Agriculture, Farming, Food, Nutrition and Technology: 
From the “green revolution” to the “Ever Green Revolution”: The Case of India

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Summary

This paper discusses, using the example of India, agriculture (policies, strategies, structure), farming (actual production of crops in farms), food, nutrition (or malnutrition) and the role of technology as India may move to an “Evergreen Revolution” (Swaminathan, 2004). The selection of India is purposeful. It is a hotbed of new concepts and minor revolutions in agriculture and farming and almost represents a majority of economically developing countries in their progress towards food and nutritional security and reducing poverty.

India is at a crossroads, economically, socially, politically, environmentally and technologically. India’s agricultural production from about 50 million tonnes to now 250 million tonnes has shown spectacular growth in the last 50 years. The country was considered a basket case in agricultural production in 1950s with very little expectations of rapid growth and was a major importer of food grains. It is a net exporter today. India now has overflowing granaries.

There has been a call in India that it needs to move from the “Green Revolution”, which brought huge production increase in Indian agriculture but also large economic and social inequities and environmental damage, to the “Evergreen” revolution, where productivity must increase, but in ways which are “environmentally safe, economically viable and socially sustainable”.

Indian farming is largely small holder based with not only small land holdings but also livestock holdings. A large part of India’s rural population, more than 60 per cent of the rural population, is “landless” or with very marginal holding of less than a hectare and yet considered “farming”. For an “Evergreen revolution” in India intensified sustainability of the small “farm” is the key. How to do this? The approach can be to usher in area specific production. This would entail reintroducing pre-green revolution farming systems, which were in no way less “productive” then those developed in the “Green revolution. These farming systems were based on mixed farming growing cereals, pulses, vegetables, fruits, fodder, livestock and trees on the same farm.

Albeit, the return to pre-green revolution farming systems will be with enhancements brought about by new technologies for intensified sustainability through improved seed and animal varieties of local origins, precision agriculture at micro-levels using new irrigation methods linked to soil humidity and nutrition monitors for precise application of water and nutrients, integrated pest management, use of locally produced manures, biofertilizers and biopesticides etc. Virtual aggregation, using new ICTs, of small plots and farms at village and village cluster levels would enable better management of the farms to meet local food needs, farm inputs and of marketable surpluses.

The contours of this rebuilding of farming systems will be based on social research of the needs of small holder farmers especially in empowering them politically, socially and technologically. The technological empowerment includes the study of socio-economics of the new technologies of biotechnology, nanotechnology, ICT, space and materials sciences that are developed to meet the needs of smallholder farmer. But, more important, it will be important to understand how development and technology, with all its facets and components, work side by side. And within this context, this would need entire communities, especially agricultural, to be included in decision making through participation. It would be also important to redirect research for agriculture so that its purpose is to provide the innovations needed by small holder farmers as a direct product and not as a spillover or trickle down.
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Introduction

This paper discusses, using the example of India, agriculture (policies, strategies, structure), farming (actual production of crops in farms), food, nutrition (or malnutrition) and the role of technology as India may move to an “Evergreen Revolution” (Swaminathan, 2004). The selection of India is purposeful. It is a hot bed of new concepts and minor revolutions in agriculture and farming and almost represents a majority of economically developing countries in their progress towards food and nutritional security and reducing poverty.

India is at a crossroads, economically, socially, politically, environmentally and technologically. India’s agricultural production from about 50 million tonnes to now 250 million tonnes has shown spectacular growth in the last 50 years. The country was considered a basket case in agricultural production in 1950s with very little expectations of rapid growth and was a major importer of food grains. It is a net exporter today. India now has overflowing granaries

There has been a call in India that it needs to move from the “Green Revolution”, which brought huge production increase in Indian agriculture, to the ”Evergreen” revolution, where productivity must increase, but in ways which are “environmentally safe, economically viable and socially sustainable”. The term ‘Green Revolution’ was coined in 1968 to indicate revolutionary improvements in crop yield in several Asian countries. Many of these improvements, has evidenced in India, came at the cost of adverse social and environmental effects in areas subjected to intensive farming. The argument then was that where population pressure is high, there is no option except to produce more food. Yet India, in spite of being an exporter of food grains and with overflowing granaries is home to the largest national population of the hungry and malnourished. Interestingly, India, especially in the cities and towns, after the “Green Revolution”, also has an epidemic of metabolic diseases, especially Type 2 Diabetes.

Agriculture as an economic sector

Agriculture was the mainstay of India’s economy at the time of its independence 65 years ago and its largest economic sector. More than 90 per cent of the population was employed in it then. It is now the third largest sector after service and manufacturing with 55 per cent of the population depending directly or indirectly upon it. About 17 per cent of the national GDP is produced and shared by this population mainly in the rural area indicating its impoverishment and vast income and other inequities.

India, as a country, strives to reach about 4 per cent growth in its agriculture so that its overall annual growth reaches 7-8 per cent overall growth. However, it has managed just above 2 per cent overall annual growth in the last decade though certain parts of the country, e.g. State of Gujarat, have achieved nearly 10 per cent growth per annum for over a decade. The low 2 per cent growth is attributed to inappropriate policies and strategies that have led to a patchy but intensive, irrigation based, cereal producing agriculture, the “Green Revolution”. In this “Green Revolution” agriculture higher yielding seeds, energy, water, fertilizer and other inputs are subsidized. Farmers producing marketable surpluses are price protected through government controlled markets and minimum support prices. This has led to an agriculture, which while producing large quantities of cereal grain, also contributes rapidly growing damage to ecological foundation essential for sustainable farming – land, water, biodiversity, forests and the atmosphere - whose effects are now evident. It has led to the rise of an emerging, exploitative agricultural community that is also politically strong to thwart any reform to current policies related to the agriculture they practice.
In parts of the country with large tracts of dry lands depending on rain fed agriculture and the vagaries of the monsoon as also where infrastructure has been poorly developed, the growth of agriculture has been erratic and weak. In parts of the country with large tracts of dry land where agricultural growth has been high, it is attributed to a combination of water conservation, irrigation and its efficient use, roads, availability of quality (voltage) electricity supply at regular times and fuel, shift to higher value crops and market infrastructure for these crops. This also points to successful policy and strategy shifts by local government.

The spread of food production

Another, albeit, less known facet of India’s growth in food production and resulting in significant surpluses is that it is concentrated around about 40 districts out of a total of more than 540 in the country. These districts mainly in Punjab, Haryana, Western Uttar Pradesh, Rajasthan and the Kaveri Delta of Tamil Nadu are those that produce a surplus in wheat and rice. The rest of the country’s food needs, in varying amounts, are satisfied by these surpluses largely through a public distribution system managed by the Government. The agricultural elite in the surplus states, who benefit from the subsidized “Green Revolution” model, have significant political clout to subvert policies and strategies that affect their dominant positions of practicing a protected agriculture.

India also has to cope with very rapid urbanization with towns and cities growing at around 2.4 per cent fueled by rural migration as also growth in urban populations. This urban population of more than 350 million also needs to be fed. Food chains supplying urban needs have proved to be inefficient and wasteful due to infrastructural weaknesses. It is leading to high economic inflation and rise in food prices contributing to hunger in the urban poor. However, because of the political strengths of those who benefit from the current agricultural, food and trade policies, transforming food chains has been difficult.

The characteristics of Indian farming

Indian farming is largely small holder based with not only small land holdings but also livestock holdings. A large part of India’s rural population, more than 60 per cent of the rural population, is “landless” or with very marginal holding of less than a hectare and yet considered “farming”. This population of “landless and marginal farmers” also have farm and non-farm occupations that supplement incomes and also barter labor for farming and other resources which includes food, fuel and feed and fodder for their livestock.

Dryland agriculture is practiced on almost two thirds of all arable land in India. Dryland agriculture also supports 40 per cent of India’s population. Dryland agriculture compared to irrigated agriculture in India is technologically backward and little, despite of policy pronouncements, is done to improve it. In parts of the country, the example of Kutch region in Gujarat, where dryland agriculture has been invested upon, both technologically such as in drip irrigation and infrastructure wise, in roads and electricity, there has been spectacular agricultural growth. But this has also led to inequities and has not dented poverty, household food and nutritional insecurity significantly in agricultural communities as seen till recently in Gujarat. As in irrigated agriculture, where larger farmers with resources benefitted from use of new technologies (which as evidenced retrospectively was neither scale or socially neutral leading to major inequities) in dryland agriculture also, larger farmers with access to other resources in addition to technology have benefitted from these investments.

Agriculture and Agribusiness

It is interesting to note that policy makers and planners have only recently woken up to consider a shift from ‘agriculture’ to ‘agribusiness’ and to the view that it is an essential pathway to revitalize Indian agriculture. While the share of pure agriculture in GDP is on decline, the share of agribusiness is not and it is going up with the demand for value addition continuously increasing. The redefinition of India’s agriculture to agribusiness now needs to be urgently done and considered in its entirety as an economic sector. This will provide the necessary structure agribusiness needs to bring institutional,
structural and organizational change urgently needed to reduce endemic inflation, underemployment and unemployment in rural and urban areas. Agribusiness (including agro-industries) in India needs to stabilize as contributing about 40 per cent to India’s GDP as soon as possible.

The generation, adoption and adaptation of technology

India, as a whole, may not be considered culturally as being “technology” centered, in the way the Western world is. India may be considered more “organic” depending on holistic beliefs of harmony between all elements of the environment and life in which “technology” as understood by the Western world is only a part of the bigger picture for development. This may appear to many as a barrier to rapid “technology” based progress. However in recent years, the adoption of new information and communications technologies and those for personal transport have indicated that when making technological choices, Indians, even poor and in rural areas are judicious and quick to adopt, innovate and adapt those they find useful.

Employment outside the Agriculture sector

Employment opportunities outside agriculture for these farmers in manufacturing and the service sector, in spite of a more than 6 per cent national GDP growth rate per annum have not kept pace with the rate of displacement from this agriculture. Even the migration from agriculturally poor to agriculturally richer areas and in urban centers as “unskilled” laborers keeps them poor. Government schemes to create employment in rural offer, largely in public works, only minimal employment between 60-100 days with marginal pay. Massive programs of food subsidies at huge costs to the government exchequer such as those under the “Right to Food” have to be resorted to just to provide basic food security to the poor. These farmers are trapped in poverty for the next 30-50 years or at least two generations if their farming does not undergo a rapid transformation.

The constraints in moving towards an “Evergreen revolution”

Thus, the landscape for an “Evergreen Revolution”, in contrast of the “Green Revolution”, in India is bound by a massive proportion of “landless and marginal farmers” who are not only resource poor but politically weak. They still depend on the monsoon. They also form the large population of the hungry and poorly nourished and without regular and stable livelihoods. Their farming is, in reality, not supported by the government except in periodic, politically driven episodes of small bank loans being waived or written off. With climate change, loss of land, degradation of soils, reduced access to water, loss of biodiversity and inability to participate equitably in markets, the landscape of these resource poor smallholder farmers becomes even more complex. Land reform and consolidation is not an easy option politically in a democratic India and thus Indian agriculture, at least for the foreseeable future, has to continue with smallholder farming.

The challenge of transforming smallholder farming

It is imperative for India to now transform its agriculture at the policy, strategy and institutional level and the farming practices of the resource poor smallholders who form a majority of farmers, so that it will satisfy the urgent needs of millions of the poor, which includes these farmers also, for nutritious food and an improved quality of life. So what are the options to transform smallholder farming in India? And, what role will technology play in it? And for technology, how will it be implemented so that earlier errors that lead to political, economic and social inequities and environmental damage are not repeated.

The challenges for the smallholder farmer, within the constraints, they face are how to:

- Gain political and social empowerment to demand from stakeholders of their development, those in charge of the political, economic and social systems of India, to satisfy their (the smallholder farmers) needs for development and improvement in quality of their lives
• Contribute to producing enough quality food to remove hunger and malnourishment in both rural and urban areas at community and household levels in a sustainable way especially in natural resource
• Practice livelihoods that result in improving the quality of life of rural populations in terms of health care, education, shelter, sanitation, communication, energy access etc.
• Contribute to reducing and reversing environmental degradation, adapt and mitigate the effects of climate change and conserve agricultural biodiversity
• Participate effectively in competitive markets; local and then national and international

Empowerment of the Smallholder farmer

A key predisposing element to overcome these challenges is the political and social empowerment of the resource poor small holder farmers so that they can bring about institutional, structural, organizational and technological transformation they need for their farming and in turn reap economic benefits. Since the larger economic trend in India presently is towards a market based economy, it is a fair assumption that small holder systems will have to fit in this economy and collectively be economically empowered. The emphasis is on simultaneous aggregation of the political, economic and social power of the smallholder farmer as a force for transformation of India’s agriculture.

The technologies that can contribute to aggregation that leads to empowerment include those that bring improved governance, democratic institutions, fair, just and timely redressal and justice systems, roads with efficient and less costly transport, general literacy and education, access to financial services with banking, insurance etc. ICT tools can reduce asymmetry of information that defines the inequities that constraint these farmers and can also, such as through use of social media, communicate information to aggregate and empower them. There has been evidence of the use of new ICTs to empower urban populations. In India, as the use of new ICTs, especially cellular telephony and “Smart” phones, already with more than 70 per cent of the population grows, the chances of rapid reduction in inequity and increase in empowerment grows.

Producing quality food sustainably

The current agricultural system in India forces large amounts of food grain to be stored, transported and distributed at long distances from where it has been produced. With inadequate infrastructure, bottlenecks in storage and transport and lack of transparency in distribution this system is increasingly being found wasteful and corrupt as also contributing to endemic hunger and malnutrition. An alternative is area specific production to satisfy specific consumption preferences. India is a very large country with many diverse communities each with their food preferences. This would entail reintroducing pre-green revolution farming systems, which were in no way less “productive” then those developed in the ‘Green revolution. These farming systems were based on mixed farming growing cereals, pulses, vegetables, fruits, fodder, livestock and trees on the same farm. Albeit, the return to pre-green revolution farming systems will be with enhancements brought about by new technologies for intensified sustainability through improved seed and animal varieties of local origins, precision agriculture at micro-levels using new irrigation methods linked to soil humidity and nutrition monitors for precise application of water and nutrients, integrated pest management, use of locally produced manures, biofertilizers and biopesticides etc. Virtual aggregation, using new ICTs, of small plots and farms at village and village cluster levels would enable better management of the farms to meet local food needs, farm inputs and of marketable surpluses.

A large number of technologies and processes needed to equitably distribute and sustainably use natural resources such as water and manage soil nutrients already exist and are available in India. Equitable water distribution use at community levels has been established in several parts of India (see the example of Ralegan Siddhi; http://en.wikipedia.org/wiki/Ralegan_Siddhi). Vermiculture using manure and bio-fertilizers, bio-pesticides and integrated pest management are also available. The problem has been the neglect of the needs of resource poor farmers primarily because of their political weakness which cannot force policy decisions and investments in their favor.
Practice livelihoods to improve quality of life

The practice of livelihoods that improve quality of life of smallholder farmers and their communities require institutional and structural changes in systems that create and enable them to practice these livelihoods as also new infrastructure such as roads, electricity and communication and new capacities. India has witnessed economic growth without it creating commensurate employment which is gainful both within and outside agriculture.

Institutional change has been advocated by some of its leaders such as “Providing Urban Amenities in rural areas” and the roll out of e-governance including the world’s largest unique identification system, Aadhar that is aimed to make access to public services and participation in governance related activities simpler and efficient. Structural changes in the economic sector, for example, enabling agribusiness and non-agricultural employment such as in infrastructure and rural services is needed. This can be achieved by the use of new ICTs that can assist in opening the rural finance including banking, insurance, loans and mortgage, bringing land records and locations to date and available on line and provide knowledge services to farming, agribusiness and rural industries. ICTs can and have started to contribute to education and learning through open and distance education (ODE) at various formal and informal levels including vocational training. India today has one of the world’s largest ODE systems in the world.

Reducing and reversing environmental degradation

More than half of India’s agricultural lands are degraded to a various extent. All major rivers, emerging from the Himalayas and the Ghats are not diminished in their flows but are highly polluted. The groundwater table has fallen alarmingly in many of the districts where intensive agriculture is practiced. There is a rising conflict between water use for agriculture and industry. The abuse of nitrogenous fertilizers, in part contributed by government policies in fertilizer pricing and subsidization, and indiscriminate use of pesticides has cause major problems of pollution in rural areas. Intensification of crop production, especially cereals, has eroded agricultural biodiversity not only of plants but also animals, insects and soil bacteria.

However, there are indications in some part of the country that water conservation with simple, such as check dams and micro-irrigation and more complex technologies including large dams, interconnected river flows, rational use of water, change in cropping patterns etc., can together not only improve farming but also reduce and reverse environmental degradation such as through reclaiming soils. New technologies that can contribute to reduce environmental damage in farming can be with low cost water/humidity and soil nutrient networked sensors linked to water conserving micro-irrigation that will also reduce fertilizer and pesticide use, better forecasting of weather and the monsoon, planning using more precise and accurate geo-spatial data at different levels and geographic parcels. Biotechnology, nanotechnology and new materials such as water retaining and slow releasing polymers can also contribute. Even a simple, Light Emitting Diode (LED) battery operated torches, which enables doing farm operations such as watering at night when quality electricity is made available in India rural areas, and cell phone controlled remote pumps are reported to contribute significantly to water, energy and maintenance and repairs savings and improved farming.

Participate effectively in competitive markets

Participating effectively in competitive markets forms a major and complex challenge for smallholder farmers. There are three major avenues for smallholder participation in markets; through the “supermarket” route, where large corporate organizations intermediate the participation, through farmer aggregation such as cooperatives and “producer companies” and laissez faire, in which individuals farmers individually participate.
For each of the avenues for participating in the markets in an equitable manner, the use of new information and communications technologies (ICTs) including cellular telephony, Internet and use of computing devices as also the radio and television become important. These ICT tools can reduce asymmetry of information that defines the inequities that constrain these farmers especially when participating in markets. They can also, such as through use of social media, communicate information to aggregate and empower them to negotiate collectively in markets. There has been evidence of the use of new ICTs to empower urban populations. In India, as the use of new ICTs, especially cellular telephony and “Smart” phones, already with more than 70 per cent of the population, grows the chances of rapid reduction in inequity and increase in empowerment also increases.

**Research and Innovation in Agriculture**

India has one of the largest systems for agricultural research in the world. However this system has focused predominantly on intensification of cereal production under irrigated conditions. There has been criticism that this research system enabled an exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture.

It will be imperative to rebuild a proper scientific and training base to bring about the shift and sustain the “Evergreen Revolution”. The contours of this rebuilding will be based on social research of the needs of small holder farmers and that includes the study of socio-economics of the new technologies of biotechnology, nanotechnology, ICT, space and materials sciences that are developed to meet the needs of smallholder farmer. But, more important, it will be important to understand how development and technology, with all its facets and components, work side by side. And within this context, this would need entire communities, especially agricultural, to be included in decision making through participation. It would be also important to redirect research for agriculture so that its purpose is to provide the innovations needed by small holder farmers as a direct product and not as a spillover or trickle down. The research system would also need to recognize that there is no single “silver bullet” technology that can solve India’s agricultural problems and more of small holder farmers. The system has to recognize that a large number of technologies influencing each other and working together and in tandem contribute to agricultural development and all these need to be brought about appropriately.

The Roadmap to transform agricultural research systems globally (GFAR, 2010) indicates how this transformation can be done. According to the Roadmap a well-functioning AR4D system is one that is committed to action for impact and that:

1. Inclusively defines key AR4D priorities and actions, driven by evolving national, regional and global development needs
2. Invests in ensuring equitable partnership and accountability among all stakeholders in agricultural innovation and developmental change
3. Actively achieves increased investments in human, institutional and financial resources for AR4D systems to meet demands in development;
4. Develops required human and institutional capacities for generation, access and effective use of agricultural knowledge in development;
5. Effectively coordinates linkages relating innovation to development programmes and policies;
6. Demonstrates its value and gains recognition by society through involvement of stakeholders in effective demonstration and reporting of outcomes.

**Conclusion**
In discussing the future of agriculture, using India as an example, where the shift from the “Green Revolution” to the “Evergreen Revolution”, it becomes imperative, based on previous experience of change in Indian agriculture to empower the resource poor smallholder and marginal farmers to be able to negotiate with stakeholders to their development their needs for political, social, economic and technological development. It would be essential that they participate in all decision making. The technologies they need will not therefore be limited to those related to agriculture alone but also to politically, socially and economically aggregate and collectively decide. Those who will generate, enable adoption and, if need be, adaptation and innovation, will need to understand how development works along with how technology works and adapt each other for success.

References

