Can science and technology feed the world in 2025?

M.S. Swaminathan

M.S. Swaminathan Research Foundation, Taramani Institutional Area, Chennai 600113, Tamil Nadu, India

Received 14 December 2006; accepted 27 February 2007

Abstract

By 2025 the global population will exceed 7 billion. In the interim per capita availability of arable land and irrigation water will go down from year to year while biotic and abiotic stresses expand. Food security, best defined as economic, physical and social access to a balanced diet and safe drinking water will be threatened, with a holistic approach to nutritional and non-nutritional factors needed to achieve success in the eradication of hunger. Science and technology can play a very important role in stimulating and sustaining an Evergreen Revolution leading to long-term increases in productivity without associated ecological harm.

Keywords: Green revolution; Evergreen Revolution; Village knowledge centers; Sustainable solutions; Rural–urban parity index

1. Introduction

A combination of improved genetic cultivars, appropriate agronomic and fertilizer practices, irrigation facilities and assured and remunerative marketing opportunities led to the birth of the green revolution in many parts of Asia. The green revolution, defined as a commodity-centered increase in productivity, achieved by changes in plant architecture, improved harvest index and photoperiod insensitivity, resulted in the growth rate in food production exceeding the growth rate in population. Recent deceleration in food production growth rates due to a combination of adverse meteorological, ecological and marketing factors (sometimes referred to as the “fatigue of the green revolution”) poses a fresh challenge; to reverse this decline and ensure that there is adequate food for the growing population.

Food security has three dimensions, namely: (1) endemic hunger caused by poverty-induced under- and malnutrition; (2) hidden hunger caused by the deficiency of micronutrients like iron, iodine, zinc and vitamin A in the diet; and (3) transient hunger caused by natural calamities or civilian conflicts. Real food security, however, must not only increase the availability of needed food grains in the market, but also economic, social and physical access to a balanced diet, clean drinking water, environmental hygiene and primary healthcare. The United Nations Millennium Development Goal is to bring down the number of children, women and men going to bed hungry from 850 million to about 425 million by 2015. A review conducted in 2005 to assess progress made during the first 5 years of this millennium suggests that even this modest goal is not being achieved.

By 2025, the world population is likely to exceed 7 billion with about 2 billion tonnes of food grains needed to meet the needs of this population. Achieving this level of production is not likely to be too difficult since there is a large untapped production reservoir available in countries like India, even with technologies currently on the shelf. If these technologies can be transferred to farmers’ fields through appropriate packages of services and public policies, the food needs in physical terms can be met. However, even today the food security challenge is not just increasing production but providing jobs or livelihoods which can lead to economic access to food, and in achieving needed production increases without further environmental pollution. In general, where there is work, there is money and where there is money there is food. Therefore, it becomes important to look at agriculture not only as a food-producing machine, but also as an important source of livelihood generation both in the farm and non-farm sectors.

The persistence of widespread under- and malnutrition in many developing countries arises from policies which fail to recognize that the farming population, including landless agricultural labor, constitutes the majority of consumers. Unfortunately, the term, “consumer” seems to cover only the urban population in the minds of the policy makers. Enhancing small farm productivity and profitability will make a major contribution to reducing hunger and poverty. This in turn will...
depend on the ability to assure remunerative prices for farm produce.

In industrialized countries, farmers constitute 2–4% of the population. The per capita income of farmers is high both because of the size of the farm and the extensive support extended by governments. These farmers are technology, capital and subsidy rich. Public policies concurrently promote conservation, cultivation, consumption and commerce. Extensive support is given to promote conservation farming. The collapse of the Doha round of negotiations in agriculture is an indication that farming cannot survive in industrialized countries without substantial support from public funds to ensure its economic viability.

What then is the future for farmers and farming in developing countries? The following four areas need urgent and integrated attention: technology, training, techno-structure, and trade. Upgrading of technology, ecology and management of small farms is the need of the hour.

2. Technology

Technologies that will enhance land, water and labor productivity and that will allow an increase in long-term productivity without associated ecological harm are urgently needed (Table 1). The smaller the farm, the greater is the need for marketable surplus in order to generate cash income. A small farm can lend itself to higher productivity and profitability, provided the farmer is enabled to overcome handicaps arising from lack of capital and credit, and access to appropriate technologies, inputs and remunerative markets. The Green Revolution must be extended to the small farm and confer the power and economies of scale on small producers, both in the production and post-harvest phases of farming. Without this mounting debts will continue to affect them. Cooperative farming, service cooperatives, stakeholder companies, formation of compact production and processing estates by self-help groups and farmer-centric contract farming can all contribute to improvement in the economics of small holdings and thereby foster improved management.

At the production end, there is need for integrating more frontier technologies including biotechnology, information and communication technologies, and renewable energy technologies. New agricultural technologies like genomics and information technology, together with improved agronomic management, should form the cornerstone of increased agricultural productivity and profitability of small farms both in irrigated and rain-fed areas, as well as in problem soils and coastal areas. Recombinant DNA technology has already resulted in the breeding of crop varieties possessing tolerance to salinity and drought as well as to serious biotic stresses caused by the triple alliance of pests, pathogens and weeds. We must also emphasize their use in the development of more nutrient efficient varieties. It is however essential for each country to have a professionally- and socially-credible National Biotechnology Regulatory Authority. The bottom line for any biotechnology policy should be the safety of the environment, the well being of farming families, the ecological and economic sustainability of farming systems, the health and nutritional security of consumers, the safeguarding of home and external trade, and the biosecurity of the nation. Biotechnology does not imply only genetically modified organisms (GMOs). Non-GMO applications are many, such as tissue culture to multiply elite germplasm, bio-fertilizers, bio-pesticides and bio-remediation of groundwater, as well as marker-assisted breeding. In the case of GMOs, safe and responsible use should be ensured. Organic farming procedures permit the use of varieties developed by marker-assisted breeding.

Bio-energy based on pyrolysis and gasification of biomass can be a decentralized source of energy. Bio-fuels also offer scope wherever ecological and economic conditions are favorable. Biomass is an under-utilized resource. “Bio-parks” can be promoted in every block to convert the available biomass into a range of products, including energy and manure.

Conservation farming and green agriculture are the pathways to an ‘Evergreen Revolution’, defined as increasing productivity in perpetuity without associated ecological harm. The greatest problem with applying conservation agricultural concepts in dryland areas is the lack of adequate quantities of crop residues. The removal of crop residues for alternative uses accelerates the already fast decline of soil organic matter content in dryland farming. Long-term sustainability of dryland soils may be significantly enhanced by reduced tillage that leaves more crop residues on the soil surface. ‘Green’ agriculture involves the development and adoption of environmentally friendly technologies like integrated nutrient supply and integrated pest management.

Besides enhancing soil fertility and soil organic matter, the need for the economic and efficient use of water cannot be over-emphasized. The average yield of cereals can be increased by 30–60% annually in dryland farming areas by increasing crop

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic agriculture</td>
<td>Cultivation without any use of chemical inputs like mineral fertilizers and chemical pesticides</td>
</tr>
<tr>
<td>Green agriculture</td>
<td>Cultivation with the help of integrated pest management, integrated nutrient supply and integrated natural resource management systems</td>
</tr>
<tr>
<td>Eco-agriculture</td>
<td>Based on conservation of soil, water and biodiversity and the application of traditional knowledge and ecological prudence</td>
</tr>
<tr>
<td>Effective microorganism agriculture</td>
<td>System of farming using effective microorganisms</td>
</tr>
<tr>
<td>White agriculture</td>
<td>System of agriculture based on substantial use of microorganisms, particularly fungi</td>
</tr>
<tr>
<td>One-straw revolution</td>
<td>System of natural farming without ploughing, chemical fertilizers, chemical pesticides and herbicides</td>
</tr>
</tbody>
</table>
water use by 25–35 mm. This can be readily achieved by conservation agriculture. High input costs, uncertain rainfall and poor incomes lead to widespread indebtedness. The younger generation will be reluctant to take up farming as long as income prospects are poor. Declining terms of trade between farm and non-farm sectors is a matter of concern.

It is against this context that we have to examine the opportunities opened up by new agricultural technologies. Local Knowledge Centers (LKC), based on the integrated application of the Internet, community radio and mobile phone, will help to bridge the growing gap between scientific knowledge and its field application. It will also have the advantage of removing many intermediaries from the marketing chain.

Wholesale fruit and vegetable markets are likely to lose their importance under the growing influence of contract farming and direct supply relationships between producers and major market chains. Changes in intermediary relationship will occur as Internet-based marketing tools are adopted by both producers and suppliers. Knowledge connectivity is vital in addition to physical connectivity through roads. LKC can bring about a transformation in the economic conditions and social relations in our farming communities. Bridging the digital divide is also a powerful method in bridging the gender divide, since rural women master Internet and computer technologies with ease. The connectivity of the last mile and last person will be through FM/community radio and/or mobile phones. The Internet–radio–mobile phone synergy is a very powerful tool for social inclusion to access necessary information, including warnings of impending natural disasters. Small communities give priority to health and marketing information. In addition, an ‘entitlements database’ can empower them with information on all the government schemes designed for their well being. Gender-specific information is required.

The third technological revolution relevant to agriculture is the eco-technology movement. This involves an appropriate balance between frontier sciences and the ecological prudence of farming communities. The eco-technology revolution underpinning the Evergreen Revolution movement has many pathways as indicated in Table 1.

For most small farmers, green agriculture will be the most feasible form of eco-agriculture. Crop–livestock integrated systems of production will be ideal for organic farming. More research is needed on nitrogen-fixing tree species and shrubs, as well as green manure plants. Our soils are hungry and thirsty and they need both nutrients and water. In addition to biotechnology, Internet and computer technology and eco-technology, there are opportunities in simple geographic information systems (GIS)- and geographic positioning systems (GPS)-based precision farming. The training of ‘farm science managers’ (at least one woman and one man in every community) will be critical to a rebirth in rural agriculture, which capitalizes on both traditional wisdom and frontier science and technology. Also, like the Silicon Valley, ‘Bio-valleys’ could be organized in mega-biodiversity areas to enable the local population to convert biodiversity into bio-wealth. We can then end the irony of the co-existence of the prosperity of nature and the poverty of people. Organic farming also requires support from strategic research in the areas of nutrition for high yields and pest management. An area of technology of great importance to the survival of small-scale agriculture is proactive advice on land use, based on anticipated meteorological and marketing conditions. A ‘Land Use Advisory Service’, using the latest meteorological and computational tools is badly needed. We cannot abandon farm families with small holdings to their fate in a globalized economy without adequate support services based on the best in modern science. A Market Intelligence Service should be established that can monitor crop trends in the country and advise farmers what to plant in the coming season, so as to prevent gluts and price crashes. This can be disseminated through the LKCs.

3. Training

How can such a technological, ecological and managerial upgrading of small farm agriculture be brought about? This is where training, re-training, re-tooling and redeployment of both farmers and farm graduates become important. India already has 47 Agricultural and Animal Husbandry (including Fisheries) Universities with nearly 13,000 agricultural graduates and 7000 postgraduates, becoming available each year. Additionally, there is a vast chain of National Research Institutes and Centers, National Bureaus and All-India Coordinated Projects under the Indian Council of Agricultural Research. In many developing countries there are also a growing number of research and development institutes in the private sector and a number of civil society organizations working on agricultural issues. More should be done to make this a work force for on-farm improvement.

Training of farm and home science graduates also needs revamping. The major mission of agricultural, veterinary, fisheries, rural and women’s universities should be to help every scholar become an entrepreneur. Service cooperatives by farm and home science graduates can help to speedily upgrade the efficiency and economic viability of small farms, since they can facilitate productive decentralized production initiatives supported by centralized services. Cooperatives should be organized on a stakeholder rather than on a shareholder principle. A reorientation in the mindset of farm graduates can be brought about only by innovative changes in curricula and courses. In all applied areas, business and financial management should be added to disciplinary training. For example, a course in Seed Technology can be restructured and designated as “Seed Technology and Business”. Similarly, nutrition courses could be reorganized as “Food Safety and Nutrition Security” programs. Courses in Agronomy could be developed into “Agronomy and Agribusiness Programs”. If the business, financial and trade aspects are integrated with disciplinary training, such courses will give the farm/home science graduates the self-confidence essential to embark on a career of self-employment. A large number of graduates are now being trained in the field of biotechnology. However, many of them are not able to utilize their training after completing their
degrees due to lack of appropriate employment opportunities. Agricultural biotechnology is an area where there are considerable opportunities for remunerative self-employment. It would therefore be appropriate that support is extended to the creation of an Association of Genome Entrepreneurs who could be supported with venture capital funds in order to enable them to convert the rich knowledge available in government institutions in the field of functional genomics into commercially viable products. They could also undertake work in the preparation of genome maps of the crops of interest to developing countries. Mainstreaming entrepreneurship and business skills in all applied courses, rather than keeping business management courses separate, is essential if small farm agriculture is to become economically sustainable and educated youth are to be attracted to take to a career in agriculture. Another urgent need is the establishment of a chain of Institutes for Food Safety and Security. They can be established in appropriate agricultural, veterinary or fisheries universities. Home science graduates can be employed in such Regional Institutes to launch a movement for food safety including awareness of *Codex Alimentarius* standards.

Training of all engaged in agricultural administration in the basic principles and economics of farming is essential. In the United States, practicing farmers often occupy leading positions in Agricultural Departments for specific periods. It would be useful to begin posting active and accomplished farm/fisher women and men in positions of authority in Departments of Agriculture, Horticulture, Animal Husbandry, and Fisheries on a 5-year tenure basis. Unless there is an upgrading in the practical knowledge of those responsible for developing agricultural programs and policies, there is no hope for developing-country agriculture in a globalized economy.

### 4. Techno-infrastructure

Post-harvest infrastructure in most developing countries is extremely weak. Until that is attended to farmers will not be able to get an adequate return for their labor. Similarly facilities for food safety, water quality, sanitary and phytosanitary measures and biosecurity need to be improved.

Facilities for soil testing, particularly the estimation of micronutrient status also need considerable strengthening. Unless more investment is made in strengthening the support services needed by farmers for the scientific improvement of farming, average productivity will continue to remain low and youth will not be attracted to farming. Simple but safe storage bins need to be popularized on a large scale, along with low-cost refrigeration facilities for perishable commodities. A Livestock Feed and Fodder Corporation, a Land Use Advisory Service, an National Trade Organization, Living Heritage Gene Banks to conserve unique local breeds of farm animals, internationally recognized certification agencies for organic farm products, an Agricultural Price Stabilization Fund, integrated insurance products and other essential support services are needed to help increase the productivity and profitability of small farm agriculture. On the one hand, there is need to upgrade the technological, ecological and management aspects of the culture- and capture-fisheries, and on the other hand, the harvesting, conservation, and sustainable use of water and other steps relating to sustainable water security such as rainwater harvesting are required.

### 5. Trade

Producer-oriented markets hold the key to remunerative and sustainable farming. Quality and trade literacy should receive high priority in LKCs. Facilities for farmers’ markets need to be expanded rapidly. In commodities essential for maintaining a public distribution system such as the one in India, the procurement price should be the market price at the time of purchase. Those providing essential commodities for a public distribution system should be recognized through the provision of a card that entitles them to certain benefits while purchasing essential farm inputs, including agricultural implements and machinery.

### 6. Shaping our agricultural future—a three pronged strategy

During the 21st century, most developing countries will remain predominantly agricultural nations, particularly with reference to livelihood opportunities. Therefore, there is need for both vision and action in shaping our agricultural destiny. In many developing countries, particularly in South Asia, the major agricultural strengths are a large population of hard working farm women and men, a varied climatic and soil resource, abundant sunshine throughout the year, reasonable rainfall and water resources, and rich agro-biodiversity. Converting these strengths into jobs and income is the challenge. We should look upon agriculture not only as a food-producing machine for an urban population, but also as the major source of skilled and remunerative employment and global outsourcing hub.

Just as Internet industries in India have specialized in efficiently handling outsourcing assignments in areas where there is a comparative advantage, developing nations must enable their farm graduates and farmers to take up outsourced jobs. Some examples are hybrid seed production, tissue culture propagated plants, organic farm products, biological software for sustainable agriculture like biopesticides, biofertilizers, pheremones as well as herbal products, fruits, flowers and vegetables, vaccines and sero-diagnostics and veterinary pharmaceuticals based on medicinal plants. For India, there is also scope to become a global outsourcing hub in the areas of plant and animal genomics and Internet and computing technology for rural poor. Agricultural, veterinary, fisheries and home science graduates should be trained to become genome and digital entrepreneurs. To start with, a few of the Agricultural, Animal Sciences and Fisheries Universities could set up bureaus for outsourcing business in agriculture to facilitate contacts between farmers’ organizations as well as agribusiness centers operated by farm and home science graduates and external agribusiness enterprises. Outsourcing should not only be from other countries to urban India, but also
from urban to rural India, so that educated youth can continue to live in villages.

We need a new vision for agriculture. That vision should aim to spread happiness between farm and rural families. Bio-happiness through the conversion of bio-resources into wealth meaningful to rural families should be the goal of national policy makers. The hidden and unrecognized opportunities for creating more skilled jobs and income in the farm and non-farm sectors need to be tapped through appropriate public policies and programs. Technology missions should be revamped and revitalized to help South Asian nations leapfrog others in the production of essential commodities like oilseeds and pulses.

A structurally progressive economy should reduce the share of people dependent on a sector as the share of that sector falls in gross domestic product (GDP). As the share of agriculture in the GDP falls, the share of people dependent on agriculture is also expected to fall in the same proportion. However, in the Indian economy, though the share of agriculture in the GDP is falling steadily, there is no corresponding decline in the share of population dependent on agriculture. Because of population growth, the absolute number of people depending on agriculture is increasing, even if there is a decline in percentage terms. A major integrated rural non-farm livelihood initiative, should be promoted so that both on-farm and non-farm livelihoods become skilled and profitable.

Using India as an example, the strategy for an Evergreen Revolution should have the following three components.

6.1. Defending the gains

In India, the farmers in the state of Punjab provide 60% of the wheat and 40% of the rice to the Public Distribution System (PDS) and national buffer stocks. In the Punjab net productivity has increased in rice and wheat from 1.2 and 1.1 tonnes/ha to 4.3 and 3.9 tonnes/ha, respectively, from 1960–1961 to 2004–2005. However, in recent years there has been a reduction in productivity improvement for a variety of reasons of which the following are important: (1) a decrease in farm size and income; (2) a depletion of the natural resources base, for example, there has been a steep decrease in the groundwater table and reduced water quality; (3) an increase in input costs, particularly diesel; (4) deficiencies in micronutrients in the soil and a deterioration in soil health; (5) inadequate post-harvest technology; (6) uncertain market prospects, except for the agricultural commodities listed in Table 2 that are supported by the Minimum Support Program (MSP); and (7) the high indebtedness of farmers.

Similar conditions prevail in the Indian states of Haryana and western Uttar Pradesh. Thus, the heartland of the green revolution in India is in grave trouble. These areas need conservation farming which will help farm families to conserve and improve soil health, water quantity and quality and biodiversity. Some of the eco-technologies developed by the Punjab Agricultural University in Ludhiana, India, are: the sowing of wheat on beds thereby saving 20–25% water; the use of a leaf color chart to advise when nitrogen fertilizer is required thereby saving 15% on the amount of nitrogen applied to rice; tensiometer-based irrigation scheduling; zero tillage technology for wheat; and integrated pest management in cotton saving 40% on the use of pesticides. Thus, there is vast scope both to promote ‘Green Agriculture’ and to reduce the cost of production through enhanced factor productivity. A course on sustainability should be introduced in all agricultural universities in the developing world. India will not be able to maintain a stable food security system, if the “fertile crescent” (i.e. Punjab, Haryana and western Uttar Pradesh) region is not saved through adequate support for conservation farming. Defending the gains already made in this region is an urgent task.

An example of the need for support for conservation farming is provided by the situation in rice cultivation in the Punjab. At present, nearly 2.6 million ha are under rice in the Punjab. Much of the irrigation water used is groundwater and the water table in the districts of the state that produce 70% of the rice and have 70% of the tubewells is receding at an alarming rate of 0.7–0.8 m annually. At present about 30% of the tubewells use submersible pumps and it is estimated that during the next 10 years practically all the centrifugal pumps will have to be converted to submersible pumps. It would therefore be advisable to restrict rice cultivation to 2 million ha in the Punjab with a yield target of 5 tonnes/ha. The remaining area can then be planted to maize, pulses and oilseeds that are currently in short supply. Conservation farming in intensive agriculture will involve a scientific program of restructuring farming systems.

Eternal vigilance is the price of a stable agriculture. The establishment of a science-based biosecurity system is a requirement to ensure that countries are safe from invasive alien species that can cause potential harm to crop and animal husbandry, fisheries and forestry. The wheat crop for example,
now faces threats from new strains of rusts like the 7RS84 (similar to Yr 27 virulence) race of yellow rust and the Ug 99 strain of stem rust. The steps taken to defend the gains already made should therefore include pest surveillance and management and gene deployment for checking the spread of pathogens. This is equally important in the case of poultry and animal enterprises.

Agricultural “bright spots” and “hot spots” need to be identified and mapped. Then a strategy should be developed for enlarging the area over which these advances could be promulgated. Similarly, a ‘Good Weather Code’ is required to maximize the benefits of adequate moisture availability, a ‘Drought Code’ to minimize the adverse impact of drought, and a ‘Flood Code’ to prevent excessive distress and damage, and to promote a post-flood production plan. In the desert areas of Rajasthan, India, the ‘Good Weather Code’ should include provision for raising nurseries of appropriate plants, so that in years of excessive rainfall, an extensive tree planting and sand dune stabilization drive can be launched. This will help to strengthen the ecological infrastructure of the desert, and gradually convert the desert into an oasis. The ‘Drought Code’ should include the adoption of crop life-saving technologies and contingency plans to change the cropping pattern according to moisture availability. “Be prepared” to both take advantage of good rains and to reduce the impact of adverse seasons—is a worthy motto for farmers.

Rice production can be enhanced considerably by giving attention to balanced fertilization, particularly to the supply of the needed micronutrients like zinc, boron and sulfur. Together with plant protection, the enhancement of soil health will help to improve productivity by at least 1 tonnes/ha. There are nearly 5 million ha of rice in India and improved varieties are available for all areas where rice is cultivated between November and May. Striking progress in improving the yield of rain-fed maize, soybean, sorghum, green gram, black gram, pigeon pea, chickpea, finger millet, pearl millet and castor (see Table 2 for botanical names) can be achieved through balanced fertilization (NPK and micronutrients). Seeds of improved varieties should be maintained in ‘Village Seed Banks’ in rain-fed areas, so that alternative cropping strategies can be introduced depending upon the rainfall pattern and amount. Improved cultivars alone can enhance productivity by 10–50%. Cultivar choice should be based on the likely moisture availability. The short duration chick pea variety ICCV2 has revolutionized chickpea production in Andhra Pradesh with productivity increased from 0.47 tonnes/ha in 1993 to 1.08 tonnes/ha in 2004, and the area planted has increased 7-fold. There are nearly 12 million ha of rice fallows in eastern India in which chickpea can be grown using residual soil moisture. Simple seed priming technologies (Harris et al., 2005) like soaking seeds in water and micronutrient solution for 6 h and drying in the shade will help in establishing a good chickpea crop in rice fallows. In the Indian state of Madhya Pradesh, 2 million ha remain fallow during the rainy season. Using broad beds and furrows, balanced nutrient management and short duration soybean cultivars in the rainy season, farmers have been able to take a crop of chickpea or wheat during dry season and thereby double their income. Many such simple steps in soil–water–crop management can lead to major advances in both crop output and farmers’ income. This is the pathway to making farming economically viable.

6.2. Extending the gains

Eastern India (eastern Uttar Pradesh, Bihar, Chattisgarh, Orissa, West Bengal, Assam and the northeast States) has a large untapped production reservoir even with the technologies now available. In these areas, poor water management, rather than water availability, is the major constraint. The Indo-Gangetic plains offer scope for becoming the major bread basket of India through an appropriate mix of technologies, services and public policies. In many of these areas, the aquifer should be enriched during the rainy season, and extensive groundwater use should be promoted during the October to April dry season. Given the right strategy, the Ganges River could become the main anchor of India’s food security.

6.3. Making new gains

The immediate prospect for making new gains lies in the areas of post-harvest technology, agro-processing and value adding to primary produce. In the longer term, there is need for new yield and quality breakthroughs in major crops through genomics and gene pyramiding. For example, ‘Super Wheats’ capable of yielding about 8 tonnes/ha are now in the breeders’ assembly line. Such wheats have a complex pedigree and illustrate the importance of genetic resources conservation and exchange (van Ginkel and Ogbonnaya, 2007).

‘Super Wheats’ are semi-dwarf with robust stems, broad leaves, large spikes with a greater number of grains per head and higher grain weights. The ‘Super Wheat’ architecture in the breeders’ assembly line, both at CIMMYT and the All-India Coordinated Wheat Improvement Program, is derived from a blend of Tetrastichon (Yugoslavia), Agrotriticum (Canada), Tetraploid Polonium (Poland) Gigas (Israel), Moroccan wheat (Morocco) and semi-dwarf wheats currently grown in India.

In India, we can produce 100 million tonnes of wheat by 2015 by the following steps: (1) average yield of 4 tonnes/ha from 25 million ha; (2) harnessing the large untapped yield reservoir in eastern, central and western India; and (3) developing a detailed agricultural strategy for the major farming zones and systems based on the three pronged approach outlined above.

It would be useful if a comprehensive Rural-Urban Parity Index is prepared. If the evolution of rural–urban societies is planned carefully, there will be symbiotic linkages between the village and the town, each enriching the other in both economics and employment opportunities. Work, water and energy are the key needs of rural India. India’s Sixth Five-Year Plan (1980–1985) gave overriding priority to these sectors, together with attention to technology, natural resources conservation, women’s empowerment and enhancement, and remunerative marketing. This strategy resulted in an agricultural growth rate of 5.7%, exceeding for the first time, the
overall GDP growth rate of 5.5% during the plan period. Thus, given the right priorities and strategies, progress both in agricultural growth and agrarian prosperity can be achieved.

Additionally, re-designating India’s Ministry of Agriculture as a Ministry of Agriculture and Farmers’ Welfare will lead to positive results only if this is accompanied by structural reorganization. Leading farmers should be inducted at the senior level in the Ministry for specific tasks and specific periods. This will help to change the “beneficiary” mindset in agricultural planning to one of regarding farmers as innovators, policy planners and life-givers.

The final UN Millennium Development Goal refers to global partnerships for achieving the goals. Seemingly impossible tasks can be achieved through mobilizing the power of partnership. Therefore, it is important that agricultural scientists all over the world work together in solving not only present day problems in the area of farming, but also emerging problems particularly with reference to climate change. Partnership between the public and private sectors is important both in the generation of new technologies and their spread, based on the principle of social inclusion. This is where conferences such as the one at which this paper was presented play a significant role in advancing the cause of food for all and for ever.

References