying Boserup's thinking for the twenty-first century.

## 11.2 The Status of African Women from the Pre-Colonial Era to the Post-Colonial Era

Gender discrimination is a long-standing issue. This section provides a brief overview of the status of African women from the pre-colonial era to the post-colonial era. In patriarchal African societies of the pre-colonial era and in traditional African societies today, marriage and motherhood earn a woman her honour. As a result of this emphasis, women's activities have revolved around familial work, including both productive and reproductive tasks. In most African societies, the family pattern is based on extended family with a patrilineal system of inheritance, leading to a preference for sons. Males tend to be the heads of the households and exert more power than their female counterparts. Nevertheless, African women have been involved in socio-economic activities from the pre-colonial era through the post-colonial era and there is a tradition of practical female participation in political affairs, albeit informally. In Nigeria, for example, there are powerful women's associations, such as the Yoruba ethnic group's "Iyalode" and the Igbo ethnic group's "Umuokpu" or "Umuada" council of women. The famous "Aba Riot" of 1929—organised by women from the eastern part of Nigeria in protest of a tax on women's property that the government was rumoured to be planning to introduce—has remained a popular example of the strength of women's organisations. During the colonial era, women's economic status did not improve much; the patrilineal system of inheritance continued, and women were, for the most part, still not allowed to own land or property. In fact, according to Boserup (1970), "African women are marginalised under the institution of private ownership" introduced by the colonial administrators, simultaneously experiencing a setback in their status compared to the pre-colonial period. During this time, married women were not given permanent appointments in the civil service and were only entitled to a basic salary. According to Ighadalo (1990), married women also had to resign from their jobs during pregnancy and re-apply for a position once

their child was born. In the post-colonial era, women's position in society has continued to see little improvement because women are not economically independent from men, which limits their impact on decision-making. The limited economic independence of women is rooted in the patriarchal system, perpetuating cultural inertia. The process of women's empowerment during the post-colonial era can be regarded as paradoxical (Nwakeze 2006), especially due to the adverse consequences of past macroeconomic policies, such as the Structural Adjustment Programmes (SAPs) of the 1980s. The SAPs consist of policies implemented by the Bretton Woods institutions, namely the World Bank and International Monetary Fund, which are a prerequisite to the approval of a loan. The policy measures generally aim to reduce government expenditure (austerity measures) and promote privatisation. However, according to Ruth Bamela Engo-Tjega, "structural adjustment overburdens women by relying on them to replace the collapsed public sector" (cited in Gellen 1994). In many regions, the implementation of SAPs is directly linked to the food crisis and rising poverty. Women, as the principle actors in devising coping strategies for households, thus face an additional impacts from SAPs.

## 11.3 The Role of African Women in Food Production and Agriculture

In most Sub-Saharan African countries, women play a very distinctive role in agriculture, particularly in food crop production. Most studies estimate that women contribute approximately 80 % of the labour input (cf. Gellen 1994). According to Boserup (1970), men's labour is concentrated on the initial clearing of the agricultural land (i.e., felling of trees and bushes) and on the production of cash crops, which provide returns in the form of income. Women, on the other hand, tend to perform the subsequent tasks after clearing, namely the removal and burning of felled trees, as well as planting/sowing, weeding, and harvesting of crops for immediate consumption. In addition to crop production, women engage in horticultural activities and animal husbandry, including small-scale poultry farming, animal rearing, collecting fodder for animals, and growing vegetables. Another important aspect of food production that women are involved in is fisheries. Women's roles in fisheries are processing (e.g., drying and smoking), marketing, and distribution. Apart from food production, women use agricultural products and their by-products to produce a wide range of other commodities, such as soap, pomade, oils, medicinal herbs, hurricane lamps, clothes, jute bags, baskets, and other household products, such as twine and broomsticks. Women are also involved in the marketing of surplus food and non-food items as a means of earning income to meet other family needs, including children's education, health services, clothing, and shelter. Although it is an area dominated by men, women also make an appreciable contribution to the agricultural economy through the labour they supply in the cultivation of commercial or cash crops. As the process of modernisation motivates more men to migrate to the cities and other countries for employment in industry and services, an increasing number of women

are shouldering agricultural responsibilities on a day-to-day basis throughout rural areas. However, women in agriculture continue to face the drudgery of crude technology and laborious methods of food and non-food processing. This includes lack of access to improved seeds and livestock breeds, which results in lower agricultural productivity and income. Furthermore, poor transportation facilities that prevail in rural areas and the difficulty in accessing financial credit exacerbate the situation for many women. In highlighting the crucial role that African women play in agriculture, Gladwin and McMillan (1989) argue that a turnaround in the African economy may not be possible without improving women's roles in agricultural production, which would require removing the constraints that women face in agriculture and, more broadly, in the development process. Overall, society bestows significant responsibility on women without granting them access to the entitlements, rights, and rewards associated with this essential work.

## 11.4 Women's Lack of Control over the Means of Production

Productive resources that African women have limited access to include land, credit, and improved technology. Although less frequently mentioned, the latter is highly relevant because an increase in the use of technologically advanced equipment would reduce the amount of time a woman spends in productive and reproductive activities. With increased efficiency, the relative income for women farmers would rise. Technology here refers to both equipment or tools and basic infrastructures, such as electricity, water supply, and sanitation. It is important to emphasise that the availability of technology alone is not enough—the appropriateness of the technology is of equal importance. The word "appropriateness" here implies that the technology and its use must be affordable and culturally acceptable. It should add value to the output of women's labour, either in terms of quantity or quality. Given the rising levels of poverty in Sub-Saharan Africa, many women currently cannot afford the improved technologies even if they are available.

Land and credit are also crucial productive resources to which African women have limited access. Land, in particular, is considered the most important asset for both poor and non-poor households in Africa. It underpins cultural identity, political power, and participation in decision making. It is the basis for sustenance farming, enables economic and social activities, and often serves as collateral for credit. The widespread exclusion of African women from owning and/or controlling land means that they are often barred from effectively engaging in economic activities and, consequently, having a secure and sustainable livelihood. Development partners and African governments have made commitments, which, if implemented, would help to unlock the potential for growth and development that lies in the hands of African women. These commitments addressing gender equality and the empowerment of women are based on the UN Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW). CEDAW promotes gender equality through access to social and economic opportunities and political power. The principle of

equality between men and women was also enshrined in the legal instruments of the African Union (AU). In 2003 at Maputo, the AU Heads of State adopted the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol). This protocol calls for the elimination of all forms of discrimination against women, including the condemnation and prohibition of harmful practices against women and the assurance of equal rights in marriage for men and women. The right to food security was also explicitly included in the Maputo Protocol, calling for the provision of women with "access to clean drinking water, sources of domestic fuel, land, and the means of producing nutritious food" (African Union 2003, Art. 15). However, while 46 of the 53 member countries of the African Union had signed the protocol by 2010, only 28 countries had also ratified it (African Union 2010). Despite ratification, the laws and institutional structures required for the protocol's implementation are not yet in place throughout these 28 countries. In a study by Nwakeze (2006) women's access to productive resources in Nigeria—a country that has signed but not yet ratified the Maputo Protocol—is empirically analysed, exemplifying the broader consequences of institutional weakness. Nwakeze found that 69 % of the female respondents in the study indicated that they do not own land. This was not surprising because the case study was carried out in Anambra State in the south-eastern region of Nigeria, an area inhabited primarily by the Igbo who live in a patriarchal society where the line of inheritance normally passes through the sons. This limited control over land also affects women's access to credit because land is often required as collateral.

Gender budgeting initiatives are another example of attempts to improve women's access to productive resources and unleash their economic potential. Gender budgeting is a broad and encompassing phrase for government efforts that seek to address gender issues in the domain of public expenditure and policy. Australia and South Africa were the pioneers in gender budgeting initiatives, and other African countries including Botswana, Kenya, Mozambique, Tanzania, and Uganda have adopted similar measures. Stotsky (2007) argues that reducing economic disadvantages for women can lead to higher economic growth and to greater stability. Similarly, Buvinic and King (2007) assert that greater gender equality in terms of access to opportunities, rights, and political empowerment can lead to a more efficient economy and improved institutions. However, this link between the promotion of gender equality and overall economic and social well-being has hardly entered into the mainstream political arena. Measures taken to promote equality for African women have not yet succeeded in thoroughly improving their situation.

## 11.5 Are Human Development, Economic Growth, and the Status of Females Interrelated?

The third goal of the United Nations' eight Millennium Development Goals is to "empower women and promote equality between men and women" (MDGs, cf. United Nations 2000). Although politicians, stakeholders, and researchers alike would argue that the link between overall development and specific gender issues remains

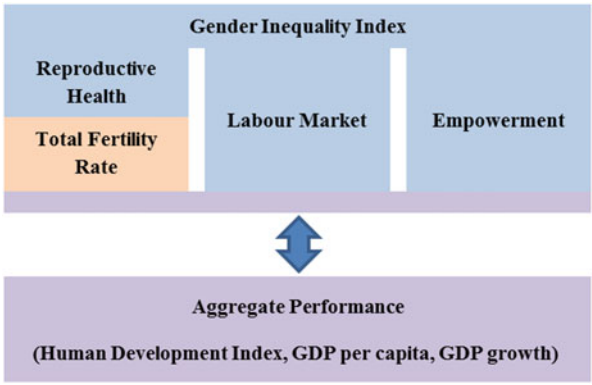


**Fig. 11.1** Framework for analysis by indicators

poorly understood and insufficiently addressed (cf. Buvinic and King 2007), much has changed over the last half-century in how the subject is approached. When Ester Boserup first illustrated the mutual relationship between the status of women and development, the Millennium Development Goals did not exist to support her claims. This did not dissuade her from arguing that understanding the role that women play within a society is essential to understanding the overall development of that society. She showed that besides women's reproductive work, the agricultural labour performed by women is especially crucial to societies' economic development (Boserup 1970, 1986, see also Chap. 8 by Ringhofer et al. in this volume). Boserup integrated these deliberations into her multidisciplinary approach cutting across issues of population, agriculture, and technology (see Boserup 1970, among others). Ester Boserup's theory was unique given the manner in which she integrated women into her fundamental theory of economic change. Her model has stimulated a number of research initiatives and international declarations on the status of women. In fact, her scholarship laid some of the groundwork for the inclusion of equality between men and women throughout the MDGs.

Although it is not always cited, Boserup's model continues to be highly influential in the discourse on women and development within the concepts of gender and development (GAD) and even gender mainstreaming.

In a contribution for the International Monetary Fund (IMF), Buvinic and King (2007) illustrated the relationships between gender equality and economic performance, arguing that "leveling the field of opportunities" through greater gender equality would have impacts at the household, economy and market, and society levels and thereby enhance aggregate economic performance both in terms of poverty reduction and economic growth.

We understand the hypothesis put forth by Buvinic and King as an expression of Boserup's theories on the relationships between the status of women and development and therefore use it as a reference to test this proposed relationship in the context of Sub-Saharan Africa. In Fig. 11.1, we have sketched out the framework of our analysis. We use the UN's Gender Inequality Index (GII, data source: UNDP 2010) as an indicator reflecting the degree of gender inequality. This indicator covers three dimensions: reproductive health, labour market, and empowerment. These

dimensions coincide well with the spheres for improvement as illustrated by Buvinic and King: household, economy and markets, and society. A GII of 1 represents total inequality, while a GII of 0 represents total equality. We have chosen to further examine the role of the total fertility rate (TFR), as it is not among the indicators included in the GII (data source: United Nations 2010a). By definition, the TFR is the average number of children that would be born alive to a woman during her lifetime if she was to pass through her childbearing years (15–49) conforming to the age-specific fertility rates of a given year. As measures of aggregate performance, we examined overall GDP growth, per capita GDP, as well as the Human Development Index (HDI) (data source: UNDP 2010; United Nations 2010b). The HDI consists of three components: income per capita (GNP per capita in US dollars at purchasing power parity), educational attainment measured by literacy rate and combined enrolment ratio, and longevity measured by life expectancy. In the following analysis, we tested whether there is a relationship between the status of females within a society and that society's overall performance in terms of human development and economic performance (as postulated by Buvinic and King 2007) in Sub-Saharan Africa. For this purpose, the aforementioned indicators were compared and contrasted for a total of 48 Sub-Saharan countries at different points in time, spanning the period from 1995 to 2005. The indicators taken into account were the Human Development Index (HDI), the Gender Inequality Index (GII), the Total Fertility Rate (TFR), and the Gross Domestic Product (GDP) in absolute and per capita terms.

Initially, we examined the relationship between GII and GDP in absolute terms as well as GDP growth as indicators of overall economic performance. We found no systematic relation between these indicators for the Sub-Saharan African countries examined. Countries with different levels of gender inequality achieved similar rates of GDP growth. Almost the same total GDP could be achieved by countries where gender inequality was similar to European countries (e.g., Mauritius) and by countries in which gender inequality was even higher than the Sub-Saharan average of 0.65 (e.g., Democratic Republic of Congo). Considering the differences between countries across Sub-Saharan Africa, it would have been quite surprising to find a correlation between GII and GDP or GDP growth, especially because economies that are similar in terms of GDP or GDP growth may be very different in terms of population. We therefore decided to focus on GDP per capita (GDP/cap) as a more comparable measure of economic performance. All correlations were checked for statistical significance.[1]

For the years 2000 and 2005, we found significant correlations between GDP/cap, total fertility rate, the Gender Inequality Index, and the Human Development Index among Sub-Saharan African countries (see Fig. 11.2). As was described above, GDP is a component of the HDI, and therefore, this correlation cannot be tested for significance.

We also found a negative correlation between per capita GDP and both the total fertility rate and the Gender Inequality Index: The higher the number of births per woman and the higher the gender inequality, the lower the GDP per capita was in 2000. This very important result illustrates that the high rates of overall GDP growth,

[1] All correlations shown in the following were tested for a significance level of $\alpha = 1\,\%$.

| 2000 | GDP/cap (current USD) | TFR 95-00 (births/woman) | GII 2000 | HDI 2000 |
|---|---|---|---|---|
| GDP/cap (current USD) | 1.00 | - 0.74 | - 0.64 | 0.85 |
| TFR 95-00 (births/woman) | | 1.00 | 0.68 | - 0.87 |
| GII 2000 | | | 1.00 | - 0.62 |

| 2005 | GDP/cap (current USD) | TFR 00-05 (births/woman) | GII 2005 | HDI 2005 |
|---|---|---|---|---|
| GDP/cap (current USD) | 1.00 | - 0.70 | - 0.65 | 0.28 |
| TFR 00-05 (births/woman) | | 1.00 | 0.70 | - 0.82 |
| GII 2005 | | | 1.00 | - 0.70 |

**Fig. 11.2** Correlation coefficients for 2000 and 2005

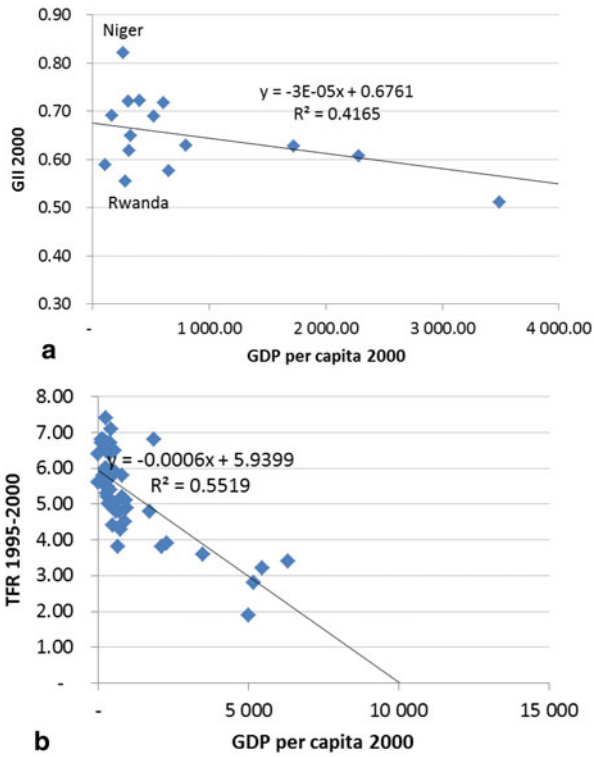


**Fig. 11.3** Relationship between GDP (in current US$) per capita and GII (N = 17; **a**) and GDP per capita and TFR (N = 48; **b**) for a selection of Sub-Saharan African Countries in 2000

which are exhibited by many of the countries of Sub-Saharan Africa, do not benefit the population. As shown in Fig. 11.3, the majority of countries exhibit fairly low per capita GDP, which is in turn coupled with high GII and TFR.

Figure 11.3 shows the per capita GDP in the countries of Sub-Saharan Africa in relation to the GII (Fig. 11.3a) and to TFR (Fig. 11.3b). The clustering on the left-hand side of both diagrams illustrates the relatively low per capita GDP in almost all countries of this region. This low economic wealth can be associated with both high gender inequality (e.g. Niger) and relatively low gender inequality (e.g. Rwanda). However, it must be noted that the GII levels analysed here were well above the world average (0.5) and significantly higher than the European average (approximately 0.3).

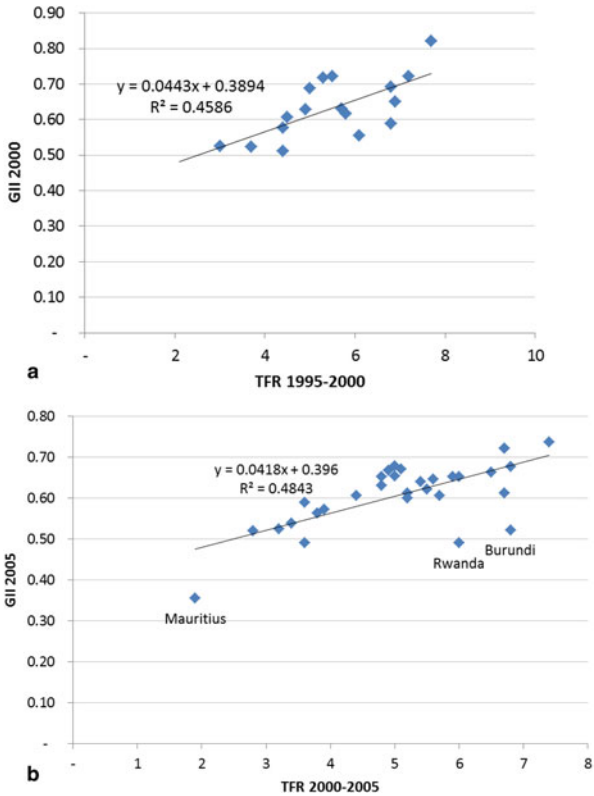


**Fig. 11.4** Relationship between GII and TFR for a selection of Sub-Saharan African countries in 2000 (N = 17; **a**) and 2005 (N = 48; **b**)

The three countries in which GII approached the world average in 2000 (Namibia, South Africa, and Botswana) were also the countries with the highest per capita GDP. The total fertility rate also varies considerably amongst those countries with a low per capita GDP and ranges from more than 7 to less than 4 children per woman (Fig. 11.3b). The majority of countries in the investigated region had a TFR of 5 or more births per woman between 1995 and 2000. During this same period, the world average TFR was below 3, and the European fertility rate was below 2. Again, those countries with a noticeably lower TFR (South Africa, Botswana, Gabon, and Mauritius) were also those exhibiting higher GDP/cap values. If we relate the total fertility rate to fertility decisions for countries of Sub-Saharan Africa, we can find evidence that the relationship between women's status at the household level (or family level, in Boserup's terms), their say in fertility decisions, and overall economic performance is worth investigating further.

The relationships analysed between the total fertility rate and the gender inequality index showed a significant positive correlation (see Fig. 11.4). In the year 2000 (Fig. 11.4a), those countries with a high fertility rate were also likely to exhibit a high level of gender inequality, with the highest level of gender inequality in 2000 (GII = 0.82) occurring in the country with the highest 1995–2000 TFR (7.7). This

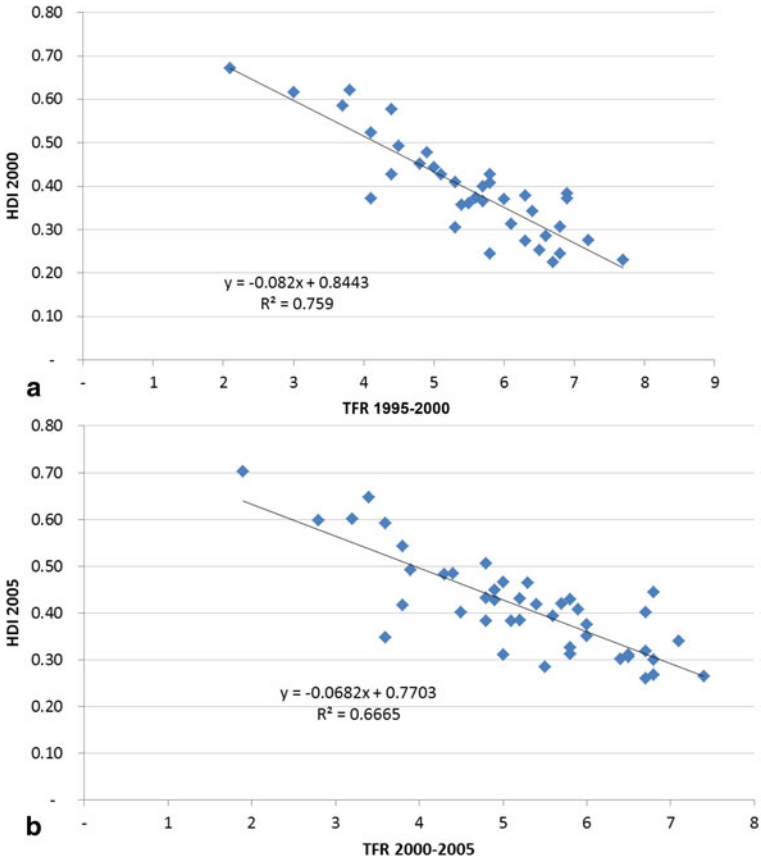


**Fig. 11.5** Relationship between TFR and HDI for a selection of Sub-Saharan African countries in 2000 (N = 17; **a**) and 2005 (N = 48; **b**)

relationship also holds true for the year 2005: As clearly shown in Fig. 11.4b, those countries with more births per woman exhibit higher gender inequality. As was noted earlier, the TFR in Mauritius was by far the lowest in the region, and this country also exhibited the lowest level of gender inequality. There are two countries (Rwanda and Burundi) that diverged somewhat from this trend because the fairly high TFR that occurred was coupled with an uncharacteristically low GII. The latter was especially due to the relatively high level of involvement of women in political decision-making processes as well as their integration in the wage labour market in Rwanda and Burundi. It is interesting to note that if Rwanda and Burundi were not included in the correlation analysis, the fit of the linear trend for the remaining data sample would improve to $R^2 = 0.74$.

Our data analysis has shown that the relationship between TFR and HDI was even stronger, mainly because all countries included in our sample seemed to follow the same trend: The more births that occur per woman (i.e., the higher the TFR), the lower the HDI (Fig. 11.5). In both 2000 and 2005, the highest level of human

development measured by the HDI occurred in the country with the lowest number of births per woman (Mauritius), while the lowest level of HDI occurred in the country with the highest number of births per woman (Niger).

Upon re-examination and our modification of the model proposed by Buvinic and King (2007) as shown by Fig. 11.1, we can postulate that the status of females at the household level plays a crucial role in not just overall gender equality but also in a society's general development. Far from being a private household issue, women's control over fertility decisions is highly political.

## 11.6 Fertility Transition in Africa

Most Sub-Saharan African countries remain in a high fertility regime. On average, a woman in Sub-Saharan Africa has five children in her lifetime. This is much higher than the world average of a 2.55 TFR (United Nations 2010a). In fact, some countries, such as Mali, Guinea-Bissau, and Niger, continue to have total fertility rates close to or above seven children per woman. In approximately 10 other countries, including Somalia, Rwanda, and Uganda, the total fertility rate is more than 6. Several factors contribute to the sustained high fertility in Africa. These factors include early marriage, preference for sons, and low contraceptive use, among others. Additionally, low levels of development, low levels of female education, and poor reproductive health influence the proximate determinants of fertility. Over the past decade, there has been evidence that some African countries have begun to experience a fertility transition. Among them are South Africa, Botswana, and Zimbabwe, with an average of 2.4 children per woman over her lifetime. In countries such as Ghana and Kenya, the decline in fertility rates appears to have stalled. The explanations for the reversals are not very clear.

Apart from the general heterogeneity across African countries, significant fertility differences exist within countries by sub-region and socioeconomic status. For example, Addis Ababa, Ethiopia, has achieved below replacement fertility (of 2 children per woman), while surrounding regions of the country have fertility in excess of five children per woman (Sibanda et al. 2003). These differentials have implications for policies and programmes aimed at addressing high fertility in Africa. There are considerable inter-country and intra-country differences in levels and rates of change of fertility, which include differences across urban and rural areas as well as across individual communities. Another classic example is the variability in fertility levels across the formal and informal settlements in Accra, Ghana (Weeks et al. 2010). These types of studies indicate that the aggregated fertility trends at the national level are composed of heterogeneous fertility trends at the subnational and local levels.

Recent focus has been on the behavioural determinants of fertility change rather than the description of fertility change. Specifically, the influences of education, marriage, religion, and living in a poor neighbourhood on fertility change are emphasised, in addition to proximate determinants of fertility change, such as contraception and birth spacing. Due to methodological challenges, it has not been easy to establish clear connections between changes in norms or behaviour and changes in fertility

while controlling for income, assets, or wealth. However, it is assumed that with education there should be increasing economic independence for women, which allows them to make independent fertility decisions, such as the number of children to have. There is no need to re-visit the debate about whether to invest in family planning or development, but rather an understanding of the interactions between family planning policies and broader development policies is required. Additionally, the dilemma of Malthus versus Boserup arguments of whether population growth is an impediment or stimulus for development has been avoided in this analysis. By and large, it is important to recognise that fertility is still very high in Sub-Saharan Africa, while the means of sustenance (food security) are grossly inadequate. This situation is worrisome given that the carrying capacity of land is limited.

## 11.7 Conclusions: The Relevance of Boserup's Theories in Twenty-first Century Africa

At the beginning of the twenty-first century, the Millennium Development Goals (MDGs) emerged as a new global development agenda that pursues a total of eight goals with specific targets set for 2015. Goal number 3 refers to ensuring gender equality and empowering women, while goal 5 (improved maternal health) has implications for reproductive health and reproductive decisions including fertility decisions. Apart from these two goals, gender issues cut across each of the other goals. In fact, to achieve the MDGs, there has been a call for gender mainstreaming in all development policies, including in budgeting for MDG-related activities. As noted, MDG 3 specifically recognises the role of women in the development process, just as Boserup did more than 30 years ago. It can even be said that Boserup's model has framed the theoretical underpinnings of the MDG 3 (United Nations 2000).

Because Sub-Saharan Africa is less industrially developed, has the highest fertility rate, and has a wider gender gap than other regions around the globe, the attainment of the MDGs is crucial for Africa. Just as issues of gender, population, and development were central to Boserup's model, they remain so for the MDGs; the MDGs strive to apply the results of her research. One way to sustain Boserupian thinking in the twenty-first century is to ensure that MDG 3 is achieved in Africa, which requires recognising the role of women in development (Boserup 1970) as well as suggesting strategies for enhancing their status in society. Generally speaking, to achieve this goal, there is a need for 1) legislation and implementation of land and property rights for women, 2) access to appropriate technologies, and 3) fundamental cultural changes towards accepting basic human rights and gender equality. In the process of attaining these goals, women's co-operatives can play an important role in counteracting men's control and the oppression of women. Furthermore, male commitment and shared responsibility in household activities is required.

Revisiting the Boserupian model in the context of Sub-Saharan Africa has provided us with insights about the interrelationships between gender, population, and development. Boserup's holistic thinking has allowed us to better understand and illustrate that the status of women in Sub-Saharan Africa is not just a question of women's development, but rather of overall human economic development.

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# Chapter 12
# An Interpretation of Large-Scale Land Deals Using Boserup's Theories of Agricultural Intensification, Gender and Rural Development

**Julia A. Behrman, Ruth Meinzen-Dick and Agnes R. Quisumbing**

**Keywords** Land grabbing · Agricultural change · Land tenure · Agricultural intensification · Gender relations

## 12.1 Introduction

Ester Boserup challenged mid-twentieth century ideas about rural livelihoods and economic development. Boserup's publications, along with other factors, initiated a re-conceptualisation of the processes associated with agricultural innovation, the transition to modernity and the importance of gender perspectives to rural development. Though considerable time has passed since Boserup's early writings, her theoretical viewpoint continues to feature prominently in contemporary discussions of rural development (see Abernethy 2005; Decker and Reuveny 2005; Demont et al. 2007; Hunt 2000). Equally impressive is the fact that her work has remained central to a variety of disciplines ranging from economics to anthropology to the biophysical sciences. However, the global context has changed dramatically since Boserup's publications first gained prominence. An entirely new set of technologies—ranging from new crop varieties to mobile phones—has been developed and disseminated throughout the world. Urbanisation has continued at an unprecedented pace on almost every continent. In addition, the emergence of new stakeholders—including civil society organisations, private sector organisations and international organisations—and an ever-changing and increasingly interconnected geopolitical climate have implications for the lives of the rural poor. Given these changes, it is worth examining the applicability of Boserup's writings in a twenty-first century context.

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This chapter focuses on the contemporary debate surrounding large-scale land deals (also called "land grabs"), an issue that is at the intersection of two themes central to Boserup's oeuvre, specifically her work on agricultural intensification and her work on gender and rural development. In this chapter, Boserup's theories of agricultural intensification and of gender in rural development are used to shed light on aspects of large-scale land deals that have thus far received scant attention. The chapter begins with a brief summary of Boserup's views on agricultural intensification and of her work on gender in rural development, followed by background information on the contemporary wave of large-scale land deals. Large-scale land deals are then presented as a contemporary example of intensification, leading to a discussion of which aspects of Boserup's theory remain relevant and which are problematic in the present-day context. Boserup's work on gender is then discussed in the context of large-scale land deals to highlight the necessity of including gender in any discussion of land acquisition.

## 12.2 Boserup on Agricultural Intensification

The concept of agricultural intensification, which became central to Boserup's understanding of economic development in rural areas, was discussed in her groundbreaking 1965 publication, *The Conditions of Agricultural Growth*. In this book, Boserup takes as her starting point the relationship between population growth and food supply, writing the following:

> Ever since economists have taken an interest in the secular trends of human societies, they have had to face the problem of the interrelationship between population growth and food production. There are two fundamentally different ways of approaching this problem. On the one hand, we may want to know how changes in agricultural conditions affect the demographic situation. And, conversely, one may inquire about the effects of population change upon agriculture. (Boserup 1965, p. 11)

Contrary to the dominant Malthusian ideas of the time, Boserup argued that population growth stimulates agricultural development via innovation and productivity improvements, rather than vice versa. To arrive at this central argument, Boserup disputed the dominant theories of how to increase agricultural output. The conventional logic at the time held that agricultural output could be increased through either expansion into new uncultivated areas or through the initiation of more intensive cultivation. Boserup made a persuasive case that "primitive" agriculture—similar to that which continued to exist in much of the developing world—does not function in this way.[1] Primitive agricultural systems do not use permanent fields. Rather, cultivation shifts from plot to plot with an intervening fallow period to give the land time to recover and to regenerate depleted soil nutrients. Thus, from Boserup's perspective, discussions of agricultural development in rural societies should focus on the frequency of cropping rather than whether land is cultivated.

[1] Boserup used the term "primitive agriculture" in her early texts to refer to agriculture before intensification; however, she refrained from using this terminology in her later writing.

By introducing the frequency of cropping as a measure of agricultural intensity, Boserup was able to distinguish five types of land use: forest-fallow, bush-fallow, short-fallow, annual cropping and multi-cropping. According to Boserup, the gradual transition from extensive (i.e., forest-fallow) to intensive (i.e., multi-cropping) land use is roughly characteristic of the sequence of agricultural development through history. As such, this transition is characterised by decreasing fallow periods and increasing levels of agricultural intensity. As fallow periods shorten, new technologies and methods to improve the productivity of the land must be developed to maintain the land's fertility. At the same time, the introduction of new methods requires additional human labour, and a household must work harder to maintain yields that are comparable to those of the past. Ultimately, Boserup argued that intensification takes place when population pressure is sufficiently large precisely because the new technologies require an additional investment of labour such that a population increase is necessary. Boserup also identified many secondary effects of intensification, which may ultimately lead to an overall growth in agriculture. These secondary effects include new work ethics and patterns of labour, new divisions of labour, and the spread of urbanisation, education and communication.

In addition to this work on intensification and innovation, another major contribution from Boserup was to draw attention to the gender dynamics of rural development. While other authors at the time had development models that were largely gender blind, Boserup highlighted the fact that rural men and women have different tasks and responsibilities and are affected differently by the processes associated with intensification. In her 1970 book, *Woman's Role in Economic Development*, Boserup drew explicit attention to the gendered division of labour in both "traditional" and "modern" agricultural systems and to the fact that—for better or worse—men and women experience the transition to modernity in different ways. Boserup was an early critic of the notion that gender differences in the labour market were due to biological, as opposed to socially constructed, differences. She went on to argue that economic development could not be fully evaluated without recognising women's myriad "hidden contributions", particularly in the form of unpaid work. In this and other publications, Boserup illuminated the complexity of women's work, a topic that had traditionally been downplayed or ignored. Boserup is credited with ushering in a new era of discussion of "women in development" and subsequently "gender and development."

## 12.3 Background on Large-Scale Land Deals

Many of the issues Boserup raised related to subsistence agriculture and intensification are still relevant to studies of rural development today. However, a host of additional issues that are related, yet new in their own right, has also arisen. One such issue are large-scale land deals that have sparked ongoing controversy among development practitioners and researchers, national governments, the international investment community, and civil society organisations at both national and international levels (GRAIN 2008; United Nations 2010; World Bank 2010). In Madagascar, public uproar over a decision to lease a large amount of land to a Korean company

contributed to the collapse of the Ravalomanana administration in 2009. In a variety of other places around the world—including Uganda, Tanzania, the Democratic Republic of Congo, Indonesia, and the Philippines—national protests have made large-scale land deals a subject of heated debate.

Simply put, the current wave of large-scale land deals is characterised by the widespread acquisition of land in developing countries by foreign or domestic investors for a variety of purposes including speculation, investment and the production of staple crops or biofuels—often for export. This land is acquired in a variety of modes including purchase, rental and contract farming arrangements. It is difficult to succinctly define what qualifies as a large-scale land deal given the deals' considerable diversity in scale and context. For example, a report by the Food and Agriculture Organization of the United Nations (FAO) suggests that these deals range from 10,000 to 500,000 ha and take place in a wide range of countries including Uganda, Brazil, Cambodia, Sudan, Pakistan, and Ukraine (FAO 2009). A report by the International Land Coalition (Anseeuw et al. 2012) considered reported deals of 200 ha or more and found deals totalling 203 million ha worldwide reported as approved or under negotiation, of which 71 million ha were part of verified deals. Africa was a particular focus of these deals, accounting for 134 million ha of reported and 34 million ha of verified deals.

Foreign investment in land is not a new phenomenon. During the colonial eras of many developing countries, it was common for colonisers to expropriate customary land and establish large estates dedicated to the production of export crops. In many instances, foreign-owned estates continued to operate even after the countries gained independence. Agricultural commercialisation—often the purported rationale for land deals—has also taken place at a variety of scales, ranging from smallholder farms to plantations owned by foreigners or national elites. However, a number of distinct drivers distinguish the contemporary wave of large-scale land deals from earlier foreign investment in land. The development of and subsequent interest in biofuels as a substitute for oil led governments from the United States and Europe to look for land available for biofuel production and exportation. An unprecedented conglomeration of factors—including urbanisation, population growth, the 2008 global food price crisis and the increasing difficulty of increasing yields in industrialised countries—drove investors from oil-rich Gulf States and wealthy Asian countries with little arable land to seek new locations for the production of staple crops to export to their home countries.[2] The concurrent financial crisis prompted the international investment community to seek new, "safer" investment opportunities in land speculation in developing countries. The magnitude of the current wave of land deals is unprecedented. A World Bank (2010) study of 464 projects found land deals

[2] We recognise that urbanisation and population growth are not new phenomena. However, we argue that the recent combination of urbanisation and population growth at unprecedented rates in newly industrialised countries, coupled with the food price crisis and decreasing yields, has been unique and without historical precedent. Likewise, the record shortages of staple crops that have resulted from this conglomeration of factors have also been without precedent.

accounting for 46.6 million ha reported in 203 projects in 81 countries, with information on land area unavailable for the rest. Proponents of large-scale land deals argue that these deals are a source of much-needed investment in agriculture and can introduce technologies that increase productivity, especially on "unused" land. Critics argue that investment in land is no longer about gaining a comparative advantage in global markets but rather about providing food and energy to wealthier countries using the land and water of the poor (GRAIN 2008; United Nations 2010).

## 12.4 Large-Scale Land Deals as a Contemporary Example of Agricultural Intensification

Arguably, large-scale acquisitions of land by foreign and domestic investors in developing countries are a contemporary example of agricultural intensification, albeit in a different manner than the intensification first analysed by Boserup. At the heart of large-scale land deals is an attempt to make the land more productive through high inputs of capital, new technologies, labour, and agrochemicals. This push for intensification is prompted by investors, who are typically under pressure to make the land productive as quickly as possible—usually within a 10-year period—to maximise profit. Thus, the large-scale land deal is a nuanced inversion of Boserup's own theory, as in this case, exogenous pressures to feed or fuel distant consumers—rather than endogenous pressures to feed a local population—lead to agricultural intensification. In other words, the *external* growth of biomass demand is inducing agricultural intensification in the countries where the land deals are located.

Large-scale land deals also differ from Boserup's original model of intensification with respect to the timing of the intensification. The endogenously induced intensification Boserup describes transpires organically—and by implication, slowly—as the population expands over generations. However, in the case of exogenously induced intensification as represented by large-scale land deals, intensification occurs rapidly, in some cases in periods as short as a few years. Entire stages of intensification may be skipped in the leap from extensive agriculture to mechanisation. Boserup's ideas about mechanisation and labour inputs also differ from the large-scale land deal example. Boserup argued that population increases allow for increased investment in labour and overall increases in yields. However, a byproduct of this development is decreased labour productivity. In contrast, industrialised agriculture was able to increase yields significantly while simultaneously decreasing labour inputs. Given that Boserup focused on pre-industrial agriculture, this point does not fundamentally contradict her argument; however, it does constitute an important consideration.

Another major departure from Boserup's intensification scenario is with regard to land tenure changes. Boserup (1965) described the gradual transformation of land tenure during the process of intensification, moving from generalised rights of cultivation and grazing for all members of a clan or family to permanent attachments to particular pieces of land to private property, with property rights becoming more defined. However, throughout the process she described, the original land users had collective or individual exclusion rights, and outsiders who were seeking to use the

land had to pay tribute to the original cultivators. Outsiders seeking to acquire land today, however, are generally not entering as supplicants asking the local authorities for permission to use a piece of land; rather, they are often much more wealthy and powerful, bypassing local authorities entirely and negotiating with central governments for land rights. In these contexts, customary land rights in particular may be ignored. There is also often a compressed land tenure formalisation process, with those acquiring the land securing it through formal title or long-term leases, which were often unavailable or unaffordable to the prior right-holders.

While the debate over large-scale land deals may appear to present a challenge to Boserup's theory of land intensification, in many respects, Boserup's work provides a means for critically examining these land deals. Within the development research and policy community, there is a line of discourse promoting the idea that large-scale land deals—or "agricultural investments"—are good for the rural poor because the intensification they bring is needed to promote rural economic growth. Using Boserup's lens to look at large-scale land deals makes it clear that the intensification these deals bring is different from the "natural" endogenous intensification described by Boserup in both nature and time-frame. It remains unclear whether local populations have the capacity to cope with these land deals and to benefit from the intensification that accompanies them.

## 12.5 Boserup, Gender and the Large-Scale Land Deal Debate

Boserup's work on gender in rural development brought to light the importance of considering how men and women are affected differently throughout intensification and other rural development processes. In *Woman's Role in Economic Development,* her groundbreaking 1970 book on the topic, Boserup contested the notion that women made little or no economic contribution at the household or national levels. On the contrary, she showed how women's paid and unpaid labour positively contributed to household income and national economic growth. Boserup was one of the first to advocate the need to document and understand women's time use and labour burdens, including the amount of time spent on domestic tasks such as cooking, childcare and the collection of water, fuel and fodder. Boserup challenged researchers and practitioners to think about the ways in which development processes affected men and women differently and in turn the different but important ways in which men and women contributed to economic development at the micro and macro levels.

Since Boserup first wrote on this subject, researchers have embraced the idea that intra-household resource allocation must be understood to make sense of development processes (Alderman et al. 1995). Sex-disaggregated time-use data have also been recognised as essential to understanding the gender dimensions of economic development. Following in the footsteps of Boserup, researchers have empirically documented the contributions that women make to household welfare and poverty reduction at the micro and macro levels. Increasing women's control over assets—such as land, physical assets, and financial assets—has been shown to improve child health and nutrition and increase allocations toward education (Quisumbing 2003;

World Bank 2001). In Bangladesh, for example, a higher share of assets controlled by women is associated with better health outcomes for girls (Hallman 2000). Research by the International Food Policy Research Institute found that equalising women's status would lower child malnutrition by 13 % (13.4 million children) in South Asia and 3 % (1.7 million children) in Sub-Saharan Africa (Smith et al. 2003).[3] Empirical work from around the world now supports Boserup's idea that increasing the resources controlled by women promotes agricultural productivity (Quisumbing 1996; Saito et al. 1994; Udry et al. 1995) and contributes to poverty reduction (World Bank 2001).

Given the body of work on the gender dimensions of economic development that has followed Boserup's early writings, it is evident that including a gender perspective is critical when looking at the implications of large-scale land deals. Women and men have different responsibilities, rights, and opportunities and will be differently affected by changes in labour opportunities and tenurial regimes, especially for land transfers to extralocal investors. Land deals that take resources away from women can reduce the welfare of women and their families, even if there are some income gains for men. Thus, considering gender is not only a matter of social equity but is also central to poverty reduction. Nevertheless, the initial discussions and debate around large-scale land deals were characterised by few references to, and limited discussions of, gender (Cotula et al. 2009; De Schutter 2009; Germany 2009; World Bank 2010). Since these first discussions, many in-progress case studies and a few larger empirical projects have been launched. In addition, a theoretical framework that incorporates gender has been developed (Behrman et al. 2012; Daley 2010). The following is a rough chronology of the processes related to large-scale land addresses a discussion that builds on the thinking of Boserup and the framework developed by Behrman, Meinzen-Dick and Quisumbing (2012) to establish the gender implications of these dominant trends. The discussion emphasises the importance of understanding the gender dimensions of large-scale land deals.

## 12.6 Integrating Gender into the Large-Scale Land Deal Debate

Before any acquisition, it is important to understand who in the community has formal or informal land ownership or use rights and how gender, age, marital status, ethnicity, and other distinguishing factors may influence these rights. Poor rural women are disadvantaged with respect to land access and ownership in both customary and formal titled systems, even before a deal (Agarwal 1994; Kevane 2004; Lastarria-Cornhiel 1997). In contexts where customary land tenure dominates—such as Sub-Saharan Africa—most women gain access to land only through a husband or male family member. In contexts where formal titles are common—such as Latin

[3] The study defines women's status as women's power relative to men. Thus, women with low status typically have less control over household resources, tighter time constraints, less access to information and health services, poorer mental health, and lower self-esteem.

America—few women hold titles and even fewer own large-scale enterprises. These existing gender disparities in land access and ownership will likely be exacerbated by land deals. In contexts where titling is prevalent, if the land is titled in the name of the male head of household, women may not have a say regarding its sale or lease, even if the land was jointly acquired or the woman uses some portion of the land for productive purposes (Peters 2010). In contexts where customary land rights dominate, there is evidence that privatisation concentrates land in the hands of those who can assert ownership, such as community leaders and male heads of household, often to the detriment of the access and use rights of poor rural women and ethnic minorities (Lastarria-Cornhiel 1997). In addition, common land that women depend on for collecting firewood, water, fodder, and medicinal plants often has the least secure tenure, even being designated as "wasteland" by governments and is therefore the most likely to be opened up to outside investment (Rossi and Lambrou 2008).

Land acquisition for large-scale land deals is typically initiated through a process of consultation and negotiation that ultimately leads to a contract that formally enunciates the terms of the deal. The diversity in how this process plays out and the extent to which the perspectives of local populations are taken into account has important implications for local men and women. During formal and informal consultations and negotiations, men and women may not be equally represented due to legal or social restrictions. For example, in a case study of oil palm plantations in Indonesia, the companies coming into the district to establish palm oil plantations often reinforced or even exacerbated existing patriarchal norms and gender disparities by relying solely on male community leaders to help sign up smallholder farmers, disseminate information, and resolve conflicts (Julia and White 2010). Women were left out of initial community consultations precisely because they did not have visible positions in community leadership.

Under Boserup's model, gender tasks and responsibilities evolve during the endogenous pattern of intensification. However, Boserup also predicted that the shift from hoe to plough cultivation—in other words, the process of agricultural intensification—would decrease women's involvement in agriculture because ploughing was perceived almost universally as a male task due to the intense physical labour required. At the same time, weeding, a "female task," would become less important with intensification, pushing women further out of agriculture. In the case of large-scale land deals, ideas about appropriate "male tasks" and "female tasks" may likewise shape employment prospects for the local population. In the production of high-value crops and biofuels, as well as for other types of commercial agriculture, there is also a trend toward the gendering of tasks: women are perceived as more nimble and assigned tasks such as pruning, spraying, thinning, and tying, and are thereby excluded from activities that may be better paid, less strenuous, or less dangerous (Barrientos et al. 1999; Dolan and Sorby 2003; Rath 2003; Torres 1997). In some contexts, it is assumed—by investors or local communities or both—that formal-sector jobs are largely or exclusively for men. Many communities—especially rural ones, where resources are limited—have a history of prioritising boys' education over girls', resulting in potential gender disparities in human capital (Klasen 2002). These disparities may influence the ability of men and women to take advantage

of new employment opportunities by relegating women to lower-skilled positions. Women workers also have the added burden of balancing childcare alongside paid work duties, particularly when employers do not provide adequate childcare facilities. In some instances, rather than drawing from the local population to build the labour force needed to run large-scale farms, investors may decide to import their own workers from their home countries to fill lower level or managerial positions. This can be damaging for local men and women who will likely be relegated to peripheral jobs or excluded entirely from large-scale farm employment.

The introduction of mechanised production may be a mixed blessing for *both* local men and women. As Boserup noted, "Obviously, the adoption of a farming system where the main farming equipment is operated only by males entails a tremendous change in the economic and social relationship between the sexes" (Boserup 1970, p. 21). While exclusive reliance on mechanised methods can limit employment opportunities, some mixed labour and mechanised systems can help women by eliminating the most physically strenuous part of the process (Dolan and Sorby 2003). Ultimately, whether men and women benefit from mechanisation and other new technologies depends on whether there are concurrent increases in the demand for labour, the opportunities for application of the technologies outside the realm of the investment project, and the targeting of the technologies.

An alternative to establishing a large-scale farm is for the investor to enter a contract farming agreement with the local farmers. Under a contract farming agreement, the farmer agrees to provide a given quantity and quality of a product within a specified timeframe, and the investor agrees to either purchase the harvest at a set price or to provide a fixed percentage of the harvest to the farmer as rent. Contract farming is often presented as a more equitable option for smallholder farmers because it allows them to retain control over their land and labour and thereby benefit from returns to land as well as labour. However, the gender equitability of contract farming arrangements depends on a variety of factors including who in the household will receive compensation for the contracted production and whose crops will be displaced by the new production. In some instances, investors make the contract only with the male head of household, although many male and female family members will provide the labour (Raynolds 2002). There is also evidence of men in contract farming systems taking over women's crops as these crops become more profitable (Dolan and Sutherland 2002). On the other hand, when investors target female participants, provide training and input to female farmers and promote enterprises appropriate for women, contract farming can be profitable for female farmers (Bangwe and Van Koppen 2010).

For both large-scale and contract farming systems, the environmental impacts of the deals on local men and women must be considered. The use of agrochemicals releases pollutants that may reduce local soil and water quality. Monocropping crowds out biodiversity, including wild plants used by locals for food or medicine. Furthermore, if the investment crop is irrigated, the demand for water needed to sustain the large-scale agricultural production of staple crops or biofuels will likely compete with the quantity of water required for food production, livestock, and domestic consumption. Women, whose domestic chores typically include the collection of

water, fuel, and fodder, may experience the environmental impacts most directly. In addition, the use of new technologies such as pesticides may have serious health effects on the local community, particularly if proper protection and cleaning methods are not adopted. Evidence indicates that commercial endeavours often do not provide workers, especially women workers, with adequate protective gear or proper training for agrochemicals, and there is little monitoring of the effects on worker health, particularly women's reproductive health (Barron and Rello 2000; Dolan and Sutherland 2002; Loewenson 2000; Oxfam 2007).

Another issue for consideration is the type of crops that will be planted on the land in question and how the produce will be divided between home consumption, local markets, and exports. Under many land deals, staple crops—such as rice, maize, and millet—are planted for export to investor countries that lack the land and water required for domestic production. In some contexts, all of the produce is exported to the investor's country, which can be detrimental to local food security, particularly if the labour of the local population is diverted from subsistence farming to wage labour. In some cases, a portion of the produce may be sold at local markets or given to local labourers. In other cases—particularly, though not exclusively, in contract farming—local residents hired as labourers may retain a percentage of the crop yield as rent or payment for labour. The availability of staple crops, along with crops rich in important nutrients and vitamins, is particularly important to women, who are the guardians of household food security. An alternative to the production of staple crops is the production of biofuels, including bioethanol and biodiesel, which are increasingly produced in developing countries and sold on the global market as an alternative to fossil fuels. Exclusive biofuel production can be detrimental to local food security, because land and water are diverted from food production to biofuel production, while land available for livestock grazing may also be given over to biofuel production (UN Energy 2007). Biofuel production may contribute to the socioeconomic marginalisation of women because so-called "marginal lands"—often the domain of women—are often used to produce biofuels.

As part of land deals, investors often provide ancillary services, for example, investment in infrastructure, hospitals, educational facilities, stores and so on. Targeted investments in non-agricultural infrastructure, such as the construction of roads, rail links or port facilities, are mutually beneficial to investors looking to improve supply chains and to members of the local population with existing social and financial mobility. Some investors also invest in primary schools, hospitals, clinics or other local public amenities that are beneficial to local populations. Investments of this type may be of particular benefit to women of reproductive age and women who oversee the education and healthcare of their children. However, company stores can be a source of indebtedness and thus perpetuate cycles of poverty unless the terms of trade and credit are favourable.

## 12.7 Conclusions

Ester Boserup's explanation of agricultural intensification as an endogenous process has influenced a generation of agricultural development specialists. However, the large-scale land deals of recent years provide a different model of intensification. These land deals are much more rapid and are characterised not by endogenous local changes as Boserup predicted, but by external influences from global actors. Contrary to Boserup's argument, intensification does not bring decreasing labour productivity as a result of the mechanisation of agriculture. Given the rapid pace and exogenous nature of these land deals, both land tenure and gender-specific tasks and responsibilities may become confused or distorted, with negative implications for women. This does not mean that endogenous intensification is necessarily good for women, particularly if non-farm employment does not adequately grow and absorb women. However, the contemporary wave of large-scale land deals is different in that the intensification is so rapid that local economies may not be able to adapt and create alternative employment opportunities for local women and men who are displaced from agriculture or their land.

Properly executed large-scale land deals that give appropriate attention to gender can provide opportunities for both women and men through the introduction of new employment and income opportunities, new technologies, and new services. Appropriately designed land deals may even increase the gender equitability of the distribution of local resources. Investors also stand to benefit from land deals that take into account the full range of skills, labour potential, and knowledge of local women and men. However, if land deals fail to address the local context and gender dimensions, investments will at best perpetuate existing gender inequality and at worst increase poverty and conflict. Investors will lose out if their plan ignores the labour potential of half the population or causes community unrest. Large-scale land deals are not isolated events, but are linked to many interrelated policies, including land reform and certification, agricultural investment, and trade policy, as well as legislation to promote gender equality, attract investors, and regulate investments.

Appropriate programs and policies that consider gender from the start can help ensure that the intensification resulting from large-scale land deals is gender equitable. For example,

- Land reform and certification can help secure existing users' land rights and thereby ensure that both women and men benefit from the land's sale or lease. Including the names (and photos) of both husband and wife can help to secure the land against expropriation by one spouse.
- Agricultural research and infrastructure investments in developing countries, coupled with private investment to improve input supply, processing, and marketing, can increase the productivity of existing male and female land users without requiring that they surrender their land to outside investors.
- Countries can ensure that trade and investment policies, which affect the profitability of land deals and the incentives for foreign investors to acquire land as a tool for obtaining food, are not biased against existing local male and female producers.

- Legislation to promote gender equality—for example, in cases of inheritance or in the actions of local governments—can strengthen women's voices and bargaining power, making government services such as extension and land registration more gender equitable.

The challenges are to assess how the existing policy framework surrounds agricultural development and influences land deals; to assess how gender can become an integral part of the framework, rather than an afterthought; and finally, to enact changes that support gender-equitable agricultural development in programs, policies and institutions.

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# Chapter 13
# Labour Migration and Gendered Agricultural Asset Shifts in Southeastern Mexico: Two Stories of Farming Wives and Daughters

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**Keywords** Mexico · Labour migration · Agricultural change · Female property rights

## 13.1 Introduction

In this chapter, we present evidence of two gendered agricultural asset shifts associated with labour out-migration in the municipality of Calakmul, Campeche. The first is a shift in land rights from men to women (wives), which occurred as men's labour out-migration, largely to the U.S., coincided with the process of land privatisation and the reform of the ejidal system in Mexico. Ejidos are collective land tenure institutions dating back to the Mexican Revolution and the redistribution of land in the previous century. The second is a more recent shift—one that entails the labour migration of younger single women (daughters) from ejidal villages to nearby cities, the generation of cash earnings, and the subsequent household acquisition of land and cattle back in their home villages. Although Mexico initiated a process of ejidal land parcelisation and privatisation in the mid-1990s (De Janvry and Sadoulet 1997), the ejido remains the most important institution of community organisation and smallholder land tenure in Calakmul (Haenn 2006). Therefore, we focus on the ejidal sector to understand the dynamics of gendered changes in agricultural assets and labour out-migration for smallholder, semi-subsistence households in southeastern Mexico. Through two stories, we illustrate and assess the sudden and unexpected shifts that can occur in women's productive asset control (in this case, land and cattle) with different patterns of gendered labour migration. In rural Calakmul, agricultural assets remain central to generating viable livelihoods in the area, even as smallholder agriculture wanes under difficult economic and environmental conditions.

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There is ample evidence from studies around the world that men's labour migration leads to changes in the gendered division of agricultural labour. However, there has been little to no examination of the changes in the gendered allocation of productive assets within agriculture that might also accompany labour migration. Studies on changes in the gendered division of agricultural labour date back to Boserup (1970), who noted that in regions where men migrated for wage labour, women took over tasks that men had previously performed. In their review of studies on gender and migration, Pessar and Mahler (2003, p. 825) found a similar overall trend. From the findings of eight studies, they concluded that in most cases, "'traditional' rules governing work weaken as nonmigrant women and girls assume the tasks usually performed by the now-emigrant men and boys." More recently, a number of studies in Mexico (Radel et al. 2012; Riao and Keilbach 2009) and elsewhere (De Brauw et al. 2008) have questioned the inevitability of feminised agricultural labour resulting from men's out-migration. Moreover, we know even less about shifts in control over agricultural assets and inputs other than labour. We aim to address this gap through an examination of the changes in gendered agricultural asset rights and control resulting from different patterns of labour migration in Calakmul. We focus on two assets central to agricultural production in the region—land and cattle.

As state support for small-scale agriculture has diminished (Echánove and Steffen 2004; Gravel 2007), rural livelihood strategies in Calakmul have diversified (Radel et al. 2010). One response to the changing opportunities for and conditions of semi-subsistence agricultural production has been the emergence of circular or temporary migration patterns over the last decade, similar to those found elsewhere in Mexico (Massey et al. 2002). Beginning around 2000, an increasing number of men travelled to the United States in search of wage work to generate remittances and cash savings (Schmook and Radel 2008). The absence of men (for just under a year to many years) carried potential implications for agricultural production and the social arrangements surrounding that production. Household engagement in labour migration that generated income also carried implications for household and individual asset accumulation and control, including those of land and cattle.

This chapter combines findings from three phases of research that we conducted in Calakmul. The study zone is a sub-area within the municipality, with historically higher chilli (jalapeño peppers) cultivation. In 2007, we surveyed 155 households in six villages, asking questions related to the agricultural impacts of men's labour migration and gendered land tenure patterns. We followed up on the survey with qualitative interviews in 2010 and 2011 in one ejidal village (Fig. 13.1). The 2010 interviews revealed a new labour migration pattern—younger women migrating to nearby cities, such as Playa del Carmen, and the subsequent investment by those women's households in land and cattle. In 2011, we initiated a second set of qualitative interviews to better understand the relationship between women's internal labour migration and land and cattle acquisition.

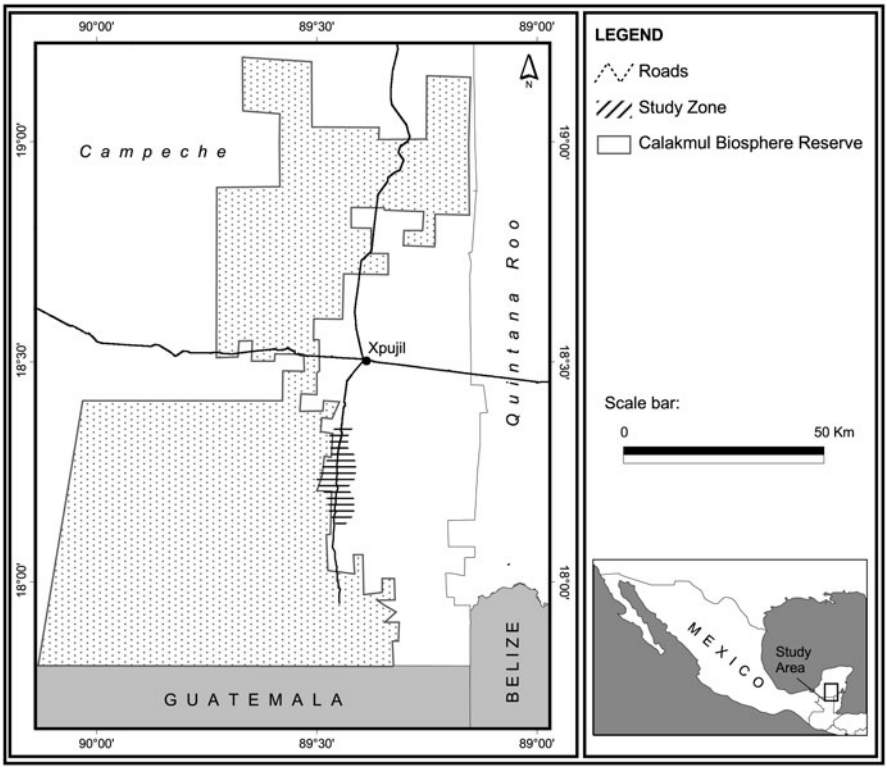


**Fig. 13.1** The study sub-area within Calakmul. (Source: Radel et al. 2012)

## 13.2 Labour Migration, Gender, and Productive Assets: A Review of the Literature

Numerous scholars have documented the impacts of labour migration on household productive assets, but little of this work has detailed the intra-household division of these assets. Many case studies of remittances and migration earnings have primarily documented their use in terms of household consumption and housing versus the acquisition of productive assets (e.g., Basok 2000). In contrast, Sana and Massey (2005) argue that in Mexico a cohesive patriarchal family funnels migration earnings into local productive investments for household risk diversification. In addition, de Haas (2005) argues that the notion that remittances are primarily spent on conspicuous consumption and non-productive investments is a myth, founded on "a rather poor empirical and analytical basis" (p. 1274): Migrant households are often more likely to invest in productive enterprises than non-migrant households (De Haas 2005; Taylor et al. 1996).

Investment of remittances in cattle is one of the preferred economic options in Calakmul (Schmook and Radel 2008). Busch and Vance (2011), in their article on the

diffusion of cattle in the region, conclude that cattle ranching is spreading, as it is well suited for households with abundant land, but often facing labour constraints. Labour constraints can typically be found in households with male migrating members. The same authors state that cattle ranching is less risky and can therefore reduce household vulnerability, given unfavourable conditions for crop production because of shallow soils and unpredictable climate variability. Another trigger for cattle ranching is support from government programmes. Even money from the "Farmers Direct Support Program" ("Programa de Apoyos Directos al Campo", PROCAMPO), initially designed for basic staple production (Schmook and Vance 2009), can now be invested in pastureland. In addition to remittance investment, several households have invested other income (e.g., from chilli cultivation) to cover the start-up costs of cattle ranching (Busch and Vance 2011).

The intra-household re-allocation of existing assets or the allocation of new assets is central to any understanding of the gendered impacts of labour migration on a household's productive assets and economic wellbeing. Underlying our analysis is an understanding of households as being more complex than cooperative units of consumption and production. Although a unitary model of the household, in which members are treated as if they have the same preferences and pool resources (Quisumbing 2003), is widely employed in economics and other social sciences, scholars of feminist economics have pioneered a more complex conceptualisation of the household (Folbre 1986; MacDonald 1995). The alternative model we adopt is best characterised as one in which gender cooperation accompanies individual interests (Jackson 2007). In economics, this is often referred to as the cooperative conflict household model (Sen 1987). Although the household, or family, is conceived as sharing common interests, each individual member also has interests that may at times conflict with those of other members. A woman's control over productive assets has important implications for her position within the family and the community and for her ability to further her individual interests.

Boserup (1970) expresses concern over the deterioration of women's rights to land that accompanied land privatisation, particularly under European colonisation and land reform. The concern over women's rights to land, especially under land reform, has abided for scholars three to four decades later (Casolo 2009; Jacobs 2009; Razavi 2003, 2007; Sargeson 2008). In her work on women and land in South Asia, Agarwal (1994) argues for formal land rights to empower women, and Deere and León (2001) have made the same argument for women's land control in Latin America. As land provides women with resources and choices, it thereby alters the power relations within the household. Some scholars have questioned the power of *de jure* land rights *per se* to transform gender relations (Jackson 2003), arguing that effective land control is more likely to lead to women's gender empowerment (Radel 2005). In this chapter, we examine both *de jure* land rights and effective land control, using land decision making as an indicator of effective land control.

Compared to research on women and land rights, very little research exists on women and livestock rights. Most of this research comes out of pastoral societies, especially in sub-Saharan Africa (Curry 1996; Hodgson 1999; Mkutu 2008; Oboler 1996). In a study conducted in the state of Veracruz, Mexico, Vázquez-García

(2003) argues that women's ownership of cattle leads to their increased participation in household decision making over income expenditures, in the same way land ownership does.

## 13.3 Methods

The research documented in this study was conducted in three phases in a sub-area of the Calakmul municipality (Fig. 13.1). The ejidos there are relatively land rich, compared to elsewhere in Mexico. The six study ejidos have an extent of approximately 3,000 to 5,000 ha each.[1] Parcel sizes allocated to ejidatarios/as (official ejidal rights holders, including to ejidal land) also vary across the ejidos, ranging from 20 to 50 ha. The majority of these ejidatarios are men, as elsewhere in Mexico. In 2002, only 10 % of ejidatarios in a sample of 38 Calakmul ejidos were women (Radel 2005). This figure is lower than the 23 % rate reported for the country as a whole (Amaya Quiroz 2007).

The first phase of research consisted of a random-sample household survey across all study ejidos. We selected 155 households, with the sample stratified by ejido and household migration status. These 155 households represented 37 % of all households across the six ejidos (INEGI 2006). Migration status was defined in three categories: 55 households with no member having participated in transnational labour migration (non-migrant), 61 households in which the male head had at least one labour migration experience (migrant male head), and 39 households in which some other member (but not the male head) had at least one labour migration experience (other migrant member). To collect data from the surveyed households, we conducted oral interviews with both the male and female heads whenever possible.

To compare households with migrant male heads to those without migrant male heads, we created a category of 94 households with non-migrant male heads by combining the "non-migrant" and "other migrant member" groups. To ascertain our ability to combine these two sample stratification classes, we first examined the results of cross-tabulations to confirm the lack of statistically significant differences between these two groups for the key variables of interest. We then performed cross-tabulations for male and female *de jure* land rights and for women's reported participation in land-use decision making.

The second phase of research consisted of follow-up qualitative interviews, in late 2010 and early 2011, in Villanueva,[2] one of the six ejidos. These interviews allowed us to validate and interpret the household survey findings on women's land rights.

A third phase was motivated by our learning that increasing numbers of household members, especially younger, unmarried daughters, had begun to migrate to the

[1] One of the surveyed ejidos covers only 626 ha, according to Mexico's Registro Agrario Nacional, but this extent is an outlier relative to the others in the study.

[2] We have changed the names of all individuals and ejidos to protect the confidentiality of participants.

tourist corridor of Quintana Roo along the eastern coast of Mexico's Yucatan peninsula (including the cities of Playa del Carmen and Cozumel). In this third phase during the summer of 2011, one of the authors conducted 32 in-depth interviews of household members in Villanueva, mostly mothers, with migrating children in the tourist corridor and of the migrant children, mostly daughters, in Playa del Carmen. In addition, we "inventoried" nearly half (36) of the households in Villanueva to collect additional data on household members who have been, or currently are, labour migrants to the United States, to the tourist corridor, or to elsewhere in Mexico. We present this quantitative "inventory" information on the 36 Villanueva households in the form of descriptive percentages to demonstrate the importance of the new migration destinations and the household use of the resultant remittances. Finally, we conducted a brief workshop in Villanueva with girls aged 14 to 20, asking them to write down their goals in life and what they would like to do in the next three years.

Established in 1983, Villanueva is a product of rural to rural migration within Mexico. Most residents came in search of farmland from the neighbouring states of Chiapas and Tabasco and consider themselves *mestizo* in terms of ethnic identity. Male out-migration began here in 2002. By 2007, over half of the male heads-of-households had migrated to the United States for at least some period of time. Residents cited the lack of local job opportunities and crop failures as the primary causes of labour migration. By 2010 and 2011, we observed fewer and fewer community members migrating to the United States. Instead, new migrants had begun to head to close-by Mexican destinations. According to several informants, the reasons for this shift in the labour migration pattern included the growing difficulties of the border crossing to the U.S. due to intensified border control and the growing cost of the crossing. Increasingly, migration to the United States is considered permanent or long-term, as going back and forth to Mexico is perceived as being too dangerous and expensive. However, informants state that migration to nearby tourist resorts is cheap and going back and forth to the home village is easy. Young women find the tourist corridor an attractive labour destination, with employment available in stores and restaurants. Some of the migrant daughters stated that there are no adequate work opportunities for them in Villanueva, as agricultural work is neither desirable nor appropriate for them (see also McEvoy et al. 2012).

## 13.4 Husbands' Migration and Wives' Land Assets

The 2007 survey found that for households without migrant male heads, 10 % of the women held ejidal land rights in their own names (*de jure* land control) (see Table 13.1). In contrast, for the surveyed households with migrant male heads, more than double the number of women (24 %) held ejidal land rights ($X^2 = 5.23$, $p = 0.02$). We also examined the association of migration with rates of ejidal land rights for the male household heads. Of the three categories of households (migrant head, other migrant member, and non-migrant households), migrant heads were the least likely to hold ejidal land rights. Only 56 % of migrant heads held ejidal rights,

**Table 13.1** Household Survey Results, 2007 (n = 155)

| | Husband is or has been a U.S. migrant | Husband is not and never has been a U.S. migrant | Husband is not a migrant, but another household member is or has been[a] |
|---|---|---|---|
| *De Jure Land Control: Ejidal Land Rights* | | | |
| Wife holds rights | 24 % | 10 % | |
| | Chi-square results $X^2 = 5.23$, $p = 0.02$ | | |
| Husband holds rights | 56 % | 62 % | 86 % |
| | Chi-square results $X^2 = 9.09$, $p = 0.01$ | | |
| *De Facto Land Control: Land-Use Decision Making* | | | |
| Husband makes planting decisions | 60 % | 83 % | |
| Wife makes planting decisions | 15 % | 1 % | |
| Husband & wife make planting decisions together | 25 % | 16 % | |
| | Chi-square results $X^2 = 14.123$, $p = 0.001$ | | |

[a] For the husband's holding of land rights, this stratification category of the sample was not combined with the non-migrant male head category; for all other variables, it was combined

while 62 % of the male heads of non-migrant households held those rights and 86 % of the male heads of households in which some other household member was a migrant held those rights ($X^2 = 9.09$, $p = 0.01$).[3]

As an indicator of effective (*de facto*) land control (Radel 2005), we also asked the male household head who decides if and what the household will plant on the land held by household members. For households without a male migrant head, in 83 % of the cases the reported decision maker was the man, while in 16 % it was the man and woman jointly, and in only 1 % it was the woman (see Table 13.1). In contrast, for households with a migrant male head, in 60 % of the cases the reported decision maker was the man, while in 25 % it was the man and woman jointly, and in 15 % it was the woman ($X^2 = 14.123$, $p = 0.001$). Women with migrant husbands thus were more than twice as likely to be reported as participating in planting decisions, either making the decision autonomously or together with her male partner.

The interviews in Villanueva revealed key insights into these survey results. In 2010, 20 of the 67 Villanueva ejidatarios/as[4] were women (30 %). In 2002, only five of the 84 ejidatarios/as were women (6 %). What explains this increase and the positive association between wives' land tenure and their husbands' labour migration?

[3] For the categorical variable of whether the male household head had ejidal land rights, we did not combine the two non-migrant male head groups (non-migrant households and households with a migrant member other than the male head), as we found a statistically significant difference between the two groups.

[4] The list of 67 ejidatarios/as is that managed internally by the ejido; the list held by the Registro Agrario Nacional is slightly different.

Many women in Villanueva became ejidatarias as a result of the certification of ejidal land rights under Mexico's PROCEDE process. In 1992, Mexico passed the New Agrarian Law and began the process of regularising, privatising, and documenting land rights in the countryside. The Registro Agrario Nacional (RAN, the National Agrarian Registry) was the federal state entity tasked with the PROCEDE process—a process that has taken nearly 20 years and is still not complete. The first step was the certification of ejidal rights. As reported by Villanueva residents, RAN officials visited the community in 2003 to conduct this certification and register the names of the individuals holding rights to ejidal land.

The general understanding in the community was that for the rights certification to occur, individuals needed to be present and of legal majority age. Ejidal rights that were not certified by RAN at that time would be forfeited and the land would be designated as common ejidal property. It remains unclear whether it was the RAN agents or particular community leaders who encouraged women to step forward in the place of absent men and underage sons. In any case, an expectation emerged in that moment that these women would become land-titled ejidatarias as caretakers for the land rights of men and soon-to-be men. As Reyna, an ejidataria and wife of a migrant, said,

> Each has their [land] right and each knows why they have it. Perhaps I did not want to be an ejidataria, but I was obliged to become one when my husband left, leaving the land, as they say, abandoned. And as a result, they were going to give this land to the so-called common use. At a meeting they [the ejidatarios] supported me, because my husband was not present and one had to get this title so that one could have the [land] right that was for the family. So the ejidatarios supported me and for that reason I am an ejidataria.

Subsequently, however, considerable conflict emerged in the community and within households over the legitimacy and appropriateness of the land transfers to women. For those women whose husbands continue to be absent in the U.S. and are seen as having been abandoned, the larger community validates their status as ejidatarias. These women are referred to as "viudas"—widows. Women who hold the land rights "temporarily" for underage sons, while their husbands hold a separate set of rights, also receive validation in the community. One male migrant spoke of what he considered to be an appropriate case:

> What happened was that when they did the registration, some [men] were not warned, and for this reason they did all these registrations, for this reason there are so many women ejidatarias. Although it is good, for example, in the case of my sister, because her husband still has not returned, and thus in this case it was good.

However, for those women whose husbands did return to the community, the land transfers have been considered usurpations of men's rights. As another male migrant expressed:

> What happened is that when RAN came in 2003, many husbands were away and some women took advantage to transfer the [land] rights into their names; so to speak, they came to possess the right of their husbands. In the case of my wife, she didn't want to and my title came to me, but other women yes took advantage; as one might say, they dispossessed the men.

In at least one case, the perception of male land dispossession contributed to the dissolution of the marriage. One migrant's wife who effected a transfer in her husband's absence spoke of her experience:

> The problems deepened when I changed the ejidal right into my name. He said to me very angrily that now that I had robbed him of his land, if he returned he would have nothing here. He said to me, 'if I return I will be your man servant, you will hire me.' I told him that the only thing I had done was to protect the right for his children. If I had not put it [the land] into my name, they were going to convert it into communal land, but that when he returned they would put it into his name again. But he said he could not ignore what I had done, and he told me he didn't want anything to do with me—that I should live my life as I see fit. I telephoned him several times and was crying, but he didn't want to be with me anymore.

The implications of shifts in the gendered distribution of land control are potentially significant, at both the community and household levels. These shifts are visible in terms of the wives' increased participation in land-use decision making and in terms of their increased likelihood of holding formal rights to ejidal land. The survey results show that male household head migration is associated with higher rates of (1) women's participation in deciding what and how much to cultivate, either autonomously or together with her husband, and (2) women's formal holding of ejidal land rights. Together, these findings suggest that men's labour migration has led to greater *de facto* and *de jure* control of land in some Calakmul villages. Women's *de jure* land control, although not always associated with effective land control (Radel 2005), suggests women's potentially decreased dependence on men to access and mobilise land and development resources. In Villanueva, the recognition that *de jure* rights have real meanings in terms of power and community standing has led to considerable conflict over the shift of rights from men to women. Ejidal rights are more than just rights to land as a productive asset; they also accord a sanctioned voice in community decision making and in the distribution of community resources, including incoming benefits from development and poverty-alleviation projects. However, to the extent that women simply hold these rights on behalf of men and underage sons, with control and voice vested instead with husbands and in-laws, the gendered transfer of land rights carries little to no change in broader gender relations within households and the community.

## 13.5 Daughters' Migration and Daughters' Land and Cattle Assets

Even as men's U.S. labour migration began to decline, migration remained a significant aspect of household livelihood strategies in many Calakmul villages. As male heads of households have increasingly returned from the U.S., the remittances of migrant sons and daughters have become the key source of migration earnings. In 2011, 68 % of the inventoried households in Villanueva had at least one migrant child, whether in the U.S., the tourist corridor of Quintana Roo, or elsewhere (Table 13.2). Half of all households had at least one migrant child in the tourist

**Table 13.2** Households with migrant children, with destinations (n = 36)

| | Number[a] | Percentage |
|---|---|---|
| Households with migrant child(ren) in the United States | 12 | 35 % |
| Households with migrant child(ren) in the Tourist Corridor of Quintana Roo | 17 | 50 % |
| Households with migrant child(ren) elsewhere in Mexico | 16 | 47 % |
| *Household with migrant child(ren) in any destination category* | *23* | *68 %* |

[a] Households sum to more than 36, as a given household can be in more than one category

**Table 13.3** Children's migration destinations, by gender (n = 168)

| | Sons | Daughters | Total |
|---|---|---|---|
| Migrant children to the United States | 18 | 1 | 19 |
| Migrant children to the Tourist Corridor of Quintana Roo | 9 | 21 | 30 |
| Migrant children to elsewhere in Mexico | 10 | 18 | 28 |
| Migrant children to any of the three destination categories | 37 | 40 | 77 |

corridor, and these migrants often were daughters (Table 13.3). 47 % of all inventoried households had daughter(s) and/or son(s) in other parts of Mexico, such as the nearby city of Chetumal, where the daughters work as domestic servants, in stores or in restaurants.

An examination of the destinations for all son and daughter labour migrants demonstrates a clear difference by gender. Sons are just as likely to travel to the U.S. as they are to remain in Mexico. Daughters, however, are just as likely as sons to be labour migrants but rarely travel outside Mexico (Table 13.3). Of the 168 total children in all 36 households, 77 (or 46 %) are migrants, and 40 of those are daughters.

Of the 36 households inventoried, 16 reported receiving remittances from migrant daughters. Only two households reported receiving remittances exclusively from sons, and 18 reported not receiving remittances from a migrant child. The interviewees also specified that it is mainly daughters who remit funds to Villanueva, with sons often expected to save for the establishment of their own households. Most (69 %) of these 16 households receiving remittances from daughters reported using the remittances for household expenses in general or for household consumption (Table 13.4). However, 44 % of households invested remittances in land. In this category we include land purchases, including agricultural lands or lots within villages or towns, and/or the purchase of agricultural inputs. As some migrant daughters left their young children with grandparents, 38 % of the households reported using the remittances specifically to feed or otherwise provide for their grandchildren. Investment in cattle was another important reported use of remittances among 19 % of the households.

**Table 13.4** Use of Remittances by Households with Labour Migrant Daughters, 2011 (n = 16)

| | Number[a] of households reporting use | Percentage of households reporting use |
|---|---|---|
| Investment in land | 7 | 44 % |
| Investment in cattle | 3 | 19 % |
| Improvement of house | 1 | 6 % |
| Investment in agricultural implements, car, motorcycles among others | 2 | 13 % |
| Household consumption in general | 11 | 69 % |
| Caring for child(ren) of the migrant(s) | 6 | 38 % |

[a] Several families reported several of the uses

The new generation of young residents is migrating to Playa del Carmen, Cancun and Cozumel without risking their lives crossing the border to the United States and becoming indebted. Mercedes, now back in Villanueva, told us the following:

> . . . it is very difficult to get there [to the U.S.], to what they call the border. Also you have to see that they killed a lot of Mexicans, and therefore they are scared and don't go. One says I am going [to the U.S.] to improve [economically] and it happens that they kill you or something else; they say, therefore I better stay. Also you see that they suffer a lot crossing, because there is a lot of border control and they [the middlemen] charge. When my brother left they charged him 20,000 pesos . . . . But it is not very complicated to get there [to Playa del Carmen], you take an ADO [a local bus company] and you pay like 320 pesos and you arrive at the bus terminal and from there you take a taxi for 50 pesos.

Young women, who are finishing secondary school and are not ready to get married, often consider the possibility of working in the tourist corridor. This decision is possible because of relatives already living there, and hence young women in particular stay with relatives. Nineteen-year-old Valentina explains how she left Villanueva to visit a sister in Playa del Carmen, after having had to drop out of school. She remained in the city to work:

> I was studying, but as I told you it was very difficult back then for me to get from here [Villanueva] to the other village [with a high school]. There was no [public] transport and one had to walk. . . . Therefore my father said that I better don't study. . . . So I took the chance, as my sister came from Playa and asked me if I would like to go there for a vacation. It was like that, that I started to work and stay there.

In addition, single mothers who need to provide for young children often migrate to the tourist corridor. These young women, seeking to contribute to household income, do not consider unpaid work in agriculture or domestic chores to be a viable option. Moreover, paid labour in Villanueva is only available to men. As one young single mother explained,

> I did send money to my child, who was with my mother. . . as you see the situation here is difficult. For example, here we only have work for men, in the fields, and they pay 100 pesos [a day] for whatever work. . . . In the city it is different. There men and women can work, and here only men work and one doesn't. I was bored and I wanted to work, but we are in the countryside and there is no work. . . .

Many young women's aspirations can no longer be met in Villanueva. Most are not satisfied with the prospect of farming. The following quotes are from a workshop we conducted with girls (ages 14–20) in Villanueva, where we asked the girls to write down their life goals and what they would like to do in the next three years:

> I would like to finish school to be someone in life. I would like to do my bachelors in law or infant sociology. And if I can't reach my goals, I would rather call them my dreams. And if I can't finish school, what can I do? But it won't be my fault if I don't. I try. I have seen that some people don't find [work] or nobody offers them work because they did not finish school, and others how they work in the countryside. I don't like to work in the fields, . . . and therefore I will put a lot of effort to finish school because I want to study. (a 15-year-old participant)
> I would like to finish middle school in the next three years and be with my uncles and my cousin and afterwards leave the village with them. And I would like to work in Playa or in some other place and help my uncles and myself moving ahead [improving our lives]. (another 15-year-old participant)

However, the young women migrants (and would-be future migrants) are not simply abandoning agricultural livelihoods; on the contrary, we found new ways in which migrant daughters participate in agricultural production. The 2003 land titling of women in Villanueva has opened new perspectives and possibilities for young women. Migrant daughters consider the possibility of owning their own cattle or a piece of land. Young unmarried women contribute to the household's income and agricultural decision making, and some continue to do so even after they marry. One mother told us that the family used the money her daughter, Candela, remitted to buy a calf. It was the family who suggested buying that first calf. Candela liked the idea, and she subsequently bought more cattle. Now she owns seven heads of cattle. Candela subsequently married and then began to save part of the money her husband gave her for daily expenses. With it she bought land in Villanueva to establish her ranch, and she gave 7000 pesos to her parents so that they could be shareholders in a tractor. Candela also sends money to her parents so they can buy "medicine" for her cattle. She also bought a piece of land in the village, where she wants to live when she grows old. Her mother has two more migrant daughters, who also saved money and own seven heads of cattle, and remit funds for cattle maintenance.

Buying land has become a form of investment, opening new possibilities for young women. A daughter in another family, Mariana, went to Chetumal to finish school and work and purchased a village lot with the money she saved. She and her mother cultivate chilli, with her mother in charge of the land and cultivation, while Mariana studies in the nearby town of Xpujil through a recently opened, on-line university. Most often, it is the single daughters who maintain strong links with their parents and remit money. Until they marry, these migrant daughters are the central pillars of the household economy:

> My sister paid for my ticket, the one who lives in Playa, she came [to Villanueva], she came this day in July to graduation and she told me let's go. We went and as she was still single, I said yes. . . . As they paid me 1500 pesos, and sometimes with extras I earned 2000 pesos a week, I sent 1000 pesos to my mother or 1500 . . . every week. . . . Afterwards, as I got 5000 pesos from a rotating saving group], it was my father who told me that we should buy cattle. It was back then when I started to save my money.

Female participation in household asset accumulation is changing dramatically. The migrant daughters do not participate directly in the labour of cattle ranching, considered a difficult and male task, but they actively participate in the creation of family assets that are then key to the household's agricultural production. With the help of the daughters' remitted earnings, agriculture remains a viable activity. Interviewees often spoke of land and cattle as "belonging" to the migrant daughter, but the daughters' control of the assets often remains partial and conditional. Assets purchased with daughters' remittances remain with the original household when the daughters marry. Once married, the husband is expected to provide for the newly formed household. At the time of the interviews, Valentina owned 11 of the 50 cattle on the family ranch. Her sister owned six of the cattle, which she purchased prior to being married. The daughters would send money they saved from their wages to their mother in Villanueva, where the decision of how to use the money was made. Their father decided to buy a plot of land for one of the girls' brothers. The father told the daughters that he purchased the lot for the son because the daughters would belong to their husbands and would live where their husbands wanted, but sons needed land to bring to their wives. Valentina told us how her father sold cattle belonging to her and her sister to help pay for her brother's land:

> My father had to sell 10 yearling calves . . . because he was going to buy the lot here and an agricultural parcel, and this required that he sell some of my calves and some of my sister's. And he asked us also when he went to conduct the business, he asked us if we were in agreement. We said we would tell him yes or no, but meanwhile don't sell the animals.

However, the father did sell the cattle, demonstrating that the young women's interests in their cattle were secondary to general household interests defined by the father. The women's labour was converted to cattle assets, which were then transferred into land assets in their brother's name.

## 13.6 Conclusions

We have found that both self-migration and the migration of other family members can lead to the accumulation of productive agricultural assets for women. However, their rights to these assets remain contested and conditional, shaped by gender norms and ideologies that are changing more slowly than are the economic conditions facing the women and their families. These economic conditions drive (in a negative sense) and enable (in a positive sense) the asset accumulation of the women by requiring wage labour migration for household survival and opening opportunities for women in a variety of ways—both expected and unexpected. In this respect, our research deepens, extends, and contrasts Boserup's observations and concerns over similar processes she observed unfolding in rural agricultural areas of the global south in the context of European colonisation and land reform decades ago.

In the story of the wives of U.S. migrants and the transfer of land rights under PROCEDE, the women's locally recognised right to the land now in their names is conditional on their holding the land for under-age sons and absent husbands.

In other cases, many in the community regard their land rights as a usurpation of men's rights. In this sense, the *de jure* land rights have not improved the position of new women rights-holders in their households and communities, in contrast to much existing theory on women's land rights. Women remain proxies for men or their rights are delegitimised in the local ejido context. Thus we should not be surprised if the translation of women's land rights as certified ejidatarias into women's empowerment is partial at best. We also observed an increase in women's participation in land-use decision making, which represents a key aspect of effective land control. In earlier research in Calakmul, Radel (2005) argued that effective land control is more pertinent to women's gender empowerment in these villages than *de jure* land rights. In addition, a change in the percentage of ejidatarios who are women—from only six to 30 %—can change what a new generation of women consider possible and may well have played some part in paving the way for migrant daughters' acquisition of village land in the second story we relate here. The changes in women's land rights and control in Villanueva has a complex relationship with women's position within the community—neither simply and automatically improving that position for the women directly in question, nor having no meaning at all in the larger scheme of changing gender norms and ideologies.

In the migrant daughters' story, female participation in household asset accumulation is changing dramatically. The land and cattle acquired with daughters' remittances are additions to a household's portfolio of assets and, in contrast to the first story, do not represent intra-household transfers. Although the young women's asset rights are often conditional on remaining a part of the household and not marrying, in most cases the daughters' interests within the household do not conflict with the interests of other household members. In some households, however, interests are in conflict and asset control *is* contested, with the young women's asset rights subject to possible re-assignment to another family member, such as a brother. As Sana and Massey (2005) found elsewhere in Mexico, a cohesive patriarchal family can effectively funnel migration earnings into local productive investments for household benefit. However, as we have demonstrated, this outcome does not always best benefit women in the household. Finally, the acquisition of cattle, in particular, by migrant daughters raises the need for more empirical research to understand whether cattle ownership can play a role in the household positions of female members in a manner similar to the role that land has been theorised to play.

A comparison of the two asset shifts described in this chapter yields a number of potentially important differences. First, the nature of the asset shift differs. In the first case, there were intra-household transfers; in the second case, the assets were new additions to a household portfolio. This impacts the types of intra-households conflicts generated. Second, the gendered nature of the associated labour migration and its location differs. In the first case, the migrants were male household heads who were unable to return quickly; in the second case, the migrants were the women themselves who worked relatively close-by. These differences shaped the ease of return and the migrant's ability to "claim" particular assets. Third, the initial household positions of the women in question varied, with the most generalisable difference being that of wives versus daughters. This initial position clearly matters in the outcomes of

subsequent asset shifts, although the notion that the daughters would become wives in other households also clearly shaped the intra-household dynamics. Fourth, the nature of the asset itself differs. In the first case, the assets were ejidal lands; while in the second case, the assets primarily were fully privatised land lots (village house lots and private lots) and/or cattle. We would expect ejidal land rights to be much more contested because they are accompanied by a voice in ejidal governance and other sorts of financial and non-financial benefits. Together, these differences shaped the outcomes for the women and are important, therefore, in our understanding of the relationship between gendered asset shifts and local gender relations.

In conclusion and despite all of the cautions and caveats, we believe that shifts in women's role in agricultural asset decision making and tenure in Calakmul, even when partial and conditional, matter—but the degree to which they matter remains an open question. New roles in the control of productive agricultural assets such as land and cattle can open further space for the construction of new gender identities and transformations in gender relations within households and communities. To understand these possibilities, we must continue to be detailed in our examination of shifts in women's control over productive assets to improve our understandings of when, which, and to what degree shifts do and do not improve the positions of women within households and communities.

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# Chapter 14
# Working Time of Farm Women and Small-Scale Sustainable Farming in Austria

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**Keywords** Austria · Agricultural labour time · Agricultural change · Long-term socio-ecological research · Agent-based modelling · Local case study · Gender relations

## 14.1 Why Link to Boserup's Approach?

Are women farmers a hindrance to progress in agriculture? Is progress in agriculture the solution for feeding the world? How can we find a path to develop agriculture without pushing natural, economic or social limits too far? Can we obtain greater insights into these issues if we study the role of women in agriculture and development?

Ester Boserup was the first scientist to ask these questions comprehensively. During her long career, she succeeded in developing a vast pool of data and insights. Ester Boserup promoted women's role in agriculture as a new perspective through which to understand the link among economic, technological and agricultural development. Her work has been considered a starting point in understanding the importance of women's role in development globally (e.g., Boserup 1970). Reading her work as students of social anthropology, sociology and biology, we were introduced to thinking about these questions in varying contexts.

Her focus on unequal workloads and strategies of using the available time enables researchers to grasp problems for which analysing solely economics will fail (Boserup 1965). It encouraged us to pursue time-use research as a non-reductionist approach for analysing social development, especially gender inequalities and dynamics, when tackling the problems of agricultural structural change.

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Boserup was an economist working with economic and non-economic data and theories. She was apt to communicate and cooperate across disciplinary and academic boundaries. She was heard by scientists, public administrators and politicians alike. Our socioecological research is based on an interdisciplinary team working with stakeholders concerned with the problem in question. Here again, we believe that Ester Boserup gave a fine example of the importance of inter- and transdisciplinary research when attempting to find solutions.

In the current paper, we aim to show how we used the three-fold influence of Ester Boserup, i.e.,

- A focus on women's role in agriculture,
- A focus on time use as important data beyond the economic and ecological factors and
- An inter- and transdisciplinary approach,

as guidance in the research project "GenderGAP".[1]

In "GenderGAP", we examined how changes in agricultural subsidies affect the economic, ecological and social situation of farms. We further investigated the factors—apart from economic factors—that influence decisions concerning the type and scale of production in small-scale family-run farms.

These research questions made it obvious that Ester Boserup's work remains important for analysing agricultural development and sustainability issues in Austria today. Time use is a crucial factor in decisions concerning production strategies on Austrian farms. Today, farmers aim to avoid having a high workload combined with low income. Technological change can diminish the workload of farmers. However, in the setting of industrialised agriculture, efficiency gains can only be expected in regions that are favourable for large-scale industrialised agriculture. More sustainable forms of agricultural production, therefore, must focus on mixed production and the maintenance of cultural landscapes in a lively region and must be attractive for young people, men and women alike, to keep them working on farms.

Following this introduction, which draws a link between Boserup's approach and the research undertaken, part 2 describes briefly the project in which this research was embedded. In part 3, we continue with a brief conceptual introduction to sustainable development and quality of life from a gender perspective. In part 4, we present the methods of agent-based modelling and its participatory application as well as the results for three scenarios. The final part recapitulates the significant findings and attempts to derive recommendations from them.

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[1] The project "GenderGAP. A gender perspective on the impacts of the reform of EU's Common Agricultural Policy" 2005–2008 was funded by the Austrian research program TRAFO (Transdisciplinary Forms of Research); it was a partner project to "PartizipA. Participative Modelling, Analysis of Actors and Ecosystems in Agro-Intensive Regions", funded by KLF (Cultural landscape research) and SÖF (German socioecological research).

## 14.2 The "GenderGAP" Project—An Austrian Case Study

The on-going structural change in Austrian agriculture, with its implications for ecology (e.g., land use, material and substance flows) and society (e.g., regional development, food and crops, cultural landscapes), is one of the well analysed and documented long-term socioecological changes in Austria (Krausmann 2008; Rammer 1999).

In "GenderGAP", we asked how the industrialisation and restructuring process that has been occurring in rural regions since the Second World War, and especially under the conditions of the Common Agricultural Policy (CAP) reform in 2003, can be analysed from a socioecological perspective (Fischer-Kowalski and Erb 2006; Fischer-Kowalski and Haberl 2007). What can we learn about the possible pathways to sustainable development if we study the interaction between social and ecological aspects of agricultural production? How can we create knowledge that can support social systems on their way to more sustainable solutions? We use the term "sustainable agriculture", meaning a spectrum from an ecologically friendly type of agriculture, which is characterised by farms using less fertiliser and other artificial inputs than allowed by the EU subsidy scheme, to certified organic production without any non-organic inputs. Within this spectrum, we do not further differentiate the degree to which production is ecologically friendly. We choose building a model as a way to use scientific knowledge and the knowledge of agricultural experts and farmers to develop future scenarios and regional strategies for sustainable agricultural development.

As Austrian agricultural development is highly influenced by the Common Agricultural Policy of EU, in 2005, we began the project "GenderGAP" with the following questions:

- What are the ecological, economic and social implications of the EU's CAP reform of 2003?
- Are women and men on farms affected differently by the CAP reform?
- How can scientists, farmers and stakeholders create and use an agent-based model to work on future scenarios and strategies for a sustainable development of Austria's agriculture?

The CAP reform adopted in June 2003 by EU agriculture ministers led to a profound transformation of the support mechanisms for the common agricultural sector. In particular, Brussels decoupling of the subsidies (which were previously bound to area use or livestock numbers) from the production volume had the intention to support a long-term perspective for sustainable agriculture.

Austrian agriculture produces much of Austria's food and feed despite its Alpine environment. As a main player in the task of shaping the cultural landscape, agriculture is one of the touristic and ecological assets in these mountain regions (70 % of national area). Approximately 45 % of the national area is used as agricultural area and is worked on by only 5 % of the total people employed. Off the fertile lowlands, agriculture is characterised by small-scale family farms that produce dairy products

and meat. It is further characterised by a high degree of organic farming (16 % of the national area) and a high percentage of women farmers (32 % of farms are headed by women; 17 % by married couples) (BMLFUW 2005).

The study region around St. Pölten, the capital of Lower Austria, is largely defined by the catchment areas of the two rivers Traisen and Gölsen. It extends from the political districts of St. Pölten in the north to the municipality of Lilienfeld in the south. We selected this region because it represents practically all production forms that are relevant for Austria within a relatively small area (Statistik Austria 2003). Whereas the share of the land used for agriculture is between 30 and 70 % in the northern municipalities in the St. Pölten region, only between 5 and 30 % of the land is used for agricultural purposes in the southern district of Lilienfeld. This proportion is reversed when forested area is considered, as 50 to 70 % of the land area in the south of the region is wooded. Because the technical aspects of modelling did not allow to consider the entire regions with all of their agricultural holdings, the two municipalities of Nussdorf ob der Traisen (in the north) and Hainfeld (in the south) served as case studies for modelling the southern and northern parts of the region.

In "GenderGAP", we attempted to widen the analysis of the impacts of socio-economic conditions upon farms in two Lower Austrian municipalities by including a gender perspective. In cooperation with farmers and agricultural experts, time use was selected as an indicator that enables the integration of a gender perspective within an agent-based model (Smetschka et al. 2008). This model allows for a simulation of the social, ecological and economic conditions on farms and the evaluation of the living and working conditions of women and men farmers.

## 14.3 Sustainability Research, Gender Issues and Quality of Life

### *14.3.1 The Sustainability Triangle*

In "GenderGAP", the sustainability triangle served as the overall conceptual starting point for our research questions and the modelling process. The triangle sets the three aspects of sustainable development—economic, ecological and social—in relation to one another and translates them into economic prosperity, natural resource use and human wellbeing or quality of life (Fischer-Kowalski and Haberl 1998). There is a dynamic inherent in this triangle (Fig. 14.1): increased wellbeing requires increased prosperity, which requires increased resource use. From a perspective of sustainable development, it is necessary to analyse the logic of the dynamic within the triangle and to determine the crucial points for intervention.

Decisions that are made about the types and scales of agricultural production at a particular farm are influenced by numerous factors. Subsidies, production costs and product prices form the economic conditions under which agricultural production occurs. Influence is also exerted, however, by the regional labour market situation and opportunities for manufacturing and marketing (niche) products. General physical

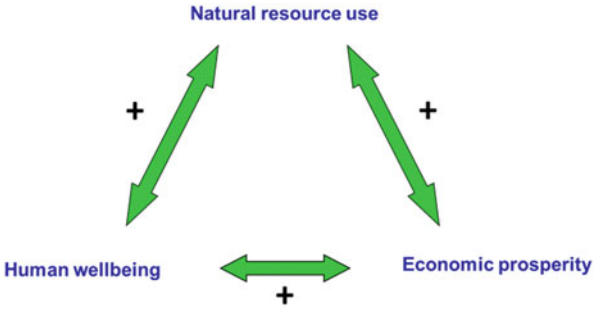


**Fig. 14.1** Sustainability triangle. (Modified from Fischer-Kowalski and Haberl 1998)

environmental conditions determine the production type and the options for either intensifying or extensifying production.

In addition to these environmental (or external) factors that condition the system "farm", intrinsic characteristics of the farm itself affect the key management decisions. These characteristics involve social issues such as the planned transfer of farm ownership, the openness to innovation that often accompanies this and the size of the farm workforce. Family structure and the expectations and needs of family members in regards to their life and working conditions are determining factors for changes in agricultural production.

The primary goals of family-run farms are not growth and profit maximisation, but the achievement of a balance between income and expenditure (Vogel and Wiesinger 2003). In this respect, family farms can be defined as "peasant economy" or "domestic economy" (Chayanov 1966; Sahlins 1969). Questions concerning how much income can be achieved with how much land, livestock and working time form the basis for decision-making on the farm. Expansion and agricultural intensification represent opportunities to increase income sufficiently to secure the farm's continued existence. Moving to more lucrative production branches or niche production may be a further strategy for achieving this goal.

The sustainability triangle serves as a framework within which decisions made by actors—in this case, farms as the agents of a computer model—can be analysed from a sustainability perspective, focusing on interrelations, impacts and limits. An agent-based model can consider these economic, ecological and social factors and the limiting factors that can be found both internally and externally.

### *14.3.2 Time-Use Approach as a Means for Analysing Changes in Gender Relations*

Time-use surveys on the development and organisation of work have a long tradition in industrialised countries. These studies originally focused on paid working hours and the "normal" biography of a fully employed man. Since the 1980s, the discussions on gender relations and the gendered division of labour have led to a demand for

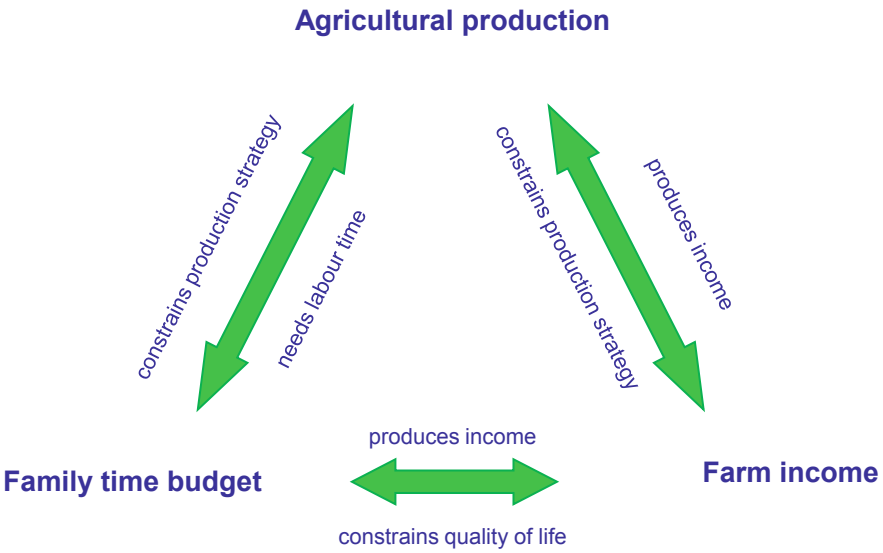


**Fig. 14.2** Sustainability triangle for a farm household

data on paid and unpaid work. Time-use surveys are a regular part of the United Nations Statistical Division (UNSD) surveys: "Time-use statistics offer a unique tool for exploring a wide range of policy concerns including social change; division of labour; allocation of time for household work; the estimation of the value of household production; transportation; leisure and recreation; pension plans; and health-care programme, among others" (UNSTATS 2013). A number of European nations conduct time-use surveys on a regular basis. These data are widely used to analyse changes in gender relations (Aliaga and Winqvist 2003; Bundesministerin für Frauen 2010; Döge 2006; Sellach et al. 2005; Statistisches Bundesamt 2004) and socio-economic conditions such as family and household structures, working hours, recreational behaviour and consumption patterns (Gershuny 2000; Hartard et al. 2006; Schor 2005; Stahmer and Schaffer 2004).

In "GenderGAP", we used time-use data to model the agricultural development in an Austrian region. The agents in the model are farms modelled along the concept of the sustainability triangle according to their economic, ecological and social circumstances (Fig. 14.2). The quality of life of a farm family can be operationalised for a formal model as the family time budget. The family time budget consists of the number of family members multiplied by 24 hours per day. Time is a resource that is clearly limited and distributed equally to all. The opportunity for individuals to decide freely about how to use their time is, however, unequally distributed. In every case, individual time use differs with socio-economic and cultural patterns of division of labour according to age and gender. The social situation within the farm business comprises the family composition by age and gender and the possible and preferred working hours of all family members as a measure of quality of life (Gershuny and Halpin 1996).

**Table 14.1** The four spheres of time use

| Area of life/societal sphere | Division of labour possible | Working hours in the model |
|---|---|---|
| Individual/physical | No | No |
| Family/household | Yes | Yes |
| Farm business/economy | Yes | Yes |
| Society/politics & culture | Yes | No |

Individuals use their time for the production and reproduction of four areas of life (Table 14.1) (adapted from Haug 2008; Fischer-Kowalski et al. 2011). This concept helps broaden the definition of working time, which in the current model includes the areas of family and household work, all types of para-agricultural tasks and the farm work per se. The model thus includes reproduction and subsistence activities, which are often the activities of women.

Studies on the situation of women in farming show that the traditional gender-related division of labour is changing slowly. This slow change relates to the fact that women farmers tend to have a higher workload due to their combination of various roles and responsibilities (Inhetveen and Schmitt 2004; Oedl-Wieser 2008).

We used data on farming and domestic working time from two comprehensive studies from 1979 and 2002 (Blumauer et al. 2002; Wernisch 1979) and agricultural statistics (Handler et al. 2006; Pöschl 2004) for Austria. This material was verified through several workshops and a series of qualitative interviews with men and women farmers and adapted for use in the model.

Time-use data have several functions in the model. They can help in the following ways:

- Operationalise the changing needs of members of a family-run farm.
- Depict ways to overcome divisions in the sphere of production and reproduction as supported by research on gender and women's issues.
- Facilitate differentiated treatment of subsistence work, para-agricultural activity, household and family work and agricultural production, particularly in the farming sector.
- Support communication about quality of life and work and structural transformations in transdisciplinary research processes.

Because we focus on the gender perspective of living and working on a farm and on the changes that we can find and envision, time use seems adequate because of its inherent quality as a natural resource at the disposal of every individual equally, despite their sex, age or other differences. Another advantage of using time-use data lies in the limits that time represents. In the model, alternatives in agricultural production can increase income and working time. It is useful to be able to set the limits at the maximum of time available in a specific family. This farm family is a specific group of individuals—male and female children, adults and elderly—who must spend some time on their personal reproduction and some on care and group reproduction. Therefore, as a group, they only have a certain amount of time left for working on the farm.

### 14.3.3 Quality of Life: Time Use as a Bridging Concept Between Sustainability and Social Issues

In sustainability science, it is important to find indicators to assess quality of life and any changes therein. Time use is an integrative aspect of many facets of quality of life, and therefore can be used for monitoring changes in quality of life (Carlstein 1981; Fischer-Kowalski and Schaffartzik 2008; Garhammer 2001, 2007; Mischau and Oechsle 2005; Moe 1998; Mückenberger and Boulin 2005; Schaffer 2007). The terms "time scarcity" and "time affluence" (Heitkötter 2007; Kränzl-Nagel and Beham 2007; Rinderspacher 2002; Schor 2010) are used to link economic and social factors and to find alternatives to a solely economic notion of growth and development (De Graaf 2003; Kasser and Sheldon 2010; Sanne 2002). In its European Quality of Life Survey, Eurofound (the European Foundation for the Improvement of Living and Working Conditions) examines a range of issues, such as employment, income, education, housing, family, health, work-life balance, life satisfaction and perceived quality of society. "Having sufficient time to fulfil both professional and personal goals—raising children, caring for older relatives, maintaining social and family contacts—is a crucial element in determining a good quality of life. However, findings from the European Quality of Life Survey 2007 indicate that work–life balance remains an elusive goal for many working Europeans" (Eurofound 2010, p. 3; see also Boulin 2003).

Linking sustainability research with time-use research is attaining some importance in socio-economic national accounting, non-monetary input-output approaches (Minx and Baiocchi 2010; Schaffer and Stahmer 2006; Stahmer et al. 2003) and other new attempts to strengthen socio-economic features within sustainability discourse (Chiou 2009; Hayden and Shandra 2009; Jalas 2002, 2008; Vinz 2005). An Australian survey on lifestyles, consumption and environmental impact includes time-use data as an important factor (Schandl et al. 2009).

Using time-use analysis helps to consider the quality-of-life aspect as one of the three aspects connected in the sustainability triangle. For the farms in the current model, we used the following data:

- Farm and off-farm income and subsidies for the economic aspect of a farm,
- Land-use and type of production for the ecological basis and
- The time that the farming family used on work and other activities as an indicator of their social situation.

## 14.4 Agent-Based, Participatory Modelling and Scenario Results

### 14.4.1 Agent-Based Model of Two Villages

On the one hand, models can be used to reach a better understanding of dynamics within a system, reconstruct dynamics of past or ill-documented systems and develop future scenarios. On the other hand, they are useful for structuring communication

processes on recommended actions. Many examples of modelling sustainable development are overly complex and elaborate to make without stakeholder involvement (e.g., IPCC 2007). With participatory modelling, we attempt taking a step towards translating knowledge about paths for sustainable development into societal action.

Agent-based modelling is a computer technique that allows the simulation of different actors as agents, the socio-economic and natural environment in which they are embedded and the interactions among agents and between agents and their environment. The simulation of these agents and their interactions according to the needs of a transdisciplinary working group makes these types of models particularly attractive. The similarities with a computer game add to this attraction (Fig. 14.4). Additionally, the equidistance of a computer game to the working practice of scientists and stakeholders involved helps foster the transdisciplinary process.

The current research questions require integrated analyses of ecological, social and economic factors and their interdependencies. A change in the economic framework conditions (e.g., CAP reform) simultaneously produces new preferences for women and men farmers regarding land use and the use of working time. These new preferences, in turn, have social and ecological consequences. We developed an agent-based model to analyse the interaction among these various factors and observe potential developments of socio-economic and biophysical processes in scenarios.

Each agent depicted in the model represents a particular farm that is characterised by more than 50 different features. In the case studies presented here, all agricultural holdings in the two municipalities of Nussdorf ob der Traisen and Hainfeld (Nussdorf 98, Hainfeld 105) are modelled. Referring to official statistical data (Statistik Austria 2003), distinctions are made among forestry holdings, forage growers, mixed farms, cash crop farms, permanent crop farms and graft nurseries. Demographic characteristics, e.g., the number of occupants in a household and household composition by age and gender, are also recorded. Other key attributes that flow into the model relate, for example, to family structure, farm succession, identifying whether the farm is run as the main or supplementary source of income and whether the farm is run with the aim of achieving future expansion. In accordance with the three dimensions of sustainability, the characteristics and attributes of the agricultural holding are assigned to the three spheres of social affairs, economy and ecology.

The environment in which the agents operate comprises natural environmental conditions together with the economic, social and political setting. The labour market, as a significant basic condition that affects farms, is represented in the model together with CAP subsidies and, in particular, payments related to the Austrian ÖPUL programme. The agents account for both aspects of their environment and other agents. This concerns not only subsidies but also production costs and prices for agricultural and forestry products. Agents calculate their household income using information on subsidies, production costs and prices for agricultural and forestry products. The available working time is calculated based on the household characteristics and perceived environmental conditions.

Farms annually make decisions regarding new patterns of land use and the utilisation of working time. Concrete decisions made on the farm are influenced by its internal structure, e.g., the number of agricultural workers on the farm and external

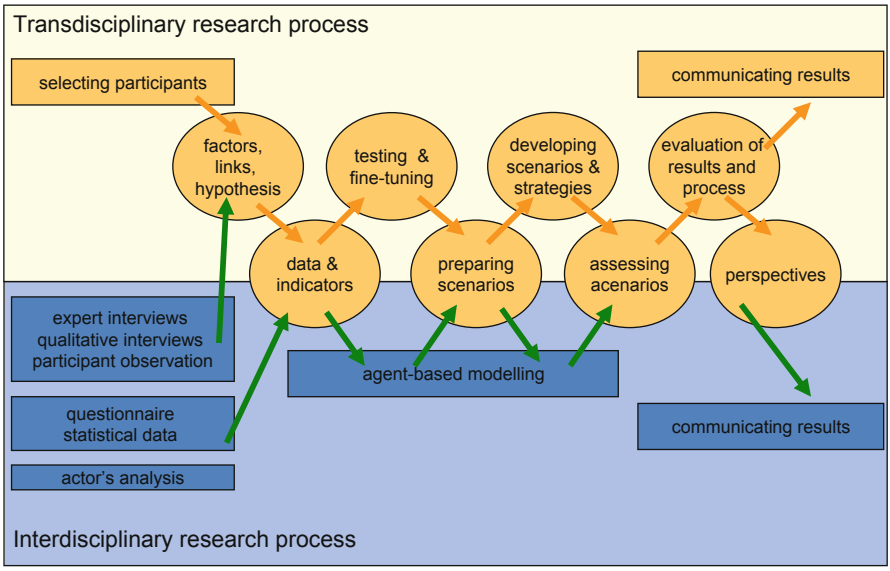


**Fig. 14.3** Transdisciplinary research process

framework conditions, e.g., subsidies for agricultural products. As agents, agricultural holdings have the opportunity, pursuant to differently weighted probabilities, to react to changes in their environment (e.g., a reduction in agricultural subsidies) and choose from a range of actions, including intensification, contraction, expansion, extensification, farm abandonment, converting production, moving to supplementary income activities, hiring external labour and direct marketing.

Interaction between agricultural holdings consists of leasing land from and to one another. Leasing and rental offers are collected at rental markets, and leasing agreements are made. Leasing agreements can only be made where lessor and lessee reside within 20 km of one another (according to the experts participating in the transdisciplinary research process). Where several such partners are available, the lessor and lessee are chosen at random from among them.

### *14.4.2 Participatory Modelling*

Participatory modelling allows integrating the most relevant issues for stakeholders into the model and developing scenarios and strategies together with the stakeholders. The agent-based computer model was developed in a transdisciplinary research process (Fig. 14.3) in cooperation with six women farmers from farms representing the different production types and three experts from the Chamber of Agriculture.

During a total of four workshops at regular intervals over 2 years at the Lower Austria Chamber of Agriculture (Landeslandwirtschaftskammer NÖ, LLWK NÖ), a

transdisciplinary working group took each of the steps from problem definition via model development to scenarios and options for taking action. As project partner, the department "Bildung, Bäuerinnen, Jugend" (education, women farmers, youth) within the LLWK NÖ played a central role in the project. The manager of this department facilitated contact with women farmers, most of whom were active as local farmers in the "Arbeitsgemeinschaft der Bäuerinnen" (working group of women farmers), and LLWK experts. Women farmers who were invited to the workshops were involved in distributing the project results. The inclusion of women farmers' views and their expertise about farming decisions and family working time proved essential to ensure that the model depicted reality as effectively as possible.

At the same time, the method of participatory modelling fostered collaborative structuring of themes and mutual learning across inter- and transdisciplinary boundaries. Participating actors recorded that the process had been particularly interesting for them, not least because the discussions regarding the model had significantly increased their understanding of their own living environment and those of women farmers working in different farming and production environments.

### *14.4.3 Building Scenarios and Model Results*

The main results of the research process are the three scenarios generated in collaboration with women farmers and representatives of the LLWK NÖ. They were developed in the course of the third workshop. Scenario building began with homogenous working groups, in which women from similar forms of agricultural production created stories of best-case scenarios for their farms and regions. We transferred these stories to a combined set of variables and calculated for the year 2020. The scenarios can shortly be defined as follows:

- TREND-Scenario: Continuation of the current subsidy conditions and price relations
- GLOB-Scenario: Substantial reduction of agricultural subsidies, liberalisation of the economy
- SUST-Scenario: Increased support for environmentally friendly and sustainable production and consumption patterns.

The variables that were identified during the workshops as most relevant are presented as controls at the user interface of the model and may be individually adjusted. Among the controls for working and family situation are important factors for management decisions, such as farm succession, willingness to introduce innovations, the desired level of leisure time and minimum income. Alongside these controls, diagrams of the results are presented, in which the impacts of each respective change in the controls can be viewed after each run of the model (Fig. 14.4).

The model interface is a result of the participatory process. The aim was to find a consensus among all participants concerning which framework conditions are of general interest and exert a significant influence to merit appearing as interactive

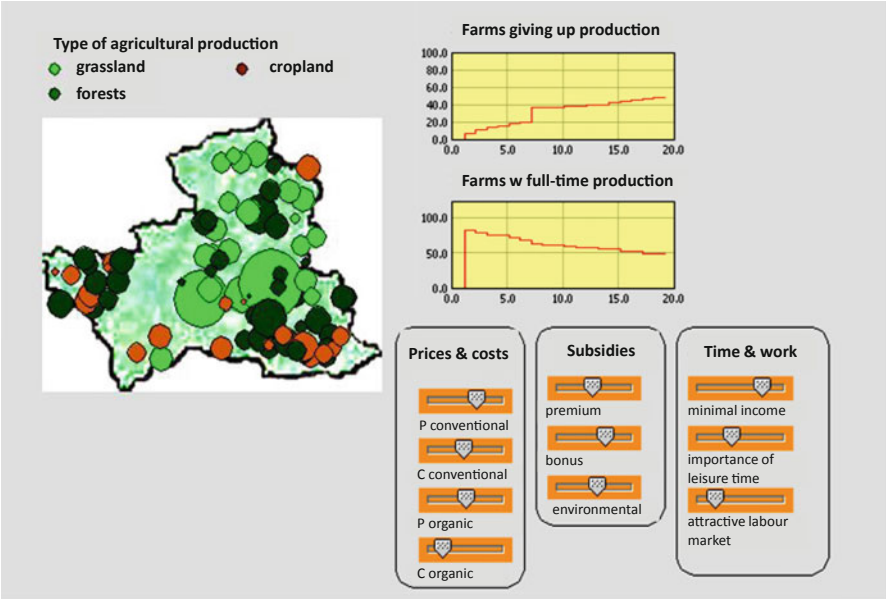


**Fig. 14.4** Agent-based model of Hainfeld

elements of the user interface. Discussion related to the directly observable results diagrams identified which areas were sufficiently relevant for users that their development should be simultaneously visible throughout the course of the model calculations.

Figure 14.4 shows the resulting model interface. It shows the municipality of Hainfeld, with the green circles representing farms working mainly with grassland, dark green circles indicating forests and brown circles representing crop land. The tables (yellow) show the percentage of farms that have terminated agricultural production and the number of farms moving from full- to part-time production. The orange slides can be used as controls of (1) prices and costs for conventional and organic farming, (2) different EU and national types of subsidies and (3) the social situation for farm production, showing (a) minimal income required, (b) importance of leisure time and (c) situation on the local labour market.

The main model results for agricultural development in the study area are as follows:

- From 25 % to more than 40 % of all farms will go out of business.
- Full-time farmers decline in all scenarios by at least 40 %.
- Most of the surviving farms have forests in the GLOB-scenario.
- In the SUST-scenario, land use diversity (grassland/forest/cropland) can be maintained.
- Cultivated agricultural area diminishes by 50–80 %.
- Animal stock is reduced by 50–90 %.

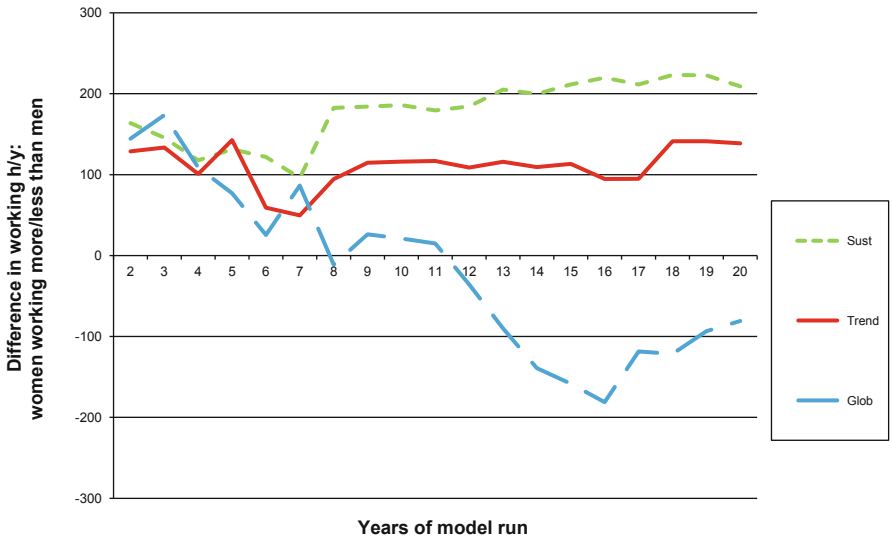


**Fig. 14.5** Difference in working hours between men and women farmers in small-scale dairy farming

It is evident that the land area used for agricultural purposes decreases in all three scenarios, although it does so most strongly in the GLOB-Scenario and to the least extent in the SUST-Scenario. According to the GLOB-Scenario, this decrease leads to a concentration of a few intensively farmed large-scale holdings. In the SUST-Scenario, the reduction in the number of agricultural holdings is least among the three scenarios; the farms that remain enjoy relatively good living and working conditions. The share of grassland is highest in the SUST-Scenario and lowest in the GLOB-Scenario.

Modelling results show that the most sensitive parameters are

- Regional labour market and infrastructure,
- Production costs and prices/subsidies and
- Quality of life—minimum income and leisure time.

The results of this model show that strengthening the regional labour market does not lead to a reduction in the number of agricultural workers; instead, it contributes to the continuation of agricultural activity inasmuch as it becomes possible to stabilise the farm business through the creation of relatively attractive non-agricultural work opportunities. The measures associated with the SUST-Scenario would thus allow a sustainable development of agriculture to be fostered.

However, the SUST-Scenario also results in a larger share of work for women farmers than men farmers for grassland areas (Fig. 14.5). Time-use studies show that when household work, para-agricultural activities, agricultural activities and non-agricultural employment are added together, women farmers work more hours annually than men farmers. The scenario calculations show an increase in the workload inequality in the SUST-Scenario, rising from 100 to 200 h/y worked more by women

farmers than men farmers. In contrast, this relationship is reversed in the GLOB-Scenario, with the workload of men farmers exceeding that of women farmers by 100 h/y.

The main outcomes of the agent-based model show that increasing forest area caused by a decline of agriculture in Austria could be reduced in a sustainability scenario. In this scenario, it is assumed that agricultural production becomes more attractive through fair prices and subsidy systems. Nevertheless, the workload of women farmers is much higher than that of men farmers in this SUST scenario, thus making working on the farm less attractive to women farmers. Thus, to enhance the success of any effort towards sustainable agricultural development, we must integrate time-use and gender aspects.

## 14.5 Sustainable Agriculture in Austria in Light of Ester Boserup

This project generated new insights with regard to the theme of gender and sustainable rural development through participatory modelling and integrating gender aspects into agent-based models. The gender perspective was incorporated into the model via time-use data. Time use illuminates important aspects of the quality of life of men and women, families, older people and children in farm settings. The focus on time use and the integration of working time for production, subsistence and reproduction shifts gender relations into the centre of attention and facilitates their placement as the subject of transdisciplinary working groups.

Participatory model design is well suited for articulating complex interrelations and causal chains and communicating these to the most diverse groups drawn from working practice, education and research. The inclusion of women as experts and the organisation of a women's group strengthened the awareness among the women involved regarding their own expertise and opportunities for action as individuals and in the organisations to which they belonged. In the case of "GenderGAP", it also contributed to the founding of the "Frauen in der Landwirtschaft" (Women in Agriculture) working group within the Lower Austria Chamber of Agriculture. Integrating women as experts also increased system knowledge and extended the approach to potential future scenarios and options for action. The future scenarios that were developed in focus groups and the scenario workshop were key elements and formed the basis for the creation of scenarios in the model.

Sustainable agriculture is interesting for small-scale farmers if it secures the survival of their family farms. In this interpretation, sustainability nearly equals the survival of small-scale farms. The farmers have little or no interest in growing the size of their farms, and they do not specialise or intensify production as long as they feel no financial pressure. This notion of sustainable agriculture can have dynamics similar to subsistence agriculture, as it means that many small farms have diverse non-specialised production and little technological input but depend on the family workforce.

Given a traditionally gendered division of labour on farms and better wages for men on the labour market, many forms of sustainable farming can lead to an even larger workload on women farmers. The feminisation of farming, as Boserup described it, in marginalised areas with labour-intensive but otherwise extensive forms of production can be observed in modern Austria.

In the transdisciplinary working group, the research finding of potentially increasingly unequal working hours kicked off the desire to develop options for action and strategies towards solutions that consider the needs of all members of a family-run farm, regardless of their age and gender.

To prevent the workload of women farmers from growing with the SUST-Scenario in regions comprised primarily of grassland cultivation with a high degree of traditional gendered division of labour and a high proportion of women workers in agriculture, it is necessary to offer attractive regional infrastructure with adequate care services for children and older people in the region. Good education and training opportunities for women farmers, effective public communication regarding the diverse roles taken by women farmers and support schemes for sustainable agriculture to the benefit of the wider society are further joint recommendations made by the transdisciplinary working group. Women farmers wish to play an active role in these areas. However, they must also participate in decision making so they can structure their life and work in the farm setting in such a way that family-run farms may continue to provide a satisfactory mode of life, high-quality food and maintain the cultivated landscape well into the future.

If organic and small-scale farming increases the workload of women in a traditionally gendered working environment, there are two options. Either farmers opt for less sustainable means of production or they stop agricultural activity altogether. Consequently, the ecological burden in favourable regions will increase (higher nitrogen flows in our model) and agricultural activity and, therefore, the maintenance of cultural landscape in less favourable regions will decrease (mostly reforestation). Farmers may also opt to adapt to socio-economic changes and find means of producing for the growing market of sustainable products with a new work organisation that is attractive for young people and does not place greater burden on farm women than men.

Pathways to sustainable development can only be identified in cooperation with women and men from both the field of research and working practice and through the inclusion of the gender perspective in sustainability research. If a high percentage of women farmers is a hindrance to "progress" in agriculture, this could be considered a driver of sustainable agricultural development that attempts to feed the world without pushing natural, economic or social limits too far.

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# Chapter 15
# A Human Ecological Approach to Ester Boserup: Steps Towards Engendering Agriculture and Rural Development

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**Keywords** Human ecology and gender · The ecological complex: PETO and Ester Boserup · Engendering development · Gender relations · Women and technological change in rural areas

## 15.1 Making Women Visible

With her pioneering comparative studies in Asia, Africa, and Latin America, which were published as *Woman's Role in Economic Development* (1970), Boserup provided empirical evidence of the importance of women in agricultural activities and rural development.[1]

When analysing the gender arrangement, particularly in rural areas, we should consider the following issues defined by Boserup:

1. Access to productive resources: land, water, and other environmental resources and assets (Boserup 1970)
2. Technological development (Boserup 1981)
3. Population growth (Boserup 1965)
4. Division of labour and the productivity gap (Boserup 1970, 1989)
5. Effects on changes in women's status in society and on their social spaces (Boserup 1970)

Despite the changes that have occurred during the last decades, the issues listed above are still key aspects for analysing gender relations and women's contributions to rural livelihood and development. These aspects are all crucial to understanding women's social status and their spaces within communities and societies.

[1] During the Ester Boserup conference in Vienna in November 2010 ("A Centennial Tribute—Long-Term Trajectories in Population, Gender Relations, Land Use, and the Environment"), we started a discussion at the working group on Gender and Globalisation. This discussion focused on some of Boserup's theories about changes during recent decades and the lasting relevance of Boserup's work at the beginning of the twenty-first century.

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Ester Boserup conceptualized a more holistic approach to understand the complex processes of development. Her concept of the division of labour and female and male types of farming as well as her classification of food crops and cash crops from a gender perspective are still relevant today, although tremendous changes are underway (Zdunnek and Ay 1999 and some chapters in this publication). Boserup started her research as an agricultural scientist. She did not argue from a feminist perspective at first, but by analysing processes of colonial rule and modernisation, including the implementation of innovations in the field of land use policy, she discovered how those processes had affected women and men differently:

> European settlers, colonial administrators and technical advisers are largely responsible for the deterioration in the status of women in the agricultural sectors of developing countries. It was them who neglected the female agricultural labor force when they helped to introduce modern commercial agriculture to the overseas world and promoted the productivity of male labor. (Boserup 1970, p. 53 f.)

In her comparative studies in Asia, Africa, and Latin America, Boserup demonstrated that the productivity gap between women and men increased during the modernisation process. One important issue is the implementation of new agricultural technologies since colonial times:

> With the introduction of improved agricultural equipment, there is less need for male muscular strength; nevertheless, the productivity gap tends to widen because men monopolize the use of the new equipment and the modern agricultural methods. (Boserup 1970, p. 53)

Boserup explained differences in the status of women as a matter of social structure rather than individual destiny. Most importantly, she was one of the first scholars to address the "invisibility of women" in the field of human livelihoods. Boserup made women visible within scientific discourses. She argued that processes of agricultural development and modernisation, such as capital-intensive innovations including the introduction of tractors and other machinery that were monopolised by men, weakened women's position and partly marginalised them economically and socially. The gender gap that Boserup discovered long ago was recently addressed by the Food and Agriculture Organisation (FAO 2011a, b). I will discuss the FAO actions below.

Boserup was critical of the misguided developments resulting from the failure to perceive the basic contributions women made to rural life. She clearly believed that these processes of change were not beneficial to the social status of women because they threaten the improvement of their living conditions. The invisibility of female activities became and remains an important issue that has inspired subsequent debates on Women and Gender in Development.

## 15.2 The International Recognition of Women and Gender in Development

Boserup (1970) provided an important scientific basis for the discussion of Women in Development (WID) and Gender and Development (GAD) (also see Moser 1989). Her concept of the gendered division of labour—although she did not use the term

"gender"—provided an accurate explanation of issues that became more prominent in the development debate of the late 1980s and early 1990s, when differences between sex and gender as well as WID were transformed into GAD. At that point, development approaches and projects began to notice the discourse about the social and cultural construction of gender (Braig 2001).

In fact, Boserup's publication of 1970 influenced the first UN women's conference in Mexico in 1975. Two other women's conferences were subsequently organised, one in Nairobi in 1985 and the other in Beijing in 1995. The Nairobi conference was important for giving women in the Global South a voice. One of their organisations, Development Alternatives with Women for a New Era (DAWN)[2], has developed an independent position on gender and sustainable development from a Global South perspective (Braidotti et al. 1994). In conjunction with the discussion on environmental issues, concepts of Women, the Environment and Sustainable Development (WED) were established to seek sound social and environmental development (ibid.). The purpose remains to create alternatives that go beyond the mainstream modernisation processes of change and protect human livelihoods. DAWN seeks development concepts that avoid environmental degradation and the loss of biological diversity, similar to the organisation "Diverse Women for Diversity"[3] (Shiva 1989, 2007). These organisations support women's empowerment and human rights because they pursue economic and gender justice on a national and global level (DAWN 2012).

The 1995 Platform of Action resulting from the UN women's conference in Beijing put gender mainstreaming discussion on the political agenda of national and international organisations. It still is an important document for gender justice and gendering policy arenas.

However, despite the many publications about and the considerable "lip service" paid to the importance of women's essential contribution to development, the de facto changes have been modest (the "World Bank Report 2012" has been criticised by Razavi 2011[4] and by Behrman et al. in Chap. 12 of this publication).

Despite the many international activities and UN organisations engaged in gender mainstreaming and promotion of WED and GAD, the paradigm shift has not reached the mainstream research agenda and project activities. The international organisations, including the FAO, all have wonderfully designed websites, handbooks, training manuals, and packages with tool kits on women's and gender issues in agriculture and forestry (Augustin 1995; FAO 1995, 2004; GTZ 1998; Kerstan 1995), but real policymaking must still be gendered on both the national and global level. Rural gender issues require special emphasis if problems of hunger and sustainable rural development are to be solved.

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[2] "DAWN is a network of feminist scholars, researchers and activists from the economic South working for economic and gender justice and sustainable and democratic development." (http://www.dawnnet.org/about.php?page=us, retrieved February 24, 2012).

[3] Their focus is on bio *biodiversity*, *food* and *water*. This organisation called "Navdanya" seeks to strengthen women's grassroots movements and try to provide women with a common international platform (http://www.navdanya.org/diverse-women-for-diversity, retrieved September 9, 2012).

[4] The report was already published in 2011 and is subject to comments and criticism.

## 15.3 Rural Gender and Women's Studies

Numerous studies have been conducted about women and gender in rural development in the countries of the Global South. Rita Schäfer (2000/2012) provides a comprehensive bibliography in which she lists 1,300 articles, each with a short summary, for Africa alone. International organisations, particularly several UN institutions, have promoted research and publications dealing with WID and GAD. The Rome-based FAO offers a broad range of research and information on rural development, agriculture, horticulture, forestry, and fishery on the national and international level. This UN organisation has promoted the importance of women in agriculture through high-quality papers and videos. Examples include the latest research findings published in "Gender in Agriculture. Closing the Gap for Development" (FAO 2011a, b) in addition to an appealing but ambivalent video clip which underlines women's participation in the modernisation process of agricultural development. For example, the FAO notes that by giving women access to resources such as land, technology, and seeds, they will be able to produce 20–30 % higher yields.[5]

However, this FAO approach does not express any criticism of the modernisation process of agricultural development from the perspective of either sustainability or livelihood, focusing instead only on quantity and increasing women's yields. Agarwal mentions some research, particularly in African countries, demonstrating that women can be as productive as men: "A few studies show that if women had access to the same inputs and extension services they would have higher outputs than male farmers." (Agarwal 2011, p. 14)

However, one must take into account that even if they produce the same agricultural output as their male counterparts, female farmers might still be much more "productive" than men because they are responsible for a whole range of household tasks and care economy activities in addition to agricultural and horticultural work. Including their domestic activities, which involve productive and social reproductive responsibilities as well as communal work (Beneria and Sen 1981; Elson 2002; Moser 1989), women's contribution and overall "yields" actually are not lower. If women become even more involved in agriculture, the question remains: Who will manage the many other responsibilities and tasks that they have had to shoulder so far?

Such matters have not yet been resolved. Thus, the question remains whether women should get a bigger share of the same poisoned cake—a question that was asked by members of DAWN. The idea is not simply to have women do what men have already been doing, but to consider new alternatives. The aim is gender justice and engendering agricultural development towards sustainable livelihoods and food sovereignty (Jacobson 1992; Shiva 1989). Such aims cannot be reached merely by promoting greater participation by women, as the FAO's "Closing the Gap" idea

[5] For example, see the interview with Terri Raney (2011), editor of "The State of Food and Agriculture", and the film "Closing the Gap". The aim is to give women a greater share of productive resources (FAO 2011a, b).

(FAO 2011b) suggests. We need another concept that considers the negative sides of agricultural development more seriously. On the one hand, environmental movements and feminist concepts are focusing on the sustainability of development, including ecological and social welfare components as well as long-term economic prosperity. On the other hand, feminist analysis is illuminating the unbalanced power relations on the local, regional, and global levels. Feminist analysts view gender justice and the right to food and clean water as necessary human rights. This approach will involve moving beyond the strategies that have proved to be unhelpful in overcoming hunger and food insecurity during recent decades. This outcome is a shame because sufficient food exists to nurture as many as 12 billion people globally (Ziegler 2010).[6]

Meanwhile, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD 2008) offers a different approach to rural development than the FAO approach (FAO 2011a, b). The IAASTD report (2008), which resulted from the collaboration between 2002 and 2008 of more than 400 experts from most countries around the globe, offers a rather critical view of the modernisation processes for agricultural development in recent decades. The report's main message is that "business as usual" is not an option if food security is to be achieved. One of its recommendations addresses women's participation in agriculture and food security. This message should be considered more seriously if the international community wants to eliminate hunger in the foreseeable future.

> There is an urgent need for *priority setting in research* to ensure that women benefit from modern agricultural technologies (e.g., labor-saving technologies and reduced health risk techniques) rather than being overlooked in the implementation of technologies as has often occurred in the past [. . . ]. For social and economic sustainability, it is important that technologies are appropriate to different resource levels, including those of women and do not encourage others to dispossess women of land or control their labor and income. Development of techniques that reduce work load and health risks, and meet the social and physical requirements of women can contribute to limiting the negative effects of the gender division of labor in many regions. Modern agricultural technology should not undermine women's autonomy and economic position. Targeted measures will be needed to ensure this does not happen. (IASSTD 2008, p. 79)

In addition, the Executive Summary of the IAASTD report articulates some necessary steps, including strengthening the capacity of public institutions and NGOs to improve women's knowledge and skills because women's involvement in farming and other activities has changed.

> It also requires giving priority to women's access to education, information, science and technology, and extension services to enable improving women's access, ownership and control of economic and natural resources. To ensure such access, ownership and control legal measures, appropriate credit schemes, support for women's income generating activities and the reinforcement of women's organizations and networks are needed. (cited by GreenFacts 2008)

[6] "In a world overflowing with riches, it is an outrageous scandal that more than 1 billion people suffer from hunger and malnutrition and that every year over 6 million children die of starvation and related causes. We must take urgent action now." (Jean Ziegler 2010 in: Right to Food).

Gender analysis will reveal the mostly unbalanced and unequal position that exists on the local, regional, and global levels. Henrietta Moore (1995) provided a more sensitive approach in her book, *A Passion for Difference*, which has inspired empirical field research in many countries, such as some in Latin America (Zuckerhut et al. 2003).

Analysis of the potentials and challenges is required on different levels to recognise and understand the scope of action available (Teherani-Krönner 1989, 2008b). It is not the gap approach, but rather a positive evaluation of local capacities that could lead to a more balanced structure in the future. Discovering such scope of actions is a prerequisite for improving the quality of life and livelihoods in rural and urban areas. Without it, neither food security nor rural development can be achieved. This is an important aspect of a sustainable development process that will enable the overlap of ecological, economic, and social welfare dimensions within a community. Hence, we must seek a relational gender approach (see Chap. 9 in this publication) rather than a dual construction.

## 15.4 Criticism of Boserup and Her Terminology

Although Boserup's work has been praised, some scientists have criticised her articles and rejected her theoretical approaches (Beneria and Sen 1981). She has even been condemned for using a terminology that belongs to the colonial era of Western domination (McCune 2006). I do think that from today's perspective, terms such as "underdeveloped countries", "primitive societies", and "primitive techniques", as used by Boserup, are controversial. They sound strange and outdated. They are no longer applicable because they belong to the periods of colonial history and Western hegemony. However, such ideas might still exist because even the use of "developing countries" instead of "underdeveloped countries" does not really change the concepts behind these terms.

During the 1970s and 1980s, in the time of the Cold War, the West and East were seen as the "First World" and "Second World", respectively, whereas non-industrialised countries were known as the "Third World".

Old labels such as "underdeveloped" and "primitive" must be avoided because of political correctness. Now we talk about the countries of the Global South and take a post-colonial approach, but I am not sure whether we have really overcome the attitudes that accompanied the former concepts.[7]

In the time when Boserup was actively involved in research while living in different parts of Asia and Africa during the 1950s and 1960s, the terminology was indeed different. To a certain extent, I agree with the criticism expressed by researchers

[7] In his book on Orientalism, Edward Said (1981) brought to light the deeply rooted domination and superior attitude of European and Western cultures towards the Middle East, for example. Raewyn Connell (2007) discusses the ongoing hegemony in this work on southern theory, in which he provides numerous examples of patronisation of countries of the South and their knowledge systems.

such as Julie McCune (2006) who argue from a post-colonial perspective. McCune rejects Boserup's work partly because terms Boserup used are considered insulting today. However, if we read between the lines in Boserup's articles, we find that she was quite progressive and made advanced arguments on conceiving and theorising issues such as gender and globalisation in the field of agriculture, horticulture, and food security almost half a century ago (Braig 2001).

## 15.5 Gender Order Rather than Women's Role

Another point that I think should be revisited is found in the title of Boserup's pioneering work, *Woman's Role in Economic Development*. Still in line with her own explanations, we know that the different ways of dividing the workload are subject to change:

> Despite the existence of stereotyped sex roles and the universality of women's concentration in domestic work, Boserup noted significant differences in women's work across countries and regions. She criticised the 'dubious generalisation' that attributes the provision of food to men in most communities; women too have been food providers in many areas of the world. (Beneria and Sen 1981, p. 280; Boserup 1970, p. 15)[8]

The idea of a women's role—as with role theory itself—is no longer generally accepted. "Role theory" and the women's role model might no longer be adequate. Therefore, the term "role" should be questioned. Considering the possibilities of moving towards more dynamic conceptualisations, we need to recognise women's agency and respect their bargaining power. Many WID studies assume that women are vulnerable. Such studies do not sufficiently value women's strength and power in managing the challenges of everyday life within the household and the community. To consider such relationships, we cannot use models and terms that are too static, which may obscure the gender arrangements embedded in the complex structures of personal, social, and cultural dynamics. This is important in the field of agricultural production as well as in the food security debate.

> In general, strategies for attaining food security are still based upon an image of women that depicts them as vulnerable or deprived, and that wholly underestimates women's active share to food and household security. The visible and the invisible contribution of women have not yet been fully recognized and appreciated in the mainstream of food security debate—either in Iran or at the international level. (Teherani-Krönner 1999, p. 195)

The negotiation of gender and gender arrangements is changing. Indeed, it has always been negotiated and rearranged. This is one of the well-documented facts in the comparative studies by Gudrun Lachenmann and Petra Dannecker (Lachenmann and Dannecker 2008). Gender relations are not a matter of individual destiny but are embedded into the social power structure of a society that constitutes gender order (Bourdieu 2005; Connell 2007). This is why the socio-economic as well as the context are an important aspects of gender analysis.

[8] See the citation in the next section on the term "natural".

Women are not a homogeneous group. Boserup did not explore this particular issue in great detail (Beneria and Sen 1981). However, one can recognise the many different positions that exist in the gender order, not only between men and women. Differences among social groups, such as class hierarchies and ethnic discrimination, must also be taken into account. Social status by age, religion, and other group identities must be considered to understand the social structure and relationships within a community. These intersections and overlapping connections create the gender orders in both rural and urban livelihoods.

Instead of using the terms "women's role" or "gender role", which are assumed to be given and fixed, I recommend more dynamic descriptions. Using the term "gender arrangement" will facilitate a more flexible relationship that is open to negotiation. However, "gender arrangements" might be located on an individual level, where they may remain dependent on the bargaining potential and power of different actors. In contrast, the term "gender order" will include relations or arrangements within the hierarchical structures of the entire society with respect to the cultural setting. Thus, I would suggest investigating the "gender order" instead of discussing gender roles. We should focus on women's and men's contributions, shares or burdens in managing everyday life challenges. Broadening the scope of action and freedom of choice for women are important development aims. Gender justice remains a target because we face discrepancies and gender gaps that encompass the structural differences within and among the members of societies on a local and global level.

I think that we can still use more dynamic concepts of gender order in line with Boserup's approach because in her own work she was critical of the use of the term "natural" and the way that the relationship between women and men was taken as given and fixed.

## 15.6 What is "Natural" About Nature?

It is worthwhile to think in depth about Boserup and her attitude towards "nature" and the "natural" division of labour. She presents a good example for her perceptive observations. The following quotation reveals an interesting differentiation in her understanding of "natural":

> Both in primitive and in more developed communities, the traditional division of labor within the farm family is usually considered 'natural' in the sense of being obviously and originally imposed by the sex difference itself. But while the members of any given community may think that their particular division of labor between the sexes is the 'natural' one, because it has undergone little or no change for generations, other communities may have completely different ways of dividing the burden of work among the sexes, and they too may find their ways just as 'natural'. (Boserup 1970, p. 15)

The way that Boserup perceived the variations in the division of labour within different societies appears to perfectly define the differences between sex and gender. I find that her argumentation aligns with later discourses on sex and gender. In Anglo-Saxon terminology, sex refers to biological differences whereas gender is the social

and cultural construction of the gender order.[9] In a way, this distinction was an integral part of Boserup's thinking when she discussed the female and male parts in agricultural and horticultural societies in different regions of the world.

In the IAASTD report on the global development of agricultural technologies and modernisation processes, we can read the following under the heading of "Women in Agriculture":

> Gender, that is, socially constructed relations between men and women, is an organizing element of existing farming systems worldwide and a determining factor of ongoing agricultural restructuring. (IAASTD 2008, p. 11)

This quote is similar to the results Boserup documented in her work more than 40 years ago. She questioned the "natural" when she examined working conditions in different global regions. Boserup led the way in contextualising the division of labour as socially and culturally constructed, although she used different terminology at that time. I will return in the next section to the way she perceived the "status of women".

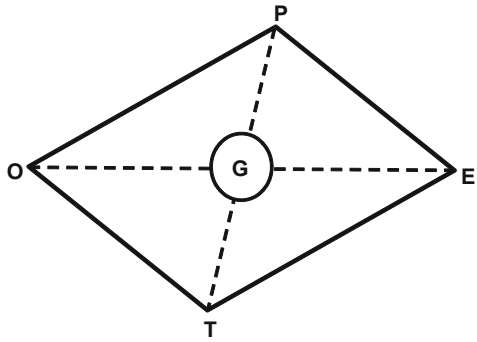
In the livelihood approach, we must consider all the work that is required within a community and its household units to organise daily survival strategies. Thus, we need a more holistic view that bears in mind that the activities for people's livelihoods include more than the productive sphere, which is the focus of some narrow economic approaches. Therefore, I believe that Boserup has offered us an inspiring and multidimensional concept.

## 15.7 A Human Ecological Approach to Boserup

I suggest considering Boserup and her holistic approach from a human ecological perspective. As far as I know, she herself neither mentioned this term nor referred to its concepts. However, in her broad approach that explored agricultural development and social change, Boserup's arguments were similar to the ideas and theoretical framework of human ecology that were developed in the USA. The concept was introduced within the Chicago School of Sociology by Robert Ezra Park and Ernest Burgess (1921), who are known as the founders of human ecology. In the 1950s, it was studied by Otis D. Duncan (1959), followed by Amos Hawley (1971).[10] The

[9] I will not go into the debate within Anglo-Saxon-influenced gender studies that seeks to overcome the notion of polarised heterosexuality and calls for a more open view of the term "gender" to include queer and homosexual groups. This might be an interesting discussion, but for the purposes of this paper, which focuses on the global food security debate and women and gender in agriculture, I prefer to confine it to the above definition.

[10] The discourse was reshaped by Catton and Dunlap (1980), who were looking for an ecological paradigm within 'New Human Ecology' in the environmental debates in the Club of Rome. In the international arena, the Society for Human Ecology (SHE) has opened a forum for international debate on human ecological approaches. In German-speaking countries, the German Society for Human Ecology (DGH) and the Institute for Social Ecology (SEC) of the Alpen-Adria-Universität Klagenfurt located in Vienna are further developing and reshaping the human social ecological frameworks and theoretical approaches.




P Population
E Environment
T Technology
O Organisation

**Fig. 15.1** Model of Duncan's ecological complex. (Based on Duncan 1959)

way Boserup (1981) combined technology with population growth and social organisations with agricultural changes can now easily be placed in Duncan's ecological complex.

Ester Boserup's thinking and Otis Duncan's approach have been combined with respect to demography, technology, the environment and social institutions (Fischer-Kowalski and Erb 2003; Opschoor 2002; Tremmel 2005). This chapter aims to create a new connection between Boserup's pioneering work on women in agriculture and economic development and Duncan's ecological complex. In an earlier publication, I constructed a framework with a gender perspective by combining the human ecological triangle (Steiner 1992, p. 194) and the human ecological pyramid (Teherani-Krönner 2008b). Here I want first to return to the "ecological complex" that Duncan introduced in his publication, "Human Ecology and Population Studies" (Duncan 1959) because I see remarkable similarities to Boserup's approach. In his rhombus, Duncan constructed the four human ecological components that he thought important to analyse societal changes.

Based on the human ecological pyramid by Robert Ezra Park (1952, p. 145–164; Teherani-Krönner 1992a), Duncan developed his model for comprehensive research on societies. He believed that social scientific analysis must include the interplay and interaction of the following components: Population, Environment, Technology and Organisation. This research approach became known as the Ecological Complex (Duncan 1959; Mackensen 1978; Teherani-Krönner 1992a; Fig. 15.1).

### *15.7.1 Duncan's Ecological Complex*

For Duncan, these components were important for analysing what he called the "level of living" (L). He conceptualised "the level of living" as a function of the four points

of his rhombus: "L = f (P, E, T, O)" (Duncan 1959, p. 707). The challenge is the interrelation of these components that Duncan combined in his model to address questions of social change and processes of development.

> According to Duncan, a sociological "... account of social change is attempted by referring to such instigating factors as environmental change (whether caused by man or by other agencies), changes in size and composition of population, introduction of new techniques, and shift in the spatial disposition or organization of competing populations. The interdependence of factors in the adaptation of a population implies that changes in any of them will set up ramifying changes in the others." (Duncan 1959, p. 683, as cited in Teherani-Krönner 1992a, p. 138)

The interrelations and dependencies within this ecological complex are important for the following processes of social change within a human ecological framework. Duncan wanted to overcome the weaknesses of other social scientific discourses because they use fewer components to explain social processes.

> Malthus, of course, emphasized P, or rather the ratio, P/E, attributing only secondary importance to T and O. Marx's theory was notable for its emphasis on O. The theoretical and empirical case for the importance of T has been presented by Ogburn (1922). (Duncan 1959, p. 707, as cited in Teherani-Krönner 1992a, p. 137)

As Duncan perceived it, the aim of human ecology is to consider all these components rather than focusing on single items and their relationships. The inclusion of these components transcends any single discipline. This integration is what Duncan sought and what he found lacking within the great theoretical discourses of his time.

In my view, we can reshape Duncan's ecological complex as a concept of livelihood (L) and combine it with Boserup's approaches to engender the human ecological models (Teherani-Krönner 2008b).[11]

A gender-sensitive concept of livelihood (L) can be formulated as L = f (P, E, T, O) G, from a gender perspective.

I will use this model as an intermediate step because it includes and refers to the development of population and technology—questions that were similarly central to and of major importance in Boserup's analysis. Thus, as a combination of Duncan and Boserup, I suggest the following description of P, E, T, O:

**P**—Population was one of the key questions that Boserup investigated. In contrast to Malthus, she demonstrated the importance of population density in developing innovative agricultural techniques and methods of cultivation and intensification.

**E**—Environment was the source and means of production according to Boserup. This includes agricultural land and the environmental conditions that influence the mode of production. Environmental conditions are important as the basis for agricultural production and shape the type of cultivation activities. Boserup was aware that environmental changes affect living conditions and gender relations.

When Boserup collected her data about agricultural development while she was working for UN organisations and during her stay in India in the 1950s and 1960s, ecological and environmental conditions were not recognised as being in danger

[11] In my empirical research on an irrigation project in southwest Iran, I introduced an engendered model of human ecology.

as they are now. With the publication of "Silent Spring" by Rachel Carson (1962) and the report by the Club of Rome (Meadows 1972), environmental and ecological deterioration, loss of species, soil erosion, and ecological conflicts such as air pollution, climate change, and water scarcity became more obvious, and environmental problems were added to the scientific and political agenda.

**T**—Technology, as perceived by Boserup, was the creative power enabling people to cope with population growth and differences in ecological settings. Technological innovation and changes in cultivation practices are how people accommodate[12] changes in environmental conditions, including population density. In other words, a certain population density is needed for a certain technology to make sense. Some pressure must exist to create adequate coping technologies. However, advanced technologies do not guarantee the wellbeing of all because they are not equally beneficial to everyone. There are winners and losers. It was Boserup who clearly pinpointed the differences that can occur between women and men when new agricultural technologies are implemented that lead to gender gaps.

> Thus, in the course of agricultural development, men's labor productivity tends to increase while women's remains more or less static. The corollary of the relative decline in women's labor productivity is a decline in their relative status within agriculture, and, as a further result, women will want either to abandon cultivation and retire to domestic life, or to leave for the town. (Boserup 1970, p. 53)

**O**—Finally, the organisation—the human arrangements or social institutions—was discussed in combination with the modes of agricultural production and the division of labour. Organisation refers in particular to the different types of agricultural practice, "from shifting cultivation to permanent cultivation of privately owned land" (ibid, p. 57), using plows and later tractors mostly operated by male farmers, that Boserup used to classify the division of labour between women and men. The gender division of labour and the productivity gap between women and men that Boserup emphasised built a foundation for social organisations and institutions. P, E, and T are the components that lead to O. Because these other components build mutual and dynamic relationships, the social organisation can also influence the other elements of the ecological complex.

Boserup underlines the importance of O regarding land policies with respect to gender relations.

> With few exceptions, privatization of land leads to a deterioration in the status of rural women. Under the system of common tenure, both male and female community members had the right to use the land for cultivation either by simply farming it or by having it assigned to them by the village chief. (Boserup 1989, p. 49)

Boserup investigated the communal land systems where women had the right to cultivate land. Her position was taken up by Elinor Ostrom, who reexamined and fundamentally criticised the thesis of the "tragedy of the commons" in her work,

[12] Accommodation is the term human ecology has used to describe the interaction of human beings with their environments via culture instead of the expression adaptation, which belongs to the sphere of biology. (Teherani-Krönner 1992a, p. 92 f., 154 f., referring to Park and Burgess 1921, p. 664).

"Governing the Common" (Ostrom 1990). Ostrom was subsequently honoured with the Nobel Prize in Economics in 2009.

**G**—G stands for Gender or Gender Order. It is a point that I have added to the Ecological Complex. The crosscutting space of the rhombus and the core reflects the interplay between PETO components. This is a space to demonstrate and visualise what Boserup has called the "status of women" by analysing different components. With this concept, gender order as a social and cultural construction can be based on the components of the ecological complex.

I will revisit the concept in my conclusions and the following illustrations. The status of women has often been explained by referring to culture and socio-cultural backgrounds of societies. It was and mostly still is treated as a black box, somehow inaccessible to scientific investigation and analysis. However, with G in the centre of the Ecological Complex, a new space for scientific research can be discovered within human ecological studies and the related fields of research.

## 15.8 Conclusions

By combining Duncan's ecological complex with Ester Boserup's findings, we can develop a new model that helps us to engender human ecology and agricultural development. The following two sections will reveal different aspects and conclusions. They have a prospective character, introducing possibilities for further research and future development. First, it becomes possible to introduce conclusions from the theoretical models that combine PETO from human ecology with Ester Boserup's research on women in development. These findings will help to explain what Boserup called the "status of women". "Status of women" can become an analytical and conceptual framework for research and fieldwork, based on the PETO components.

Second, the importance of the combination of human ecology and Boserup's approach to agricultural sciences for overcoming male bias will be discussed. Gender perspectives are essential for scientific and practical work in agriculture as well as research and teaching, including curriculum development.

**First Conclusion: The "Status of Women" as a Cross-Cutting Space** The gendered combination of PETO enables what Boserup called the "status of women" in the relevant areas, which is necessary for understanding the cultural attitude and position of women and men in a society. The status of women changes according to variations in PETO, as Boserup demonstrated clearly in her pioneering research. The gender aspect that she emphasised is absent from Duncan's rhombus. We can see the centre of the connecting lines as a core and cross-cutting space. This allows us to discover a new gender dimension, which Boserup described as the "status of women".

It is interesting to observe how, on the one hand, Boserup's concept fits into a model of human ecology based on Duncan's ecological complex, whereas on the other hand, it transcends the model by explaining and partly operationalising a concept that is described and discussed within human ecology and cultural ecology

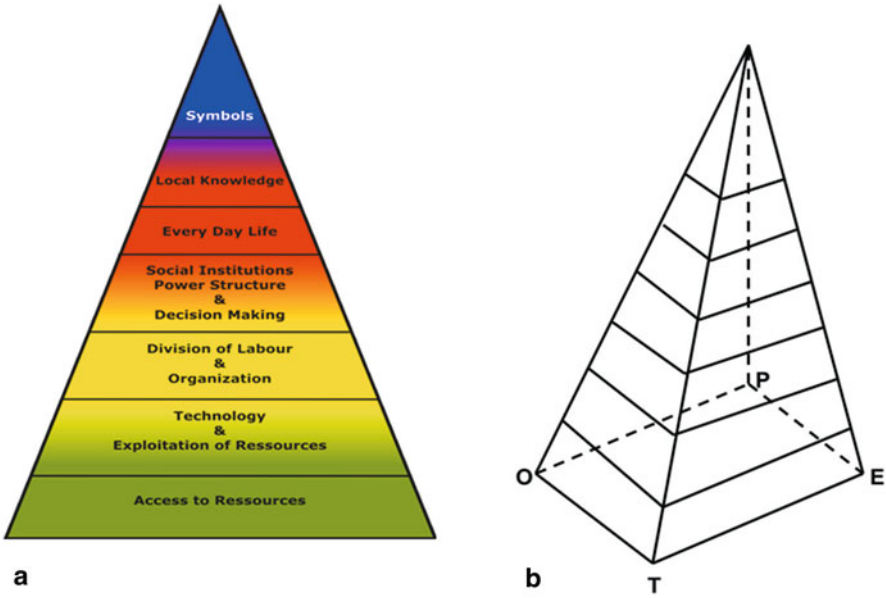



**Fig. 15.2** The engendered human ecological pyramid (**a**), in combination with PETO (**b**). (Source: Teherani-Krönner 2008)

as "cultural value" or "moral order" (Park 1936/1952; Steiner 1992, 1997; Steward 1955; Teherani-Krönner 1992a, 2008a, b). With her concept of the "status of women", Boserup added the missing dimension to Duncan's ecological complex. Thus, she moved closer to Park, who described the ecological pyramid. The ecological order forms the basis (biotic substructure) of this pyramid. Next comes the economic order, followed by the political order. Finally, the moral order is on top of the pyramid. The last three layers are seen as a "cultural super structure".[13] It is the moral order—and the symbolic value system—that limits humans' freedom of action.

> On the cultural level, this freedom of the individual to compete is restricted by conventions, understanding, and law. The individual is more free upon the economic level than upon the political, more free on the political than the moral. (Park 1936/1952, p. 157)

I combined Duncan's PETO concept with Park's pyramid and Steward's immaterial culture. By adding Boserup to this combination, I can perceive her concept of the "status of women" as an expression of the cultural dimension of societies. This concept of culture is founded on the components and the dynamic of PETO or on the layers of Park's pyramid.

> O thus includes some aspects of Park's 'cultural super structure'. However, there is one exception: the 'immaterial culture' and 'moral order' level that encompass customs, morals and world view in Park's work and is located at the top of the pyramid are not mentioned as

[13] I used Park's description of the ecological pyramid in designing the human ecological pyramid. (Teherani-Krönner 1992a).

> special variables in Duncan's concepts. One can assume that these aspects are either included in the entirety of the variables mentioned or have simply been excluded and are not to be further discussed. A strict classification of the variables of the ecological complex does not need to be made in a juxtaposition of the elements from nature and culture raised by Park. Instead, one can assume that the variables included by Duncan already combine nature and culture. (See Teherani-Krönner 1992a, p. 136)

A gendered ecological complex can be designed by combining Duncan's ecological complex with Boserup's concept. The status of women or the gender order can be placed as the core and cross-cutting line in the centre. In combination with Park's pyramid and the variation of a gendered human ecological pyramid (Teherani-Krönner 2008b), a new concept of gender research in human ecology can be designed that can become relevant for development studies and gender studies. In this way, we can better understand the cultural and normative structure of societies. The symbolic structure, gender order and power relations become more comprehensible when they are grounded on PETO interplay (Fig. 15.2).

**Second Conclusion: A Challenge for the Agricultural Sciences—Male Bias and Gender Blindness** Therefore, we can use an engendered human ecological approach to explain the status of women. One must also consider the historical context of Boserup's work. Women's status and the gender order are often explained by "tradition" or "culture", without taking the ecological and historical context into account. Boserup demonstrated how women's status can be traced back to the history of colonial times. She charted the influence that powerful colonisers had on the mode of agricultural production, particularly in Africa. Boserup devoted an entire chapter to the "Loss of Status under European Rule" (Boserup 1970, p. 53 f.) in which she clearly addressed the problems of external interventions and power structures. This process is ongoing, as discussed in the paper on large-scale land deals (see Chap. 12 by Behrman et al. in this publication).

Even when she collected data, Boserup discovered interesting examples in which the male bias had warped results when counting the animals in a region. Only men, the expected heads of the households, were asked to provide figures. It was not recognised that women were also cattle owners and had their own animals and herds. The men correctly provided the number of their own cattle. Why should they mention the animals of the female members of the household when they had no control over them?

> In many communities in developing countries, married women have, besides their land, livestock of their own. Among both the Hausa and the Fulani tribes of Northern Nigeria, women own domestic animals and men cannot dispose of them without the consent of their wives. But when the British administration made a census, by asking only the men they excluded the stock belonging to the women... (Boserup 1970, footnote p. 60)[14]

[14] We might think that this empirical evidence belongs to a past period that we have now overcome. During the 1990s, I was able to evaluate the results of an irrigation project involving the construction of a dam in Iran financed by loans from the World Bank and evaluated by UNDP. The animal husbandry of the female population, their source of independent income, in the area of Behbahan in the province of Khuzestan in southwest Iran was not taken into account when planning the modernisation project for intensive crop production. (Teherani-Krönner 2008b).

Even if knowledge about WID and GAD exists, it does not appear to significantly influence decision-making processes in regard to large-scale "development projects". Agricultural sciences and policies remain gender-blind. In other words, they look with one eye only. It is important to open both eyes to see the combined contribution of women's and men's activities and responsibilities in organising rural livelihoods. Apart from the many publications about women and gender issues, the FAO itself admits that agricultural policy is not yet gender-sensitive.

> While the dominance of women in rural areas is evident, policymakers, planners and extension officials often behave as if women did not exist, as if the situation and needs of all farmers were the same, whether they are men or women. 'Development policymakers are becoming increasingly aware of the crucial contribution of women farmers to food security,' said Sissel Ekaas, Director of the FAO Women and Population Division. Nevertheless 'gender blindness' prevails and agricultural policies on the whole still do not address the needs of women farmers adequately. (Northoff 2011)

This is a challenge that can make use of the concept of engendered rural livelihood as introduced in this paper. Combining human ecology models such as PETO with Boserup's approaches to women in agricultural development establishes a framework for analysing development processes towards gender-just and sustainable rural livelihoods. Such a new approach in agricultural sciences can influence agricultural decision-making and agricultural policy. This is a new approach to influencing rural development, which needs to be reshaped to overcome hunger and malnutrition worldwide.



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# Chapter 16
# Conclusions: Re-Evaluating Boserup in the Light of the Contributions to this Volume

**Marina Fischer-Kowalski and Anette Reenberg**

**Abstract** In this concluding chapter, we repeat and try to answer the book's core questions: In what regards was Ester Boserup a visionary? How has her work become pointof departure for following generations of scientists? How did her work influence the authors' own research agenda? In what ways has later research transgressed or contradicted her approaches? And finally: How can her work be used to enhance sustainability science today?

**Keywords** agricultural development · gender roles · technological transformation · land and labour intensity · comparative case studies · long-term socioecological research · environmental history

In the closing session to the conference in memoriam Ester Boserup's 100th birthday that evoked the contributions now assembled in this book, the following four questions were asked.

1. In what regards was Ester Boserup a visionary? How has her work become point of departure for following generations of scientists?
2. How did her work influence your own research agenda?
3. In what ways has later research transgressed or contradicted her approaches?
4. How can her work be used to enhance sustainability science today?

These questions evoked a rich and lively discussion, which could not be easily captured in a concluding statement. The main lines of thought emerging from the conference closing session provide, together with the written contributions presented on the previous pages, a basis for a set of conclusive reflections in terms of answers to two broad overarching questions: on the one hand, asking about the influence of

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Ester Boserup's work on the contemporary research, on the other hand, asking about new directions of research transgressing or challenging Ester Boserup's perspectives.

## 16.1 In What Ways Did Ester Boserup's Work Influence the Research Agenda of the Contributors to this Volume?

The original work of Ester Boserup was not only interdisciplinary to a degree rare at the time of her writing, and thus spread across and influenced many disciplinary fields, it was also synthetic and holistic in nature. The mind-set she presented aimed to condense a wide array of considerations and observations into simple but nevertheless compelling and general theses. These apparently reductionist generalizations were helpful to inform, stimulate and provoke further research. We will use some of the main themes that she considered for generalizations to structure the insights offered by this book.

### *16.1.1 Population Growth Leading into a Malthusian Trap or to Productive Innovations?*

Already her early book on agricultural change (Boserup 1965) reopened the enduring theme of population growth and environmental resources: is it a Malthusian trap, with population growth overstretching natural resources, or does it primarily work the Boserupian way, with population growth stimulating technological innovation and opening new avenues for development?

The authors in this volume frame this alternative in various ways, and therefore also come up with different answers. In Chap. 3, Fischer-Kowalski et al. confirm the Boserupian version by demonstrating, on a global level for the twentieth century, a non-linear relation of population and the use of land: population growth exceeded the amount of additional cropland drawn into use by far. The opposite, though, is true for the human use of material resources: their use expanded much beyond population. Boserup's hypothesis of the beneficial effect of increased human collaboration under conditions of higher density, on the other hand, was confirmed also for energy and materials use.

Lemmen in Chap. 6 deals with the global historical transition from foraging to agriculture, and refers to Boserup's later (1996) more generalized framework, appreciating the elements of classical political economy behind it. His GLUES model though, based upon this thinking, comes up with ambiguous results: is the transition from foraging to agriculture driven by population growth (Boserupian), or is it technology driven (Malthusian)?

Birch-Thomsen and Reenberg in Chap. 4 also employ Boserup's generalized (1996) model as a heuristic framework when they investigate the impact of population growth on changing land use practices on a Solomon island between 1960

and 2006. They find the substantial population growth of that period to have had relatively little impact on changing land use practices, but they see other innovations such as a diversification of livelihood pathways (labour migration, non-agricultural occupations) facilitated by globalization as more relevant solutions.

### *16.1.2 Land Use Intensification and its Drivers*

Another prominent theme, which runs through several chapters, is the issue of land use intensification and how it may be induced by growth in population and demand.

In Chap. 5, Erb et al. underline the Boserupian (1965, 1981) emphasis on land use intensification and the need to analyse the complex interaction between social and natural systems in order to understand the change processes. Starting from what they call Boserup's "input side oriented definition" of land use intensity, as indicated by the frequency of cropping, they develop and compare complementary indicators such as technological efficiency, the "$\tau$ factor", and human appropriation of net primary production (HANPP). By doing this, they pay tribute to Boserup's early contribution but see the need to go beyond it.

Infante-Amate et al. in Chap. 7 present a case study on a community in the south of Spain for which they have assembled detailed data on population and land use for the period 1750–2000. Their key dependent variable is soil degradation and soil loss in olive tree plantations, which they see as unintended long-term consequence of various forms of land use intensification. In this context, they ask, what explanatory value does population growth, the Boserupian (1965, 1981) key variable, have? The issue turns out to be more complex than immediately anticipated, with causal loops varying by time period and circumstances. Hence, the authors see the Boserupian explanation as valid for some periods, but as insufficient to explore the transition from traditional to fossil fuel based agriculture.

Chapter 12 by Behrman et al., while focussing mainly on gender aspects, discusses the introduction of mechanized production methods in the context of large scale land deals by (mostly) foreign investors. According to their findings, these innovations impact both local men and women, creating disadvantages and benefits for both, but in different ways. Clearly, the drivers of these changes are not rooted in local or regional population growth, but on the global level (in biofuel policies, for example).

### *16.1.3 Labour Time and Labour Productivity*

Labour time was presented by Boserup (1965, 1981) as an important factor in her basic hypothesis about drivers of technological change: population pressure triggers technological change which is increasing yields at the expense of labour time.

Ringhofer et al. in Chap. 8 compare four local communities (mostly from tropical regions) which they order on a "developmental axis" to probe into Boserup's

hypothesis. They find compliance with her hypothesis among the subsistence agriculture cases. In the hunting and gathering community, they find both land productivity and labour productivity to be much higher than in any other case. On the other end, the transition to the use of fossil fuels in agriculture provides a decoupling from (rising) labour intensity. When they translate human labour into energy and add fossil fuel input, they find a continuous decline of energy return on energy input (EROI) along their developmental axis—hence, they present a quite non-Boserupian storyline.

In Chap. 14, Smetschka and Gaube present a case study on a contemporary Austrian rural community. They adopt Boserup's interest in the use of time and find labour time to be a highly relevant and useful element in their agent based land use model. It helps to maintain the attention to the fact that labour time, even under conditions of industrial agriculture, particularly of women, matters in decision making about land use as much as income does.

### *16.1.4 Genderizing Development*

A number of chapters in this book elaborate on Boserup's (1970) thesis that Western-led development policies were blind for the key role of women in agriculture and in effect reduced their status and opportunities, while for successful development just the opposite was required.

Lachenmann in Chap. 9 addresses the "invisibility of women's work" on policy levels and expresses the need of "engendering development", pleading for Boserup's (1970) message to be more seriously taken into account. Nwakeze and Schaffartzik in Chap. 11 take point of departure in an empirical example from contemporary sub-Saharan Africa (which Boserup had considered a region of female farming par excellence). They demonstrate a strong positive link between gender equality (GII index for nations) on the one hand, and income (GDP/capita) as well as the degree of human development (HDI) on the other. They are also able to show that increasing gender equality is associated to declining fertility rates (TFR). While causalities of course are hard to establish, the empirical associations provide a compelling support in favour of Boserup's hypothesis.

Chapter 10 by Gooch presents related results for India. Building upon an older study by Miller (1981) that had demonstrated female child survival rates across India to be associated to the importance of female labour in agriculture, she compares two communities in the Himalaya region. The results show female child survival rates to equal male rates in situations where labour intensification in agriculture requires much female work. She also demonstrates that there is a strong preference for sons and their survival in places where de-intensification of farming occurred because of low land productivity.

In Chap. 12 Behrman discusses contemporary large scale land deals. They are perceived as a type of industrial land use intensification, and the analytical lens employed is directed towards the question of whether these "land-grabs", in their consequences for males and females, comply to Boserup's (1965) theoretical assumptions. She

concludes that these land use changes are very different from endogenously induced technological change in agriculture; also the gender impacts should be expected to be complex, but not necessarily in compliance with Boserup's reasoning.

Schmook et al. analyse the genderization of land rights in six Mexican communities across the last decades. They come to the conclusion that a number of mechanisms work in favour of women increasingly acquiring formal land rights. On the one hand, male labour migration (usually to the US) has the obvious consequence that the males are not present when formal rights are being legally re-distributed. On the other hand, females frequently invest the money they earn for example in tourism in agricultural assets.

Teherani-Krönner in Chap. 15 finally attempts to link Boserup's (1970) ideas about the role of gender in the economy to O. D. Duncan's "mind model" of human ecology. It is, in other words, proposed to incorporate Boserup's work into the theoretical foundations of human ecology.

## 16.2 In What Respects Does the Research Presented in this Volume Transgress, or Even Contradict, Boserup's Work?

The great merit of Boserup seems not to have been right in all details of her observations, but rather to have succeeded to come forward with concise assertions of an adequate level of surprise and complexity so to invite research to follow up on it. By and large, her description of the functioning of agrarian communities and their modes of evolving seems to inform historical analysis very well and to comply with the outcomes in general terms. This is not so for the transition to industrialized agriculture. There is not one single contribution in this volume that confirms Boserup's basic developmental hypotheses for this transition stage of the process.

In Chap. 3, Fischer-Kowalski et al. demonstrate with Boserup's own (1981) data that apparently she was so entangled in her model of gradualism that she overlooked the specific impact of the introduction of fossil fuel. Fossil fuel based technologies created a qualitatively new situation in which a rising demand for work no more relied on human (or animal) labour but on agro chemistry and mechanization. Therefore the previous pattern of increasing yield at the expense of the human labour made available by population growth did not hold any more. Instead, the excess labour was driven into urban agglomerations.

Similarly, Birch-Thomson and Reenberg in Chap. 4 demonstrate that continuing population growth on a tropical island did not so much result in intensification of land use, but rather in new occupations permitted by fossil fuel based transport of tourists to the island.

Infante-Amate et al. in Chap. 7 analyse the reasons for intensified use and soil degradation in olive stands in southern Spain across a time period of 250 years. For more recent time periods, they reject the Boserupian hypothesis of population growth as a driver of land use intensification; while the local population even declines, the excessive use of tractors and agrochemicals (based upon fossil fuels) to produce olive oil for the global market drives land use intensification and soil degradation.

Finally, Ringhofer et al. demonstrate very clearly that the Boserupian mechanism of increasing yields at the expense of labour input holds only for subsistence agriculture. As soon as fossil fuels come into play, it is necessary to resort to a more generalized concept of energy inputs in order to arrive at consistent explanatory models.

In effect, it seems that Boserup's gradualist model of development does not hold when it comes to the transition to fossil fuel based industrial society in which land is no more the key resource. This shift in energy regime (as described in Chap. 3) seems to be more relevant and powerful than Boserup would admit.

It is not so clear whether similar limitations to her model hold as far as gender relations are concerned. All the chapters dealing with the role of gender relations recognize their often underestimated importance in development. Empirical confirmations arise mainly in those chapters that deal with early stages of development, such as in Chap. 10 for the Himalaya region in India, or in Chap. 11 for sub-Saharan Africa. In cases dealing with more advanced industrial situations, such as Chap. 12 about contemporary large scale land deals, or Chap. 13 about contemporary Mexican communities, the storyline appears to be more mixed: It is not so clear that females tend to be disadvantaged by development over their previous traditional roles, but sometimes it seems to work the other way round.

Many of the contributions to this volume reflect that it seems more difficult for contemporary human-environmental scientists to share Boserup's in principle positive and optimistic outlook into the future. Several environmental pressures appear to have evolved in a way that demonstrate a Malthusian rather than in a Boserupian pathway: more people on earth imply an accelerating rise in the exploitation of natural resources. In particular it has been noted that, if not so much land, so many other resource uses rise over proportionally to population (see Chap. 3). Today, it is much more apparent than at the time of Boserup's writing that development has not been following the transition pathway she propagated, but in much of the world rather resembled a 'gold rush' leaving barren land behind. The "limits to growth" notion that Boserup would not take into consideration (although she was aware of Meadows' et al. 1972 publication) seems to deserve more attention nowadays.

For several reasons—such as her insistence in gradualism, her deep rooted trust in positive outcomes, and her neglect of energy sources as marking qualitative breaks in societal development—it is difficult to learn a lesson from her concerning a next transition to a more sustainable society. It seems she believed the society she inhabited made mistakes but was ok (or the only option) after all.

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# ERRATUM
# "Finding Out Is My Life": Conversations with Ester Boserup in the 1990s

**Jon Mathieu**

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The Publisher regrets to inform that the first paragraph of the chapter 2 is currently incorrect and should read as given below:

Ester Boserup began an international career as a consultant and independent researcher when she was approximately 50 years old. She had previously spent more than two decades as a civil servant in the Danish administration in Copenhagen and with the United Nations in Geneva. Yet she had been conducting research in these administrative positions as well, and she did so until her last days. "Finding out is my life", she used to say. What she found, and how she presented it, was often surprising. This was also the case with two publications that she produced after the age of 85: a short article on *Development Theory: An Analytical Framework and Selected Applications* (1996) and a booklet called *My Professional Life and Publications 1929–1998* (1999).

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The online version of the original book can be found at
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# ERRATUM
# Ester Boserup's Legacy on Sustainability
## Orientations for Contemporary Research

**Marina Fischer-Kowalski, Anette Reenberg, Anke Schaffartzik, and Andreas Mayer**

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