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From the Selected Works of Shyam Sunder

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Universities as Seed Farms of Innovation to Sustain India's Economic Growth

Shyam Sunder

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Shyam Sunder, Yale University

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An Overview

- **Innovation** is the primary engine of economic growth
- **Adoption** of innovation in the past has helped India reap its fruits and grow: agriculture, software
- **Global competition** will not allow India to sustain this strategy for long
- **An inconvenient truth:** India lags in innovation, is falling further behind—a largely unrecognized crisis
- **To lead** India needs to seriously rethink the future of innovation in Indian universities and the economy
- **Building seed farms of innovation** needs political and academic leadership, commitment, restructuring the institutions of innovation, financial investment, and social respect for scholarship
- **Key elements:** not buildings, budgets and bureaucracy but imagination, creativity and ideas from brilliant brains
- **False hope** of profit-driven colleges—which will not spend on talent or innovation—subsidy from government or charity necessary for quality
- **Engage with this problem** and India can address it as well as others
- **Better Solutions** will have to be found urgently, and from inside India

Innovation as the Engine of Growth

- Broad agreement among economists: innovation is a key to the economic leadership and prosperity of societies
- Scientific and technological innovation in Germany, Japan and U.S. is widely cited as a source of their sustained economic prowess
- Innovation of thought and creativity in the arts, humanities, and social sciences has characterized the vitality of civilizations throughout history (including in India's history)
- In this conversation, I shall take it as a given that innovation is a primary engine of economic growth
- Prosperity achieved through other means (e.g., imitation, natural resources and looting) is not sustainable for society as a whole

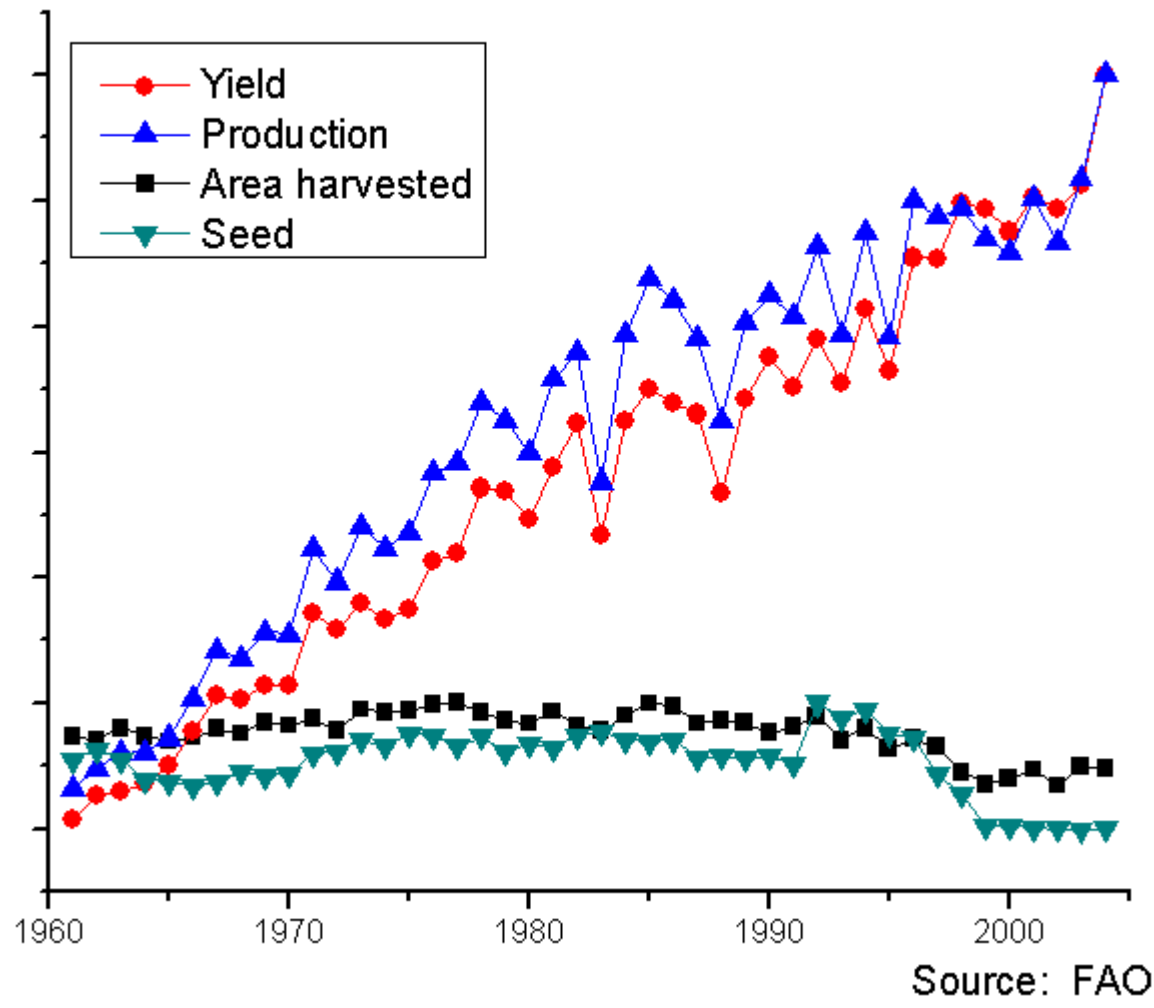
Adoption of Innovation

- **Adoption** of innovation in the past has helped India reap its fruits and grow
- India has done well at adoption and adaptation
- Examples:
 - Green revolution
 - Information technology and services

Green Revolution

- Food shortages of the 1960s
- Pioneering work in US and Mexico, with support of US foundations
- Political decisions and commitment (C. Subramaniam)
- Indian science (cross breeding with Indian varieties of wheat)
- Investment in infrastructure and industry (water, fertilizer)
- Education and agricultural extension
- Administrative structure for delivery of inputs
- Procurement, warehousing and distribution
- What is new from India's agricultural universities?
Genetically modified foods or other new agricultural technologies?

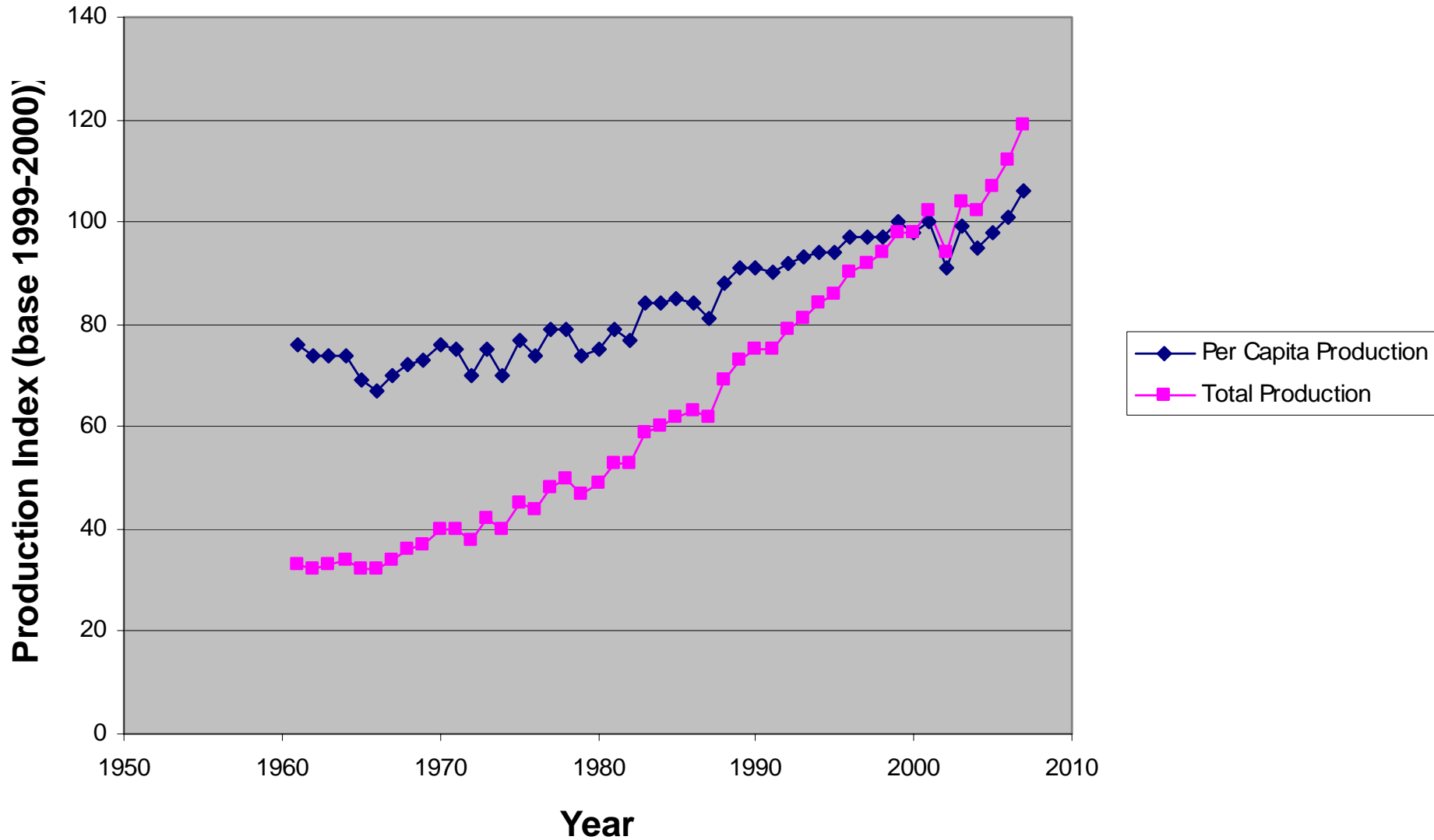
Total world production of coarse grain, 1961-2004



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in India

India Food Production (Total and Per Capita)

Growth Rate 1961-2007: 2.8% - 2.1% = 0.7 %



Computer Technology in India

- 1950s: Tata Institute of Fundamental Research built the first computer in India
- India was not far from the forefront of technology
- Computer development stalled in the mid-1960s after the wars, paucity of funds, and the self-sufficiency drive
- Advent of the Internet, and Y2K-driven demand allowed Indian entrepreneurs to build service businesses

Economic Liberalization

- Since the beginning its policy of economic liberalization in 1991, India has dismantled some of the pre-existing barriers to innovation
- The scope of business decisions that can be undertaken without official sanction has expanded, although the number of permits needed to start a new business in India still remains high (about 60th in the world; HK is #1)
- With manufacturing sector tightly controlled by government, availability of the Internet made it possible for entrepreneurs to innovate by flying under the regulatory radar by creating a software and business process engineering industry in the service sector
- This sector has consumed, and benefited greatly from, the existing educational capacity but has contributed little towards building additional educational capacity

Deregulation and Growth

- With the creation of a substantial educated middle class, the realization has grown that, with proper education, India's people become a source of its strength, not a burden
- Translating this new attitude into reality has lagged, especially in education of the rural poor, and in attracting enough high quality talent into teaching and scholarship
- Without quality education of the rural poor, the vast potential of India's human capital remains untapped
- Without enough talent in scholarship, India remains at serious disadvantage in its ability to instruct and inspire its young, and to conduct leading edge research and generate new ideas and technologies to address its challenges

Levels of Knowledge

- India exhibits a great deal of confidence in its technological capabilities today
- Confidence is a big plus, but misplaced confidence is catastrophic
- Understanding the distinction among various levels of knowledge is critical

Knowledge and Status

- Consider five levels of knowledge about a car
 - The owner
 - The driver
 - The mechanic
 - The manufacturer (production engineer)
 - The Designer (engineer)
 - The inventor
- To a layman, a person driving or riding in the back seat of his car is knowledgeable
- But owning a car requires little knowledge, driving requires only a little more
- What is the link between level of knowledge and social status in various societies?

Global Competition

- **Global competition** will not allow India to sustain this strategy for long
- Many countries around the world are preparing their educational systems and grooming large number of talented young with high quality education and promoting research to attract the “brain” industries
- Research means original work—discoveries, inventions, writing or design that has never been done before
- I would not be surprised if the “brain” industries move to these countries if they do not find labor of sufficient quality and in sufficient quantity to fill their needs
- The same global competition that has benefited India greatly could prove to be its undoing

An Inconvenient Truth

- ***An inconvenient truth***: India lags in innovation, is falling further behind—a largely unrecognized crisis
- Research and scholarship lies at the narrow top of the educational pyramid (like a seed farm at the top of the pyramid of agriculture)
 - 20 million children in schools/year
 - 10 million in high school/year
 - 4 million in college/per year
- Only 16,000 PhDs/per year

Harvesting the Crop Planted Long Ago

- India's rapid economic growth today is the result of the investments made in education during the past fifty years
- Today, most of the system is focused on educating bachelor's degree holders to meet the current demand
- Few of the top students in India are attracted to careers of scholarship
- With its inability to attract even the top one percent of each year's class into PhD programs, the quality of instruction and scholarship in Indian higher education is in a steep decline

Planting the Seeds

- India is enjoying the fruit of the trees planted long ago
- Is not planting enough new trees
- Unless India invests heavily into research scholarship and doctoral education today (as US, Europe and China do), the quality of its higher education will continue to decline with serious consequences for its economy
- There is evidence that this decline has been continuing for some time
- The technology boom may lose steam as Indian firms move their operations to other countries where they can find well-educated employees in large numbers

Sharply Rising Salaries Suggest Shortages

India Has Highest Salary Hikes in Asia

By THE ASSOCIATED PRESS

Filed at 5:41 a.m. ET, December 1, 2006

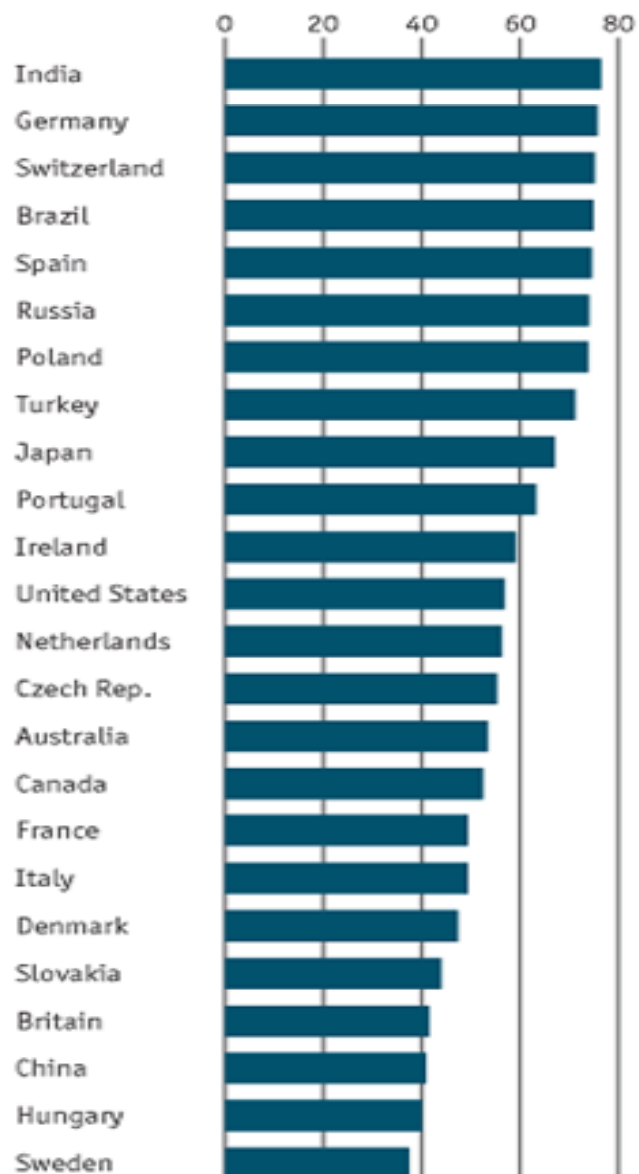
- NEW DELHI (AP) -- Salaries in India rose faster than any other major country in Asia this year, even as companies across the region remain under pressure to retain talent and spend more to compensate employees, a global resource company has said.
- An annual survey by [Hewitt Associates](#) revealed that salaries in India rose an average of 13.8 percent in 2006, with midlevel technical employees and supervisors getting the biggest hikes, the company said in a statement Thursday.

Real Pay

- Senior managers in Mumbai and São Paulo are better paid than their counterparts in New York or London, once the cost of living is taken into account, according to Hay Group, a human-resources firm. The calculations include the cost of rent, which is punishingly high in some financial centres. Sweden's heavy taxes leave top managers in Stockholm worse off, in real terms, than their peers in Shanghai or Budapest.
- Aug 10th 2006
From The Economist print edition

Real pay

Average real salary* of senior managers
2005, €'000



*Adjusted for purchasing-power parity
(including rent) of capital
city or financial centre

Sources: Hay Group; *The Economist*

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World University Rankings

	Population (millions)	Top 20	Top 50	Top 100	Top 200
China	1,321	1	2	2	6
Hong Kong	7	0	2	3	4
India	1,169	0	0	2*	3**
Japan	128	1	2	3	11
Other Asia	1,250	1	1	3	9
Sub-total	3,875	3	7	13	33
Australia	21	1	6	7	13
Canada	33	0	3	3	7
New Zealand	4	0	1	2	2
U.K.	61	4	8	16	30
U.S.	303	11	22	33	55
Total	6,396	20	50	100	200

Source: from the survey reported in **The Times Higher Education Supplement**, October 6, 2006. Each column subsumes the previous column: a university in the top 20 is also in the top 50, 100 and 200.

* IITs, IIMs

** IITs, IIMs, JNU

The world's top 200 universities											
2006 rank	2005 rank	Name	Country	Peer review score (40%)	Recruiter review (10%)	Int'l faculty score (5%)	Int'l students score (5%)	Faculty / student score (20%)	Citations / faculty score (20%)	Overall score	
1	1	Harvard University	US	93	100	15	25	56	55	100.0	
2	3	Cambridge University	UK	100	79	58	43	64	17	96.8	
4=	7	Yale University	US	72	81	45	26	93	24	89.2	
14	15	Beijing University	China	70	55	5	11	69	2	67.9	
16	23	Australian National University	Australia	72	30	48	33	38	13	64.8	
19=	22	National University of Singapore	Singapore	70	44	82	47	22	8	63.1	
19=	16	Tokyo University	Japan	72	29	8	10	35	27	63.1	
21	24	McGill University	Canada	57	61	31	33	52	10	62.3	
28	62	Tsing Hua University	China	45	34	22	9	84	1	56.1	
33=	41	University of Hong Kong	Hong Kong	48	40	84	27	46	6	54.8	
57	50	Indian Institutes of Technology	India	45	34	0	1	27	2	44.5	
68	84	Indian Institutes of Management	India	31	46	0	10	60	2	41.6	
183=	192	Jawaharlal	India	32	14	2	6	27	4	29.3	

DOCTORATE DEGREES AWARDED (India/US)

(Sources: Universities Grants Commission and National Science Foundation)

Field of Study	2002	2003**	2004**
Arts	4,524/ 5,029	6,144/ 5,018	6,774/ 5,013
Science	3,955/ 19,505	4,976/ 19,995	5,408/ 20,497
Commerce/ Management	728	954	1042
Education	4,20/ 6,491	527/ 6,638	593/ 6,633
Engineering/Technology	734/ 5,077	833/ 5,279	908/ 5,775
Medicine	219// 1,653	246/ 1,633	268/ 1,719
Agriculture	838	1012	1048
Veterinary Science	110	136	189
Law	110	146	129
Others*	336	444	743
Total	11,974/ 39,953	15,328/ 40,740	16,602/ 42,117

*Others includes Music/Fine Arts, Library Science, Physical education, Journalism, Social work etc.

** Provisional

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PhD Degrees Awarded in Science and Technology

Subject	1982-83	1988-89	1990-91	1991-92	1993-94	1999-00	2000-01	2002-03	2003-04
<i>Science</i>	2,893	3,044	2,950	3,386	3,504	3,885	3,734	4,976	5,408
<i>Engineering</i>	511	586	620	323	348	723	739	833	908

Source: University Grants Commission

Estimated Demand for PhDs (in Higher Education)

Parameters					
Population (in millions)	1100	<			>
Birth rate/1000	22	<			>
Percent of cohort in 3-year college	20	<			>
Instruction hours per week for a student	20	<			>
Weeks of instruction per academic year	35	<			>
Years in college	3	<			>
Hours in class per instructor per year	700	<			>
Number of years in instructor career	35	<			>
Percent of instruction delivered by PhDs	50	<			>
Demand					
Number of children in each cohort (million)	24.2				
Number college students in each cohort (million)	4.84				
College enrolment (million)	14.52				
Number of student hours in class per year (million)	10164				
Total Instructors needed to deliver instruction (million)	14.52				
Number of new instructors needed per year	414857				
Number of new PhDs needed per year	207429				
Number of PhD degrees granted in 2004	16602				
PhD Degrees granted as percent of instruction dema	8.00%				

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State of Higher Education

	Gross Enrollment Ratio (Relevant age)			Teachers per million population		
North America	61.7	80.7	131	2980	3205	121.2
Asia/Oce.	28.8	42.1	146	2162	3205	148.2
Europe	32.3	50.7	157	2042	2393	117.1
Arab	11.5	14.9	130	653	730	111.8
Latin/Car.	15.7	19.4	124	1422	1608	113.1
India	6	7.2	120	436	434	99.6
World Total	12.5	17.4	139	964	1084	112.5
Source: World Education Report, 1995 and 2000 (UNESCO)						

The Structure of Innovation/Research in India

- Structural obstacles to promote research and innovation in India
- In the early years after independence, India set up specialized research organizations which initially attracted highly talented scientists and engineers to conduct research
- These organizations were well financed by government, and had little contact with education, industry or the market (business was a dirty word in socialist vocabulary)
- With only a few exceptions, when isolated from the fresh air and inconvenient discipline of the market and contact with the young minds, most of the laboratories gradually fell into bureaucratic routine, promoting largely by seniority, spending much and producing little research (India hardly appears in the world research map)
- The civil services that run these organizations, e.g., Council for Scientific and Industrial Research, control much of government budget for promoting innovation

Policy of Separating Research from Education

- Second, most of the government budget for innovation was soon captured by these organizations, leaving little for the universities
- Third, isolation of research from the education of the young
- Universities reduced to classrooms for instruction and issuing diplomas
- Starved of talent in their faculty ranks, funding for innovation, and research culture. In this university environment, even talented students could have no exposure to research, and had no opportunities for even accidental discovery of their affinity for innovation.
- The few PhD programs that existed could not attract talented students
- Most members of faculty could not do or supervise research
- The quality of people entering the PhD program lowered the regard in which academia were held, and this vicious cycle of mutual reinforcement continues to this day

Specialization

- A fourth consequence was that these research institutes were given narrowly defined charters and did not see the exciting interfaces of disciplines where innovation occurs as their focus
- Each institute, defined by its own agenda or discipline, was bound by its own charter and its organization did not facilitate or encourage casual interaction with ideas from outside that may occur in broader university settings
 - You can set up an institute to conduct research on candles and will never discover electricity
 - You can set up an institute to conduct research on horse carts and will never invent a car
- The education system in India has also suffered from the same limitation imposed on them through narrow super-specialization
- Importance to diploma, not to the creativity of a young mind
- Importance to administrative authority, not to originality of thinking and power of ideas
 - Name an Indian scientist who is known for science, not authority

Keeping Abreast Is Not Enough

- ***To lead*** India needs to seriously rethink the future of innovation and original research in the Indian economy

Creator of Innovation

- To become a brain-power of the first rank, India will have to move beyond adopting and adapting the inventions created abroad, and become a major creator of innovation
- The Grain Revolution in agriculture originated in U.S. and Mexico, and even its adaptation in India needed huge investments in irrigation, fertilizer plants, high yielding seed production, extension services, and serious political commitment
- The “Brain Revolution” will need similar investments in seed farms of knowledge to attract the best and the brightest of each graduating class to careers of research scholarship and instruction

India Needs Domestic Capacity for Scholarship and Innovation

- For India to become a “brain bank,” to use a popular phrase, it will have to become a source for first class scholarship where new theories, theorems, products, and ideas are generated for itself and the rest of the world. In other words, India must create, today, the seed farms for scholarship
- From all indications, the quality as well as quantity of high-talent young people being attracted to scholarly careers is too small today to support such dreams for the future
- Even US universities which used to attract a large number of PhD candidates from India, the number has dropped as the economic reforms made better employment opportunities available to them
- India as well as China is so large that neither can depend on foreign universities to train enough PhD for it

Innovation Needs Seed Farms

- A farmer saves some of his best grain as seed to plant the next crop.
- While eating an extra mouthful is satisfying today, it is not worth the risk of having nothing on the table next year.
- What is true of agriculture is also true of society and education, except education requires us to think of much longer generational cycles, not just annual crop cycles.

Long Way to Go

- Can India have the kind of future it dreams of if she fails to attract the highest level of talent into universities to teach, and think of new ideas in science, technology, social science, arts and the humanities?
- Who was the first in the world to think and to make the things we see and use?
- The distance India has to travel to stand among the countries which lead the world in brain power becomes immediately obvious.

Attracting Talent to Scholarship

- Next ask: what were the characteristics of the people who made the inventions that have transformed our lives? If these were the people with high brain power, surely India has plenty of those
- Again, look around the class room in an Indian university. Now ask: how many of them are, or will be, devoted to invention and scholarship? It might be easier to answer the question: how many of India's brightest are NOT pursuing MBA or software engineering? The answer can sometimes be disappointing
- India cannot aspire to the future as an advanced society without large numbers of original thinkers to inspire the new generations of students, new ideas, original scientific research, development of technology, and producing fine arts and literatures that great minds create and appreciate

What Should India Do?

- **Solutions** will have to be found urgently, and from within India
 - No solutions suggested from outside would be acceptable to a proud society
 - Proposals from outside attract immediate attention to why they would not work
 - Nor are they likely to work
- If the problem is considered important, it must be addressed from within by carefully deliberation among top policy makers and experts, recognizing the serious conflicts of interest that exist at all levels (profit-making institutions owned by businessmen and legislators)

Concluding Remarks

- Conversations with the department heads, deans, vice chancellors and senior civil servants, even some politicians, in India reveal following adjectives for the current status of scholarly innovation in India:
- Crisis
- Grim
- Vicious cycle
- Broken educational infrastructure
- Needs outside intervention
- These concerns are buried under the excitement generated by the recent high rate of economic growth

Solution from Within

- Outside solutions will not work
- Grain revolution was forced by the grim food supply situation in the 1960s, made possible by admirable and visionary political, financial, technological and administrative leadership which set the national pride aside
- The computer age in India had an early start, faltered with the lack of funding and leadership in the sixties, and was revived by Internet, Y2K, globalization, and government indifference in the nineties
- Liberalization of the Indian economy in 1991 was forced by external financial constraints and made possible by the leadership of Prime Minister Rao and then Finance Minister Singh
- India's political, academic, business and administrative leadership is capable of visionary leadership to create capacity for innovation at the apex of India's system of education, scholarship, research and development, and arts
- India will have to find the internal strength to deal with this crisis, as it has done many times in the past
- The solution lies within
- What can **you** do?

Care in Building Seed Farms

- Developing the culture of innovation
- Long gestation period
- Social acceptance of, and respect for, scholarship to attract talent
- Large financial resources necessary but not sufficient
- There is no mechanical method for evaluating innovation and talent—achievement in research is easy to fake, especially when the people around you cannot judge what is new, interesting and important
- Unbalanced emphasis on financial incentives for research only induces fraud and wasted resources

The State of Innovation in India

- the engine of innovation is working well in business, and it could work even better
- Mixed record in education
- In research and scholarship, the pulse is weak
- India needs to consider removing infrastructural and many regulatory barriers to innovation as well as introduce effective controls on anticompetitive practices in business
- The education sector, especially at PhD level, needs major overhaul a new framework for management and regulation of university education
 - Focused on control and does not encourage creative minds of students and faculty to innovate
- To stoke the engine of innovation in India, major segments of the research sector of the economy can be usefully integrated with the industry and education system
- More thinking, less rote memorization and vocational training

Will They Ask Themselves?

- **Students:** Who would I want to be taught by?
- **Businessmen:** How do I get technologies, products and services to compete against the best in the world?
- **Civil Servants:** How do I deploy scarce budgets for maximum advantage of society?
- **Public men and women:** Will the next generation thank me for our foresight, as the present generation thanks Nehru and Azad for theirs?
- **Educators:** How do I deliver to earn the resources and respect of society?

I Ask You

- You know more about India than I do
- You may not reach the same answers as those I have in mind
- All I ask is that you arrive at your own answers to these important questions

Thank You

Shyam.sunder@yale.edu

www.som.yale.edu/faculty/sunder