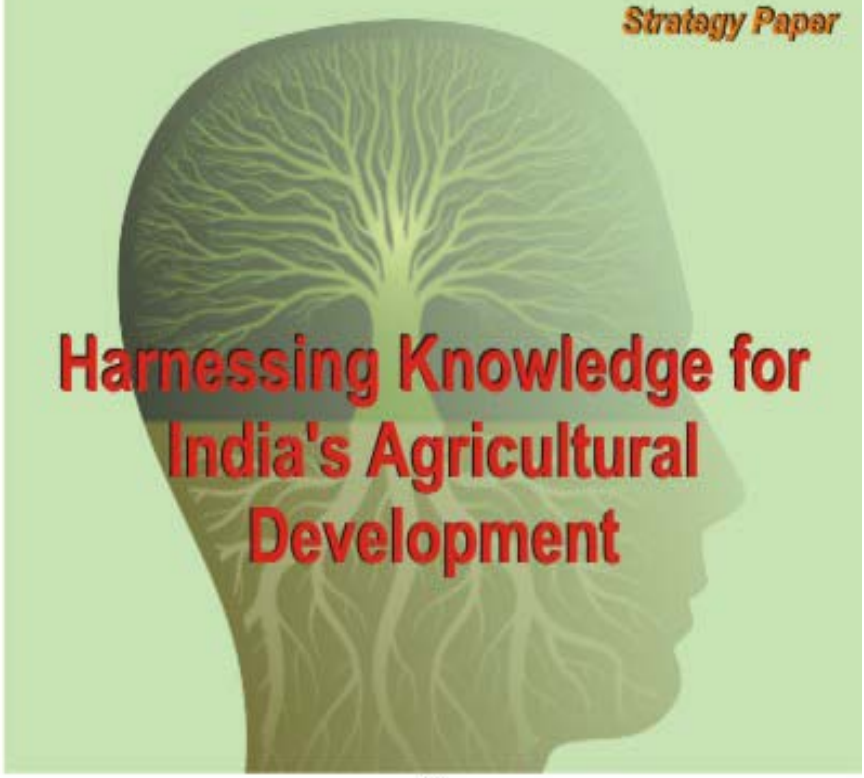
TAAS Foundation Day Lecture

Strategy Paper



Harnessing Knowledge for India's Agricultural Development

by

Dr. Uma Lele

Former Research and Operational Manager and Policy Advisor, World Bank

August 12, 2011

Trust for Advancement of Agricultural Sciences

Progress Through Science

Trust for Advancement of Agricultural Sciences (TAAS)

GOAL

An accelerated movement for harnessing agricultural sciences for welfare of people

MISSION

To promote growth and advancement of agriculture through scientific interactions and partnerships

OBJECTIVES

- To act as think tank on key policy issues relating to agricultural research for development (ARD)
- Organizing seminars and special lectures on emerging issues and new developments in agricultural sciences in different regions of India
- Instituting national awards for outstanding contributions to Indian agriculture by scientists of Indian and other origin abroad
- Facilitating partnerships with non-resident Indian agricultural scientists visiting India on short leave

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It is a great honor to be invited to deliver this TAAS lecture. Many distinguished speakers have spoken here before me. I have been somewhat hesitant to accept this invitation because I have not done any serious work on Indian Agriculture since my post-doctoral work on grain markets in India in the late 1960s. After joining the World Bank in 1971, I worked on many countries of the world except India. In the past World Bank's policy was not to assign nationals of a country to work on their country. Dr. Swaminathan, invited me in 2008 to conduct an independent review of the work of the M.S. Swaminathan Research Foundation and to "return to work on India". I accepted the invitation readily. The last few years have been professionally rewarding, with a steep learning curve. India has changed in many ways since I left, much as I have, and yet in some ways it remains the same. Sorting out what is different and what is the same about India has been an "Alice in Wonderland" experience. I look at India through the Looking Glass, comparing India's progress with the situation in the 1960s and in relation to other developing countries. In speaking about this comparative experience over time and space today, for India, I will draw largely on the recent work of Indian scholars.

Challenges in Moving Forward ?

The sharp rise in world food and fuel prices since 2007 has attracted global attention to the role of agriculture in economic development. India too has experienced food price inflation. Following the Green Revolution in the 1970s of which India was a cradle, a consistent decline in the real prices of food for nearly 30 years led to a global complacency regarding food supply and although the global attention has focused on agriculture since 2007, much as it had in the early 1970s, there are major differences in the way developing countries like India will have to cope with the challenge. In exploring how to respond to the combined food and fuel crisis, the role of knowledge, both global and local, in modernizing agriculture seems to be a

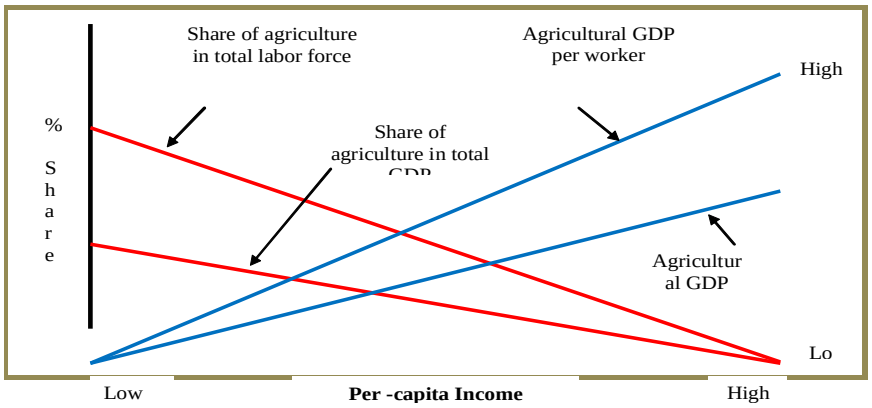
particularly appropriate theme for this lecture. Revolution in information and communication technology, GIS and many other types of information has greatly increased our understanding of the world in which we live in real time, as well as leading to a huge paradigm shift in our understanding of the processes of structural transformation, *i.e.,* the decline in role of agriculture in the course of economic development. India now is not only the country with the second highest rate of economic growth next to China, but it has also been a global leader in outsourcing, improving knowledge management systems of large private enterprises throughout the world. How can it bring its own economic growth and information revolution to the issues of modernizing its own agriculture which is urgently called for?

Importance of Agricultural Growth in Economic Modernization

In their classic paper, The Role of Agriculture in Economic Development, Johnston and Mellor had argued that as economies develop, the role of the agricultural sector declines in the share of GDP and employment originating in agriculture (Johnston and Mellor 1961, AEA pp. 566-593). Increasing agricultural productivity is crucial in the course of such a structural transformation to assure a steady food supply and to "release "agricultural labor for employment in the non-agricultural sector without increasing food prices and wages confronting the non-agricultural sector. The failure to raise agricultural productivity in the course of modernization would at best slow down, and at worst, halt the process of structural transformation (Johnston and Mellor 1961, AEA pp. 566-593; and Lele and Mellor 1981, OEP pp. 426-441). Timmer (Timmer 2009, pp. 7-9) has described this phenomenon in terms of the four trends. As can be seen from figure 1 typically the rate of decline of agriculture's share in the GDP tends to be faster than the rate of decline of agriculture's share of employment as per capita income increases in the course of modernization. Concurrently agricultural GDP per worker needs to increase at a rate faster than the rate of growth of agricultural GDP through technical change for incomes in agriculture to rise as labor is withdrawn from the agricultural sector. Economists in general have been less focused on the backlog of poverty and hunger within the agricultural sector itself, the kind of a phenomenon noted in the areas of slow agricultural growth in India.

In related work on technical progress, Evenson and Fuglie have measured technology capital as the essential price of admission to a "growth club" (Evenson and Fuglie 2010, JPA pp. 173-190). They measure technology capital as consisting of Innovation-Invention capacity, and Index of Technology

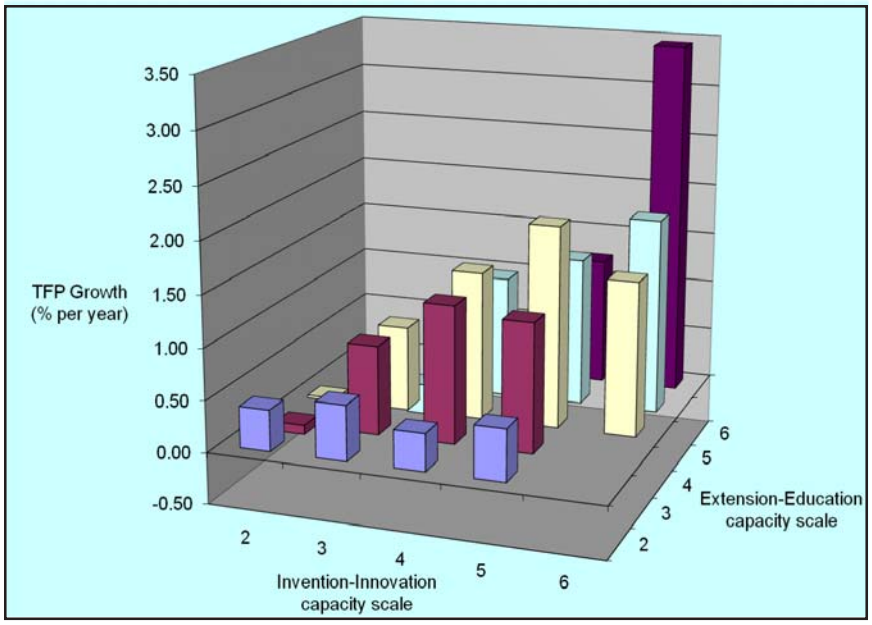
Fig. 1: Increased Interest in the Role of Agriculture in Structural Transformation of an Economy: A Classical View



Source: Based on Timer 2009.

Mastery, the former in terms of the number of agricultural scientists in relation to crop land and industrial R&D as percent of GDP, and the latter in terms of

Fig. 2: "Technology capital" Is Strongly Correlated with Agricultural TFP Growth

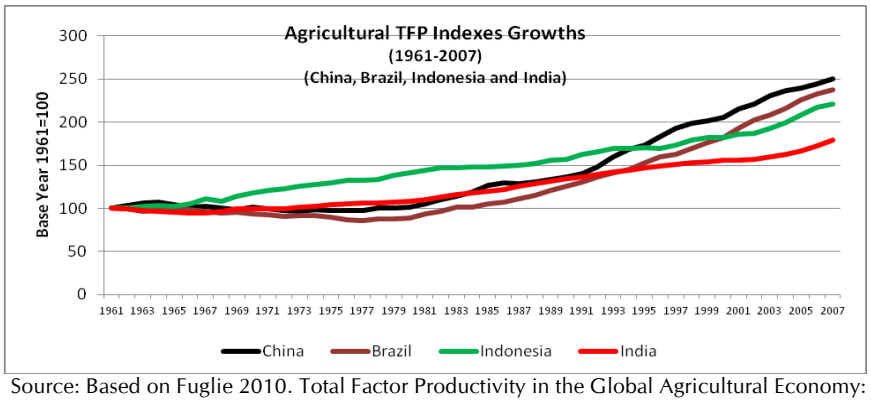


Bar Height Shows Average TFP Growth of Countries with Increasing Technology Capacities

Source: Evenson and Fuglie 2010

agricultural extension workers / cropland and average schooling of male workers (Figure 2). Measuring TFP growth in this way in 87 countries for two periods (1970-75 and 1990-95) they show distinct differences in TFP growth among countries. China and Brazil show substantial increase in TFP followed by Indonesia, India being a distant fourth in the recent period (Figure 3).

Fig. 3: Agricultural TFP Indexes Growths (1961-2007)



Source: Based on Fuglie 2010. Total Factor Productivity in the Global Agricultural Economy: Evidence from FAO Data.

In a recent study of provincial TFP growth in China Wang *et al*., report extraordinary growth rates of TFP in Chinese provinces. In the top ten provinces TFP growth ranges from 6.8 percent to well over 8 percent annually over the 1985-2007 periods (Wang, Gale, McPhail and Somwaru 2011; AAEA, July 2011). Six of the top ten provinces in TFP growth are on the east coast of China, where, according to Wang et al labor's share in agriculture has declined even while productivity has increased.

Role of Knowledge in Agricultural Development

To achieve broad based agricultural development involving a large number of small dispersed farmers however requires not just technology capital but knowledge in a whole range of areas besides agricultural research, extension and education. This knowledge is imbedded in the efficiency with which quality seed, fertilizer and pesticides are produced, delivered and applied by farmers, (e.g. subsidy to nitrogenous fertilizer or delivery of only one type of fertilizer may lead to imbalance in the micro–nutrients in soils adversely affecting land productivity, price supports to specific crops may adversely affect crop rotation cycles also adversely affecting productivity), the way water resources and climate variability are understood and managed will make a profound difference to the efficiency, productivity, conservation and equitable use of water. How value chains are organized and the way

energy and transport are harnessed will influence whether and how market signals are transmitted between consumers and producers. Knowledge determines how agricultural finance and crop insurance are effectively provided or whether provision of finance bankrupts farmers and financial institutions as has happened in India recently, discouraging savings and investments. Domestic and international markets can similarly facilitate the development of formal and informal standards with regard to food safety, food quality and storage and determine whether producers receive timely signals to influence their production decisions.

Multiplicity of actors and a range of institutions supply information and knowledge in these various areas including agricultural research, extension and education systems, universities and think tanks, private sector traders and processors, non-governmental organizations, international development agencies and environmental organizations, the media and the formal and informal rule making systems. Although there has been an explosion in the number of actors involved in the agricultural and the rural sector there remain huge gaps in information and knowledge in India with disjointed and disconnected institutions unable to harness it for the development of smallholder agriculture.

Douglas North**,** a Nobel Prize winning economist argues that how knowledge is generated and harnessed determines whether and how countries develop (North 1994a, AER pp. 359-68). Besides even when countries are on a growth path, as was India's agriculture after the Green Revolution, indefinite growth is by no means assured on a sustained basis. Whether the pace of growth or indeed even the process itself is sustained, or is prematurely aborted, is critically determined by the way information and knowledge are processed by key stakeholders in societies. North makes a distinction between institutions and organizations (North 1994b, EconWPA). Institutions according to North are the formal and informal rules, values and norms by which various actors play the game. Thus whereas institutions are the referee, organizations are the players, and as in the case of any sport, the extent to which the players play by the rules depends on the extent to which they are expected to adhere to the formal and informal rules, in turn determined by the values, norms and traditions that a society inherits. Therefore institutions tend to be path dependent, based on a historical experience. The way a country's institutions adjust to changing circumstances and challenges determines whether countries progress. And that adjustment in turn depends on vested interests. All institutions have vested interests associated with them. Clearly then how vested interests are managed, whether and how information and

data are processed, and analyzed determines the stock of knowledge, its application in the design and implementation of policies and interventions determining in turn the pace of progress, the extent to which the implementation experience is systematically tracked, monitored and evaluated and its lessons are translated into fine-tuning interventions determines outcomes. Monitoring, evaluation and application of results have become integral parts of public expenditures in most western countries.

Seen from such a knowledge perspective how does India's performance look over time and space and relative to other countries?

India's Economic and Agricultural Performance over Time and Space

India not only has the distinction of enjoying the second highest rate of economic growth next only to China's since the turn of the new millennium, since 2003-04 economic growth has accelerated in virtually all states including the poorest states and states performing less well in the past. There, nevertheless continue to be huge differences among states in per capita incomes (Figures 4 and 5).

On a cross-sectional basis, the shares of agriculture in GDPs of individual states in India and the shares of agricultural employment in total employment in these states show the same inverse relationship with respect to per capita GDP as outlined by Timmer. The states with the lowest per capita income by and large have the highest share of employment and GDP originating in agriculture. The states with higher per capita incomes have small shares of agriculture in employment and income.

Given that the poorest states depend the most on agriculture, Knowledge Management would seem to be a high priority for India's Agricultural Development. The changed concept of food security adds to this impetus. The idea of food Security has changed-

- From national availability and national self-sufficiency, to improved access to food for all households, to increased access to food of all members of households at all times and a particular and growing concern about intra-household equity and fairness in the allocation of food, particularly involving women and children. There is also increasing interest in the better bodily absorption of the available food, with greater focus on nutritional outcomes and impacts particularly on children's nutrition and health and ability to learn.
- The concept of science too has changed from formal science to informal traditional knowledge of households, local biodiversity among other features of knowledge. Yet concrete empirically based evaluative

Fig. 4: Per Capita GDP in India, by State (Rupees) (1980/82-2003/05)

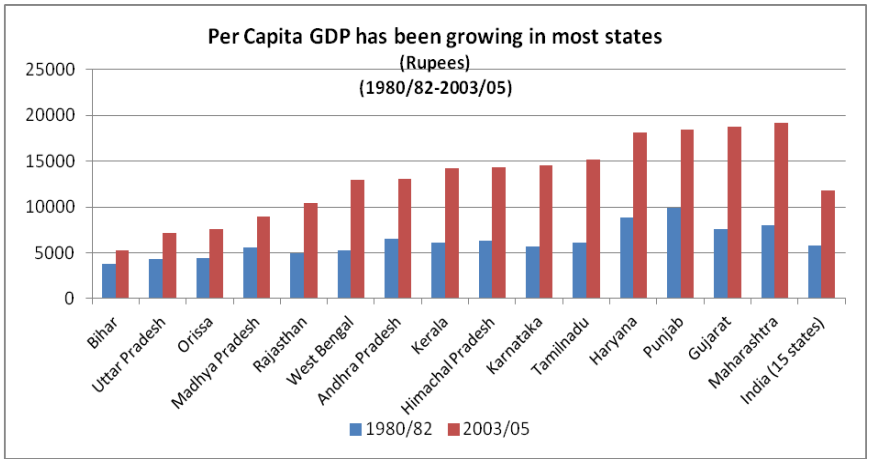
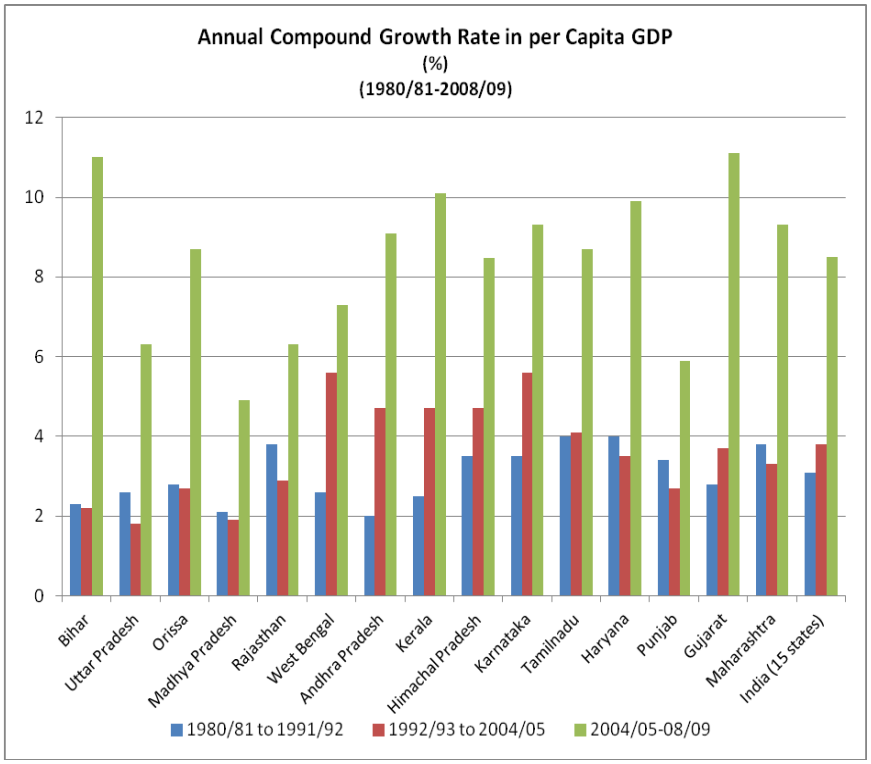


Fig. 5: Annual Compound Growth Rates in per Capita GDP (%) (1980/81-2008/09)



Source: Hans P. Binswanger-Mkhize and Alwin d'Souja 2011. India 1980-2008: Structural Change at the State Level.

evidence on performance of organizations and interventions with regard to these issues tends to be limited. This situation offers huge scope for policy and operational research within India and comparatively across countries to improve effectiveness of public, private and civil society interventions in the areas of food security.

Agricultural TFP growth in India

India's agricultural TFP growth has slowed with considerable differences in TFP growth across crops and states (Chand *et al.,* 2011, NCAP). TFP growth of wheat has been the highest and close to 2 %, rice is far behind and maize has been as low as 0.67%. Hybrid sorghum productivity declined during 1995-2005. TFP growth in bajra on the other hand has been impressive. Out of 18 crops two thirds have exhibited decline in TFP. Madhya Pradesh, Gujarat, Andhra Pradesh, Rajasthan, Maharashtra and Chhattisgarh experienced agricultural growth rates of well over 4 percent, but many other states Uttarakhand, Himachal Pradesh, Punjab, Bihar, Jammu & Kashmir, Haryana and Orissa had between 2 to 4 percent growth and Jharkhand, Karnataka, Assam. Kerala, Uttar Pradesh, Tamil Nadu and West Bengal had less than 2 percent rate of growth (Chand *et al.,* 2011, NCAP).

Indian Plan on the other hand has set target rate of growth of agricultural production at 4%, to meet growing demand from population growth at a rate of 1.4% annually, the gap between availability and minimum dietary requirements of the poor, and to meet the demand generated by income growth and urbanization both leading to changing consumption patterns.

Per capita food grain production and total cereal production has however increased little for the 1960-61 to 2009-10 period annual average growth rates of per capita total food grain and total cereal availability amounting to 0.003% and 0.21% respectively. Whereas this is a creditable achievement in view of the rapid population growth and the recurring food crises in the 1960s, the growth has been insufficient to address the pervasive issues of poverty and hunger. Per capita coarse grain production, the staple food of the poor for example has declined at the rate of 0.93% annually (Figure 6).

Gross capital formation in agriculture has increased impressively in recent years. Private investment has increased even more rapidly than public investment. However the quality of public expenditures and the regulatory environment accompanying private sector investment seem to have been challenges. Thus for example some of the sharp increase in private investment undoubtedly includes the growth of investment in tubewells by farming

Fig. 6: Food Availability per Capita in India (tones per capita) (1960/61-2009/10)

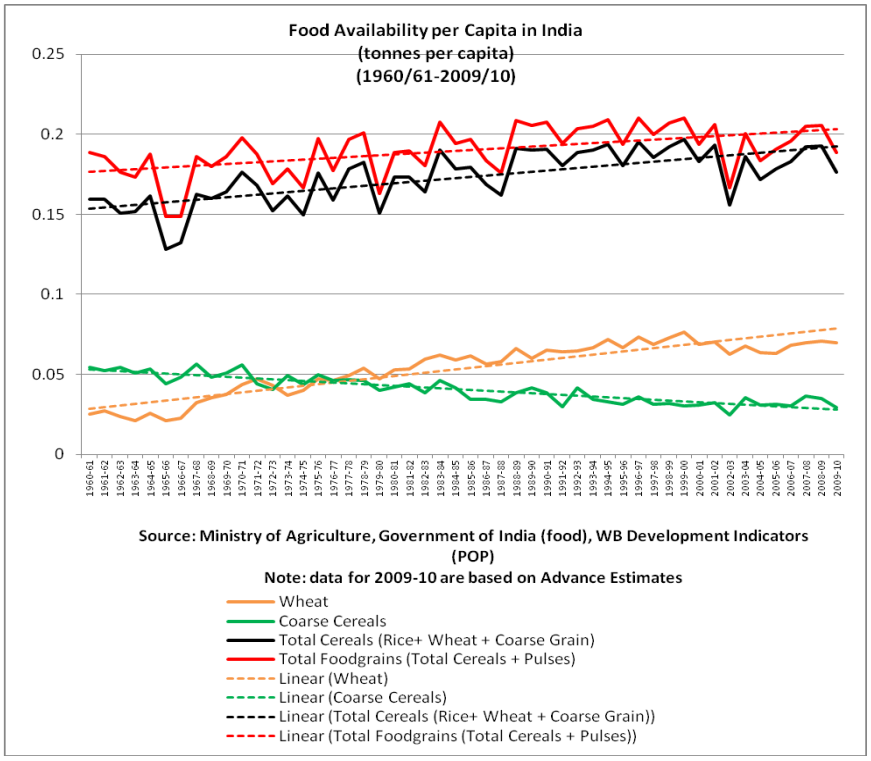
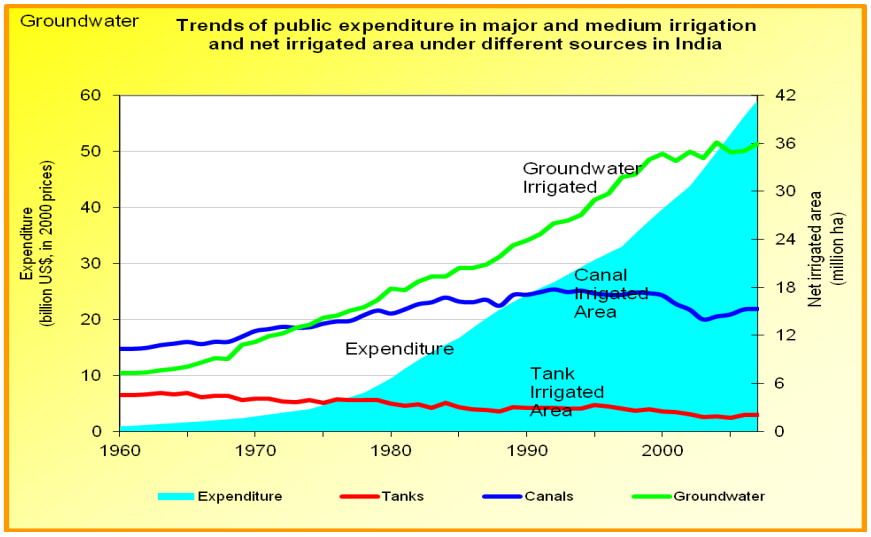


Fig. 7: Irrigation Investment & Irrigated Area in India



Source: Strategic Analyses of the National River Linking Project (NRLP) of India, Series 5. Proceedings of the Second National Workshop on Strategic Issues in Indian Irrigation. International Water Management Institute 2009.

households. Unchecked growth of groundwater exploitation has however led to unsustainable levels of groundwater use, while area under surface irrigation has remained stagnant despite the rapid growth in irrigation investments, phenomenon which the Planning Commission has acknowledged raises issues of investment strategy and quality (Shah and Lele 2011) (Figure 7).

The need to address public policy issues related to the level and effectiveness of public and private expenditures on agriculture, in a way it seems to be occurring in Gujarat, has now achieved a sense of urgency because despite rapid growth and some reduction in levels of poverty and hunger, India contains the largest number of both. According to the World Bank estimates of poverty levels, i.e. by 1981, by the criterion of persons earning less than a $1.25 a day, China had the largest share of global poverty (44%). With 835 million poor people globally, India's share was almost half of China's with 415millions poor. By 1990, China's number had declined to 683 million poor and its share in global poverty was down to 38%. India's numbers were 436 million and the share had increased to 24%. By 2005, China had experienced the most dramatic decline in poverty with 207 million living in poverty and the global share of poverty, down to 15% In contrast India's number of poor had increased to 449 millionwith the share in global poverty up to 33%.

India also contained the largest number of hungry, 237 million in 2005-07 according to FAO and that number has remained stubbornly high. Not surprisingly India remains off track on meeting the first MDG target.

Whereas the number of undernourished people had been declining in the world, India's number of hungry was increasing significantly according to FAO until 2005-2007, the latest period for which FAO published country breakdowns (Table 1). FAO estimates that globally undernourished had increased to 1,023 in 2009 but had declined to 925 million in 2010. No numbers are available from FAO for India for 2009 and 2010.

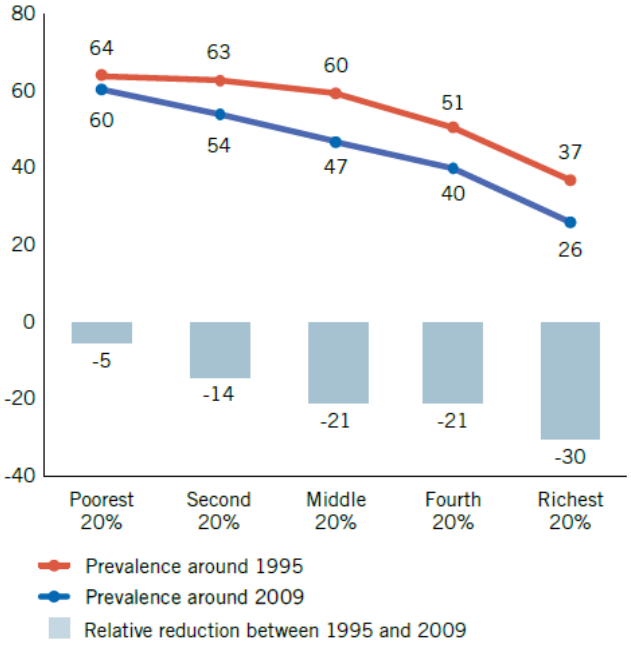
South Asia's Under Five Malnourishment Rates also remain the highest in the world despite some recent decline, and they are higher than even in sub-Saharan Africa. Besides In Southern Asia, Progress in combating child under-nutrition is bypassing the poorest (Figure 8). Amartya Sen has rightly observed that Bangladesh is ahead of India in several social indicators because it has given higher priority to the empowerment of its women.

Table 1: Number of Undernourished Persons (millions)

Country groups/Periods	1990-1992	1995-1997	2000-2002	2005-2007
WORLD	843.4	787.5	833.0	847.5
Developing Regions *	817.2	760.8	805.2	829.4
Northern Africa	5.0	5.4	5.6	6.1
Sub-Saharan Africa	166.3	189.0	203.2	202.5
Latin America and the Caribbean	54.3	53.3	50.7	47.1
Eastern Asia (without China)	5.5	8.0	9.1	9.1
China	210.1	141.8	133.1	130.4
Southern Asia (without India)	90.5	102.0	99.7	106.2
India	172.4	162.7	200.6	237.7
South-Eastern Asia	105.4	85.7	88.9	76.1
Western Asia	7.2	12.2	13.4	13.5
Commonwealth of Independent States	16.7	17.9	19.0	9.6
Developed regions	7.2	6.7	6.3	6.5

Source: FAO Statistics Division: Notes: * Incl. Oceania

Fig. 8: Proportion of Underweight Under-five Children in Southern Asia by Household Wealth (1995-2009) (Percentage)



Source: MDG Report 2011

South Asia's Progress towards universal primary education is also off track.

IFPRI estimates that India's progress in meeting Global Hunger Index (GHI) has been slow—31.7% to 24.1% from 1990 to 2010 (decrease of only 23.9%)[1]

External Environment for India

External aid played a significant role in India's generation of the Green Revolution in the 1960s and 1970s, through investment in agricultural research, education and training via the establishment of land grant type universities, policy advice, access to the CGIAR technologies, establishment of institutions and balance of payments support for the import of seed, fertilizers and through food aid. But now to the rest of the world India is seen less as a developing country needing aid than one that is competing with OECD countries in taking away their skilled jobs, a result of India's spectacular rise as an outsourcing Mecca.

Net aid to developing countries as a whole, either as share of GDP or investments has been declining over time. Indeed in the case of East Asia and the Pacific Region, and Latin America, these flows are now negative and for South Asia they are very small. It is only Sub-Saharan Africa which still receives significant shares of net aid. Indeed like China and Brazil, India too is slowly but surely becoming an aid donor.

OECD aid to agriculture of developing countries as part of the total OECD aid declined precipitously from just above 20% to 5% from 1979 to 2007, until the food and fuel price increases brought attention to agriculture. The lack of attention of the international community to agriculture had the inadvertent effect of developing country policy makers also taking their eye off the ball of agriculture and rural development. It is only since 2008 that attention of the international community to agriculture has resumed but with the growing fiscal problems in OECD countries, prospects for increased aid

[1]The Global hunger index is calculated as follows: GHI = (PUN + CUW + CM)/3

GHI: Global Hunger Index
PUN: proportion of the population that is undernourished (in %)
CUW: prevalence of underweight in children under five (in %)
CM: proportion of children dying before the age of five (in %)
All three index components are expressed in percentages and weighted equally. Higher GHI values indicate more hunger. The Index varies between a minimum of 0 and a maximum of 100, but these extremes do not occur in practice. The maximum value of 100 would be reached only if all children died before their fifth birthday, the whole population was undernourished, and all children under five were underweight. The minimum value of zero would mean that a country had no undernourished people in the population, no children under five who were underweight and no children who died before their fifth birthday.

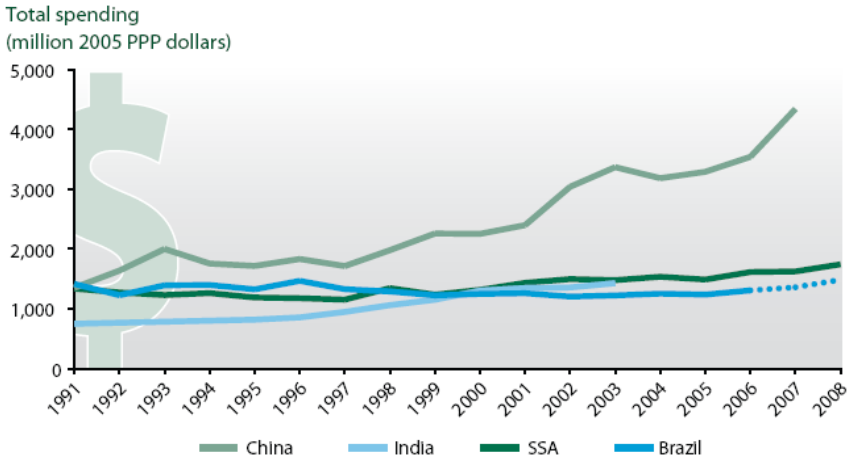
are limited. Increased knowledge in the future would have to be acquired through global and local partnerships.

Investments Agricultural research and development (R&D) have contributed to economic growth, agricultural development, and poverty reduction in developing regions to a great extent by improving the quantity and quality of agricultural produce, reducing consumer food prices, and improving environmental management in some areas (WDR 2008) and the CGIAR was pivotal in India's Green Revolution.

But the impact of the CGIAR had declined over time as its own research agenda has been less focused and funding has become more restricted. To address the problem, the CGIAR has gone through a major reform process and its resources have increased but continue to remain restricted. CGIAR's total staffing has increased but its international staff remains woefully small, with only about 1000 international scientists working throughout the developing world, although the number of research challenges has increased.

In contrast, China's total spending on public agricultural R&D has seen huge growth. It was $4.3 billion in 2005 PPP prices in 2007, more than the combined spending by Brazil and India (Fig 9). China reports 80,000 scientists in agricultural R&D compared to India's 30,000, if these latest numbers on India are reliable (Beintema and Stads 2011). India's agricultural research expenditures are 0.6 percent of agricultural GDP, woefully low given the growing pressures on land and water, climate change and other challenges it faces in increasing agricultural productivity.

Fig. 9: Total Spending on Public agricultural R&D (1991-2008)



Source: ASTI as reported in Beintema and Stads (2011).

Importance of Global and Local Partnerships Going Forward

Greater South-South and South-North Cooperation will greatly unleash the potential of Indian Agriculture through substantial external partnerships and exploration of other models of research management. EMBRAPA's Corporate Model is strongly focused on research results and China's substantially reformed agricultural research system offers new ways of establishing partnerships, not just with public institutions but with the private sector, farmer organizations, universities nationally and internationally, and with civil society organizations.

External or domestic partnerships can enhance performance only when domestic institutions are strong and know precisely what the country can get out of these partnerships. Indian experts are calling for substantial strengthening of agricultural research through increase in investment in agricultural research from 0.6 percent of ag. GDP to, e.g., doubling by 2015 and tripling by 2020 (Chand *et al.*, 2011, NCAP). They are also recommending a better balance in the allocation of research resources among crops, and between crops and livestock. Government expenditure on Agricultural extension, even after having increased, remains extremely low as share of GDP. Once again, the data assembled by Chand et al show that most of the expenditures have gone to cropping and little to soil and water resource management. But the quality of India's public expenditures seems to be as much an issue as quantity if the record of slowing productivity growth in agriculture or the no growth in surface area irrigated is considered.

Indian experts are also calling for a total transformation of India's higher agricultural education to accelerate innovation. They note that a sharp decline in the number of faculty during the 1990s has depleted research capacity in agricultural universities. The reasons seem to be non-replacement of retiring faculty, establishment of multiple universities in the same states, and bifurcation or sub-sectorially specialized universities, each leading to the lack of a critical minimum mass of faculty across disciplines and areas of research to address system level issues, e.g. of productivity and the environment (Challa, Joshi and Tamboli 2011, EPW pp. 326-329. June 25).

How much new technology can India "borrow" from the rest of the world? Most " Scientific" R and D still takes place in industrial countries, but lags in US research investments and research outputs have increased due to movement of US research more upstream. Besides relevance of upstream research of advanced countries to developing countries requires more selective borrowing. India should explore the possible relevance of the Chinese model of active international scientific research and teaching collaborations and

Brazil's LABEX model to India. Following the GREAN (Global Research on the Environmental and Agricultural Nexus) Initiatives recommendations and World Bank funding in the mid 1990s, EMBRAPA embarked on an active program of establishing its own "laboratories" in research organizations of important countries (the U.S., France, South Korea and most recently in China) to increase EMBRAPA's international research collaborations.

With the changing concept of "science", which increasingly incorporates indigenous knowledge on health and nutrition, biodiversity and medicines, developing countries can create their own knowledge beyond acquiring S and T and borrowing knowledge from overseas. Mashelkar gives many examples of innovations relevant to the poor in India. The Swaminathan Foundation conducts a major program of research and dissemination that is pro-poor, pro-environment, and pro-women including taking information technology to the poor, identifying their information needs and providing them with new knowledge that can increase their incomes and reduce risks.

India is now a world leader in innovation in the software sector with 60% of the global exports from outsourcing coming from India; Notwithstanding the 2G scam and the highly inadequate physical infrastructure, the cell phone revolution has transformed parts of rural India. India has world class IITs. It is the largest producer and exporter of generic drugs, including particularly for the diseases of the poor; India's 55 billionaires made a front page headline in the New York Times showcasing its dynamic private sector. India has a thriving civil society and an active media. The Right to Information Act, the Right to Food movement and other such movements to reduce corruption and increase accountability of the governing class are some of the many examples of India's social and journalistic dynamism.

To become a modern state, however, substantial investments are needed in support of the poor to reduce poverty and hunger. At the same time a systematic approach is required to increase the quantity and quality of R & D with reform of domestic institutions such that they accord the highest priority to effectively harness knowledge for the reduction of poverty and hunger. To be a superpower India must deploy innovation to address the issues of productivity, poverty and the environment, particularly those issues that afflict its 350 + million poor.

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Role of Information Communication Technology in Taking Scientific Knowledge/ Technologies to the End Users - National Workshop, January 10 - 11, 2005, Recommendations.

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Farmer-Led Innovations for Increased Productivity, Value Addition and Income Generation - Brainstorming Session, October 17, 2005 - Highlights & Recommendations

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National Dialogue on Building Leadership in Agricultural Research Management, Hyderabad, August 27 - 28, 2010 - Proceedings & Recommendations.

Stakeholders' Interface on GM Food Crops, May 19, 2011 - Recommendations.

Copies of all the publications are available at

www.taas.in

Dr. Uma Lele

Uma Lele, left services of the World Bank in 2005 as Senior Advisor in the Operations Evaluation Department, now called the Independent Evaluation Group. She was a panel member of the first Independent External Evaluation of the Food and Agricultural Organization in 2007. Jointly with two others, she carried out a Meta evaluation of the Global Environmental Architecture for the Lincoln Institute of Land Policy in Boston in 2008. Working with three other authors, she led the theme paper for the first Global Conference on Agricultural Research for Development, GCARD, in Montpellier, France in 2010, leading to a Road Map to transform the current fragmented system of global agricultural research for development into a more cohesive whole to achieve faster and larger impacts on development outcomes. She is currently working on the issues of the Global Architecture for Food and Agriculture.

She served on the High level Advisory Panels of the independent evaluations of the Global Environmental Facility in 2006, UNICEF in 2008, and is on the UNDP Panel in 2010-11.

She is on the Board of the Institute of Development Studies, Sussex, UK, the M.S. Swaminathan Research Foundation, and Chennai. India, and on the Technical Advisory Committee of the Global Water Partnership. She serves on the editorial board of Agricultural Science, recently launched Journal of the National Academy of Agricultural Sciences, India.

Her intermittent stints since joining the World Bank in 1971 involved being visiting Professor at Cornell University (1973-74) and Graduate Research Professor and Director of International Studies at the University of Florida (1991-1995). Her first research work in the 1960s focused on the competitiveness of grain markets in India. Her work at the World Bank during 1972 to 1989 focused on African Rural Development and aid. While at the University of Florida, she directed the Global Development Initiative of the Carter Center and the Carnegie Corporation in 1992-1994 and served as founding member of the board of the Center for International Forestry Research (CIFOR) in 1993, as member of the CGIAR's Technical Advisory Committee in 1994, and as a member of the Conway led CGIAR vision panel in 1994. After returning to the World Bank in 1995, she worked on agricultural and rural development in Indonesia, Brazil, and China. During 1999 and 2005 she led complex evaluations of the World Bank's 1991 Forest Strategy, the Meta Evaluation of the CGIAR, and Evaluation of the World Bank's Global Programs while co-chairing a taskforce on the Forests and Grasslands in the Development of the West of the China Council for International Cooperation on Environment and Development (CCICED).

The first woman to be awarded a Ph.D. from Cornell University's Agricultural Economics Department, and elected distinguished alumnus in 2008, she is Fellow of the American Applied and Agricultural Economics Association and of the National Academy of Agricultural Sciences, India.Uma Lele has written or co-authored 15 books or book length published reports and numerous journal articles. Her areas of work include food, agriculture, health, environment, global public goods, science and technology, external assistance and partnerships.

A micro-philanthropist, she has supported work to empower women in India, launched an award on Best Research on Gender at the International Agricultural Economics Association and supports work on Food Security at the M.S. Swaminathan Research Foundation.

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