Role of science and technology for agricultural revival in India

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Abstract

Purpose – Several empirical studies have shown that the "servicization" of India's economy has taken place in terms of structural changes in GDP. But the structural changes in terms of employment have been slow, as agriculture is still the mainstay of more than 50 per cent of the total workforce. Though agriculture is still the predominant sector of the economy in terms of employment and livelihood, it is losing its dynamism. The country has been striving to achieve target of 4 per cent growth in agriculture since the 8th Five Year Plan so essential for achieving the objective of "inclusive growth". However, the country is nowhere near the goal even in the penultimate year of 11th Five year Plan. The purpose of this paper is to emphasize the need for application of science and technology in India's agriculture to ensure sustainable development of agriculture with food security and also for tapping the "demographic dividend". The agricultural crisis in India motivated the author to take up this study.

Design/methodology/approach – The present study mainly used secondary sources of data. The analysis of secondary data available in various documents, reports etc. revealed that agriculture in India is indeed passing through crisis. The review of literature revealed that science and technology can play a crucial role in rejuvenation of India's agriculture.

Findings – The paper shows that an integrated application of science and technology with social wisdom can help in checking the most serious form of brain-drain (i.e. migration of youth from rural to urban areas), mitigate the adverse impact of climate change and rejuvenate/revive India's agriculture so very essential for sustainability of India's growth, as has been stressed by Swaminathan.

Originality/value – The paper emphasizes the need for application of science and technology in India's agriculture to ensure sustainable development of agriculture with food security.

Keywords India, Agriculture, Economic development, Servicization, Structural changes, Inclusive growth, Agricultural crisis, Technology fatigue, Food security, Demographic dividend, Climate change, Rejuvenation

Paper type Conceptual paper

I. Introduction

Liberalization, privatization and globalization in July 1991 heralded a golden era of growth for India with services sector playing the major role. The entire economic landscape stands changed now as India has become a service economy .The servicization of India's economy has taken place in terms of changes in the structure of production. The service sector accounts for more than 55 percent of GDP. However, in terms of employment structure India is still an agrarian economy as 55.9 percent of population in 2007-2008 was engaged in agriculture (Government of India (GOI), 2011, p. 238). In addition to employment, agriculture contributes significantly to export earnings and is an important source of raw materials. Analysis of data clearly brings

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out the fact that there is loss of dynamism in agriculture and allied sectors after the mid-1990s. The country has been striving to achieve target of 4 percent growth in agriculture since the Eighth Five-Year Plan so essential for achieving the objective of "inclusive growth." However, we are no where near the goal even in the penultimate year of Eleventh Five-Year Plan. The agrarian crisis and the issues of food security[1] are looming large. Inter-alia, the agricultural crisis in India is attributed to technology fatigue. Though food grains production in India has increased from 51 million tones in 1950-1951 to 218.1 million tones in 2009-2010 yet India is a home to 42 percent of undernourished children in the world as per Global Hunger Index (GHI) prepared by International Food Policy Research Institute (IFPRI). With a GHI score of 24.1 in 2010, India is occupying 67th rank out of 85 countries and facing alarming hunger problem or food situation. In this background, the paper emphasizes on the need for application of science and technology in India's agriculture to ensure sustainable development of agriculture with food security and also for tapping the "demographic dividend." It has been argued that the integrated application of science and technology with social wisdom can also help in checking the most serious form of brain-drain (i.e. migration of youth from rural to urban areas), help in mitigating the adverse impact of climate change and rejuvenate/revive India's agriculture so very essential for sustainability of India's growth (Swaminathan, 2010).

The paper has been organized into four sections. Section II brings out the agrarian crisis of India and highlights the need for application of science and technologies in agriculture sector. Section III focusses on three major revolutions in science and technology, which are expected to influence agricultural technology in a fundamental manner in the new millennium. Section IV highlights the role of information technology (IT) in agriculture and Section V that of students in revitalizing India's agriculture. Final section gives concluding remarks.

II. Agrarian crisis of India[2] and the need for application of science and technology

During the period 1950-1951 to 2003-2004, GDP from agriculture has increased from Rs. 127,062 to Rs. 531,302 crores (both at 1999-2000 prices). However, in percentage terms, the share of agriculture has declined from 57 percent in 1950-1951 to 23.9 percent in 2003-2004 (GOI, 2011). A look into the growth of agricultural GDP reveals that it decelerated from 3.5 percent per year during 1981-1982 and 1996-1997 to only around 2 percent during 1997-1998 and 2004-2005 (GOI, 2008a). Since early 1990s we have been targeting 4 percent or higher growth rate in agriculture. The Eighth Five-Year Plan had set the target of 4.5 percent in agriculture. National Agriculture Policy (2000) and Tenth Five-Year Plan (2002-2007) reiterated the same target. Eleventh Five-Year Plan (2007-2012) again aspires for 4 percent growth in agriculture.

GOI (2008a) clearly shows that there has been deceleration of agricultural growth from over 3.5 percent per annum during 1981-1981 to 1990-1991 to 2.5 percent during the Tenth Plan period. This was experienced in all major sub-sectors of agriculture such as horticulture, livestock and non-horticultural crops, etc., during 1997-1998 to 2004-2005 as is evident from Table I. Therefore, the objective of 4 percent growth remained unattainable in the Nineth and Tenth Plans. Even in the penultimate year of the Eleventh Plan the achievement of this target seems to be a distant dream.

A disquiet feature of agricultural slowdown is slowdown in agriculture credit and in agricultural investment. As per recent estimates, total factor productivity in agriculture has declined (Goldar and Mitra, 2008). The large number of farmers committed suicides in Andhra Pradesh, Karnatka, Kerala, Maharashtra and Punjab. Table II shows that though crude death rate is coming down yet suicide mortality rate is on the rise for the country as a whole. A large number of suicide cases of farmers provide eloquent testimony to the fact that there is deep-rooted crisis faced by agriculture and it appears that there is loss of hope among farmers.

Therefore, there is a need to shift policies from suicide relief to suicide prevention by providing multiple livelihood opportunities like livestock rearing as well as non-farm occupations in such areas as biomass utilization and post-harvest technology (Swaminathan, 2010, pp. 243-5).

It is widely recognized by planners and policy makers that if we want to make growth inclusive, major investments would be needed by both public and private

Table I. Growth rate in output of various sub-sectors of agriculture at 1993-1994 prices

Period	Crop sector	Livestock	Fruits and vegetables	Non-horticultural crops	Cereals
1980-1981 to 1989-1990	2.71	4.84	2.42	2.77	3.15
1990-1991 to 1996-1997	3.22	4.12	5.92	2.59	2.23
1996-1997 to 2004-2005	0.79	3.67	3.28	0.05	0.02

Source: Chand (2008)

Table II. Trends in CDR and SMR in India, 1981-2003

Year	CDR	SMR
1981	12.5	6.0
1982	11.9	6.5
1983	11.9	6.6
1984	12.6	7.0
1985	11.8	7.2
1986	11.1	7.2
1987	10.9	7.6
1988	11.0	8.1
1989	10.3	8.5
1990	9.7	8.9
1991	9.8	9.3
1992	10.1	9.3
1993	9.3	9.6
1994	9.2	9.9
1995	9.0	9.7
1996	9.0	9.5
1997	8.9	10.1
1998	9.0	10.8
1999	8.7	11.2
2000	8.5	10.8
2001	8.4	10.5
2002	8.1	10.5
2003	8.0	10.4
Growth rate	−2.1	2.6

Notes: CDR, crude death rate; SMR, suicide mortality rate
Source: Reddy and Mishra (2008)

sectors in agriculture. That is why, higher budgetary resource allocations have been made in agriculture by public sector since 2003-2004. This gets reflected in a steep increase in gross capital formation on public account (GCFA). The private sector capital formation is almost three times higher than that of public sector. It had started increasing since 1999-2000.Though GCFA has more than doubled when taken as a percentage of agri-GDP during the last two decades yet the GDP growth has not increased substantially. The agricultural economists emphasize on the need for more research to explore the reason for this unexpected result. They say that this might be attributed to fall in efficiency of capital or higher GCF may be on papers and not in reality or there may be long lags between capital formation (on dams, reservoirs, canals) and the realization of returns or it may be attributed to climate change or the problems like that of land degradation or fall in water table (they are so acute that even enhanced investments are not able to take it beyond the 3 percent growth barrier) or it could be a mix of all these factors combined (see Gulati and Ganguly, 2011, pp. 22-3).

Radhakrishna and Chandrasekhar (2008) pointed out that there are twin dimensions of the agricultural crisis – an agricultural development crisis and an agrarian crisis. The main reason of agricultural development crisis is that agriculture was neglected while designing development programs and there was poor implementation of agricultural programs at microlevel. Whereas the agrarian crisis is due to an excessive dependence of rural population on farm incomes which are too meager to withstand weather and price shocks and also vulnerable to technological risks. Further, low growth accompanied by declining productivity and inability of growth to create enough non-farm opportunities to absorb surplus labour in rural areas marks the agrarian crisis (Radhakrishna and Chandrasekhar, 2008, pp. 12-13).

Public expenditure on agricultural research and development (R&D) was low at 0.49 percent of GDP. This is in contrast to average R&D expenditure of 0.7 percent of GDP in developing countries and 2-3 percent in developed countries. Studies point out that there is an urgent need for raising this expenditure, as substantial variations in agro-climate require region-specific and crop-specific technologies, compatible with the endowments of the farm community. It is worrisome that neither any technological innovation is in offing at present nor agricultural extension system working properly in many states (see footnote 2).

There has been sluggish growth of institutional credit. The findings of National Sample Survey organization 59th Round (2003) reveal that, half of the farmers (comprising mainly small and marginal farmers) had no access to institutional finance. About 27 percent of the total number of cultivators' households received credit from formal sources and 22 percent received it from informal sources (Karmarkar, 2011). The informal sources of finance are popular among farmers as inadequacy of formal credit; enormous delays in obtaining credit from scheduled commercial banks and cumbersome documentation have compelled farmers to avail high cost credit from informal sources (Radhakrishna and Chandrasekhar, 2008, p. 13).

Besides, the country is contending with several issues related to agriculture like declining production, productivity and profitability, low credit flow, falling water tables/lack of irrigation facilities, problems of agriculture marketing, collapsing agricultural extension, lack of adequate storage for food grains, degradation of natural resources, climate change and its attendant problem (Karmarkar, 2011).

It is important to point out that though the country became self-sufficient in food grains in 1970s yet the concerns about low per capita food energy, non-fulfillment of basic nutritional requirements of an average Indian, i.e. food security issues are alive today. Around 56 percent of workers are absorbed in agriculture, which is a rural activity. Nearly 27.7 percent billion people live in a state of absolute poverty. About 22 percent of total population was undernourished in India during 2004-2006 and intensity of food deprivation was 15 percent. About 16.1 percent of population was at risk of multi-dimensional poverty during 2000-2008 (UNDP, 2010). A large number of people suffer from deficiencies of micronutrients such as iron and vitamin. Food insecurity and malnutrition lead to serious health problems and a lot of human potential is lost in India. Food security is a critical concern against the backdrop of rapid population growth. The resource poor small and marginal farmers, who contribute substantially to food production, need to be empowered with appropriate technologies to enhance agricultural production, productivity, profitability of small holdings farmers and also to ensure proper market linkages. In all these areas, the technology applications like that of biotechnology, remote sensing, geographical information system (GIS), IT have an important role to play.

The land-holding structure in India is sliding downwards, with progressively greater concentration in the marginal and small-holding groups. Small holding constitute 83.5 percent of total holdings in India. Most small farmers are below poverty line and belong to socially disadvantaged groups. The opportunities offered by globalization and a rising middle class as of now be only availed by farmers who have access to resources. There is a need to enlarge farm holdings, improving productivity of existing crops and for introducing high value crops (Vyas, 2011). The maintenance of electronic records of land ownership and financial inclusion of these small and marginal farmers is very essential. An extensive and imaginative use of information and communication technologies (ICTs) in the maintenance of land records is quite evident from the success of Bhumi in Karnataka. This example needs to be replicated in other states too. Then the financial inclusion[3] of small and marginal farmers and that of disadvantaged and low-income groups in the formal financial system is a must. The Eleventh Plan (GOI, 2008b, p. 260) recognizes the need for introducing suitable policy interventions and technological innovations to maximize the financial inclusion during the plan period. "Looking at from the glasses of technology enablement, the decade 2001-10 saw the most important decade for Indian banking. This is the decade when most of the public sector banks, which account for 85% of the branches and 67% of the ATMs in India (at the end of March 2010) completed their branch automation and went ahead for core banking solutions" (*Dataquest*, December 31, 2010, p. 47). These developments can provide growth impetus in the rural (agricultural) and unorganized sectors.

Since the population pressure is growing in India and average size of a farm holding is going down to below one hectare. Farmers are getting indebted and there is a growing temptation among them to sell prime land for non-farm purposes, as the price of land is exorbitantly high. Over 45 percent of farmers interviewed by the National Sample Survey organization want to quit farming. Under this scenario, there is need for a strategy to persuade educated youth including farm graduates, to stay in villages and to take agriculture as a profession. This is essential for preventing brain-drain and also for tapping demographic dividend The technological and economic up gradation of farm operations, the availability of high yielding varieties resistant to stress factors, dissemination of information through internet, FM radio, e-chaupals, improved infrastructure (physical, social and ICT) and markets, strong extension services will play a very important role in this regard. The young students have to play a very important role by bringing their knowledge to rural men and women. A combination of brain and brawn is the need of the hour. It is these students who can enlarge the service sector in agriculture (Swaminathan, 2010, 2011).

III. Three major revolutions in science and technology

As has been rightly observed by M.S. Swaminathan (2010) that "As we approach the new millennium we are experiencing three major revolutions in science and technology, which will influence agricultural technology in a fundamental manner." These are namely the gene revolution, the information and communication revolution and the ecotechnology revolution[4].

III (a) The gene revolution

There have been rapid advances made during last ten years in understanding of how biological organisms function at molecular level, as well as in our abilities to analyse, understand and manipulate DNA molecules, the biological materials from which the genes are made in all organisms. The Human Genome Project, an initiative of US Department of Energy has provided a big push to this process by providing huge resources for the development of new technologies for working with human genes. The genetically modified crops can help in increasing yield, reduce vulnerability of crops to environmental stresses, increase nutritional qualities, improve taste, text and appearance of food. The same technologies are having their application for all other organisms, including plants. This has given rise to a new discipline of genomics, which has promoted the biotechnology industry. In Europe and USA, many corporations have invested huge funds for adapting these technologies to produce new plant varieties of agricultural importance for large-scale commercial farming. These technologies can be very useful for developing countries for making them food secure.

Genetic engineering can play a crucial role in modification of the genetic compositions of plants, animals and microorganisms. However, like other products, genetically engineered products undergo a period of R&D before they are ready for commercial use.

III (b) The IT revolution

(1) Internet facility provides low-cost access to information and highly interactive distance learning. The researchers can interact among themselves through the internet and can also communicate effectively with the potential users of their research knowledge. It can be an effective tool for the delivery of extension services in rural areas as is evident from the success of projects like Warana Wired Village project in Maharashtra, Milk Collection in dairy co-operatives (NDDB), Information Village project (MSSF – International Development Research Centre), Knowledge Network for Grassroot Innnovations (IIM, Ahmedabad), Application of satellite communication for training field workers and extension workers in rural areas (ISRO), etc. (Chauhan, 2010).

(2) Computing makes it possible to process large-capacity databases (libraries, remote sensing, GIS data, gene banks, bioinformatics) and to construct simulation models having applications in ecosystem modeling, preparation of contingency plans to suit different weather probabilities and market variables.

(3) The new tools for enhancing research productivity are continuously made available by the software industry. It is also creating new opportunities for understanding complex system of growing conditions.

(4) The detailed geographic information is provided by remote sensing and other space satellite outputs for land and natural resources management.

III (c) The ecotechnology revolution

Blending of traditional knowledge with frontier technologies is termed as ecotechnology. For example, in Rajasthan, drinking water is available even in areas receiving 100 mm rainfall, because women continue to harvest water in simple structures called kunds. Similarly, biogas plants in every farm will help to improve the productivity and profitability of dry land farming:

> The decision of the World Intellectual Property Organization (WIPO) to explore the intellectual property needs, rights and expectations of holders of traditional knowledge, innovations and culture is hence an important step in widening the concept of intellectual property.
>
> Sustainable agriculture in the 21st century will be based on the appropriate use of biotechnology, information technology and ecotechnology. Practical achievements in bringing about the desired paradigm shift will depend upon public policy support and political action, regulation through legislation, social mobilization through local level community organizations and education through the mass media and information shops will be needed to meet the dual demands for food and ecological security (Swaminathan, 2010, p. 63).

IV. Role of IT in agriculture

Studies show that potential of IT in agriculture can be assessed under broad two heads: "(a) as a tool for direct contribution to agricultural productivity and (b) as an indirect tool for empowering farmers to take informed and quality decisions which will have positive impact on the way agriculture and allied activities are conducted"[5].

Precision farming is quite popular in developed countries. It extensively uses IT to make direct contribution to agricultural productivity. The agricultural output is enhanced through the use of techniques of remote sensing using satellite technologies, GISs, agronomy, soil sciences, etc. This farming is capital intensive in nature and useful where size of farms is large. It is more beneficial for farming taken up on corporate lines. The indirect benefits of IT in empowering Indian farmers are significant and the potential needs to be tapped. The Indian farmers require timely and reliable information inputs for taking decisions to remain competitive.

Here there is a need to make a special reference to the Mission 2007, which relates to the knowledge and skill empowerment of rural families with the help of ICT. The next sub-section focusses on Rural Knowledge Movement.

IV (a) Rural Knowledge Movement

Several steps were initiated in 2004 by M.S. Swaminathan Research Foundation to extend its model of ICT-enabled development activities to different parts of the country in the consortium mode involving several partners (IDRC, Tata Trusts, DIT, IIT-Chennai, ISRO, NASSCOM, Microsoft, INCOIS, etc.) (Table III).

Thus, Mission 2007 changed from a concept to a national movement for bridging the urban-rural digital divide and for ensuring knowledge connectivity in areas

Name of the organization	Contribution
ISRO	Launched a village resource center program at the block level involving satellite connectivity and teleconferencing facilities
The DIT, GOI	Launched a common service center program to cover 100,000 villages
The Ministry of Panchayati Raj, GOI	Decided to provide to each Panchayat the necessary ICT infrastructure to enable it to participate in the e-governance program
ITC Ltd	Decided to expand its e-chaupal program to cover 50,000 villages
The MSSRF	Organized so far 80 village knowledge centers in 15 village resource centers
Many state governments, public and private sector companies, academic and financial institutions and NGOs	Have organized VKCs in different parts of the country

Source: Based on Swaminathan (2010)

Table III. Organization of village knowledge centers involving several partners

relevant to the day-to-day life and livelihood of rural families. There is a plan to provide knowledge centers in all the 600,000 plus villages of India with due co-operation from government, NGOs, academicians and business sector. Since early August 2007 this network is referred to as "Grameen Gyan Abhiyan (GGA, Rural Knowledge Movement)" as suggested by several partners. It is expected that by 2010, the abhiyan will cover every village and home or hut in the country. Table IV shows the organizational structure that has been visualized for the GGA.

The GGA is expected to establish linkages between scientific know-how and field level do-how. Swaminathan suggest that village resource centers and VKCs will have to be linked with appropriate programs like Sarva Shiksha Abhiyan for literacy, the Yuva and Mahila Shakti Abhiyans of the Ministry of Panchayati Raj, the National Rural Health Mission, the National Horticulture Mission, and the National Rural Employment Guarantee Programme, etc. Moreover, the above refereed programs ensure only knowledge connectivity; there is a need to pay attention to content creation and capacity building too. The content has to be dynamic, demand driven, locale specific and in local languages says Swaminathan.

Provision planned for	Agency
Village resource center in every block	With the help of ISRO
Gyan chaupals or VKC in every panchayat	With the help of the DIT, GOI, Ministry of Panchayati Raj, Civil Society organization, NABARD and the financial institutions, multilateral donors, the academic and private sectors and bilateral and multilateral donors
The last mile and last person connectivity	Through combination of the internet, community radio and the internet and cell phone

Source: Based on Swaminathan (2010)

Table IV. Organizational structure of Grameen Gyan Abhiyan (GGA)

V. Role of students in revitalizing agriculture

The rural knowledge revolution is likely to enhance the physical, economic and social well-being of the people living in villages. Once this movement is successful, there will be a paradigm shift from unskilled to skilled workers in villages. These skilled, educated youth can help to introduce in rural India the benefits of various technologies. The Yuva Kisans can help women self-help groups to manufacture and sell the biological software like biofertilisers, biopesticides and vermiculture so essential for sustainable agriculture. These young educated farmers can also prove to be assets for opening up and running of agri-clinics for production phase of farming and agri-business centers for the post-harvest phase of agriculture. The knowledge acquired by home science graduates can be of great use in ensuring nutrition in food, food safety and processing. They can also help a group of farm women to start a food-processing park. Similar opportunities exist in case of fisheries graduates and graduates in the field of dairy development, horticulture, etc. (animal husbandry). The educated farmers can run Gyan Chuapals or VKCs and empower their fellow beings by sharing knowledge through the integrated use of internet, FM radio and mobile telephony. The knowledge sharing can start from sowing but extend up to value addition, marketing, water saving and harvesting technologies to climate risk management[6] (Swaminathan, 2010, 2011).

Indian president A.P.J. Abdul Kalam has long cherished the dream of bridging the urban-rural divide through the implementation of a unique plan called Providing Urban Amenities for Rural Areas (PURA). PURA emphasized on four types of connectivities: physical electronic knowledge and economic connectivity. Once this dream is realized, India's rural areas will become as attractive to investors as its cities are. Then, rural areas will also be generating urban-style employment to halt rural-urban migration. "If educated youth chose to live in villages and launch the new agriculture movement, based on the integrated application of science with social wisdom our untapped demographic dividend will become our greatest strength" (Swaminathan, 2011, p. 14). This Rural Knowledge Movement can play an important role in resolution of agrarian crisis and making India a food secure economy.

In fact, "The concept of agriculture in the country has undergone a sea change; earlier, it used to be highly localized, but now, thanks to scientific intervention, it has become a highly research-oriented and profitable sector" Raghuram (cited in Sriram, 2011, p. 1). There are 22 million people employed in agriculture, only two million are directly involved in farming and remaining are involved in agriculture research, farm equipment manufacturing, seed supply consulting, etc. It is believed that since agriculture is unorganized and people are not aware of the job opportunities and scope for further studies in this field, therefore, the agricultural colleges and universities have been conducting job fairs, career development programs and interactive sessions with experts from industry to educate the students on the numerous opportunities available in this sector and to remove the misconceptions about this sector. The industry-academia connect in agriculture needs a fillip to leverage the talent of the students. There is also a need to bring about innovative changes in curricula and courses and update the curricula (*The Times of India*, 2011). Even National Commission on Farmers had recommended that there should be re-orientation of the pedagogic methodologies adopted in the farm universities to make every scholar an entrepreneur.

VI. Conclusion

It is obvious from the foregoing that though serivicization of India's economy has taken place through ICT-ization yet agriculture absorbs more than 55 percent of our population. But agriculture sector is witnessing crisis. Inter-alia, the agricultural crisis in India is attributed to "a fatigue of the green revolution." The country is contending with several issues related to agriculture like declining production, productivity and profitability, low credit flow, falling water tables/lack of irrigation facilities, problems of agriculture marketing, collapsing agricultural extension, lack of adequate storage for food grains, degradation of natural resources, climate change and its attendant problem and food security. The paper highlights the need and role of science and technology in agricultural revival. There are three kinds of revolution witnessed in the current century as has been referred to by M.S. Swaminathan. These are: the gene revolution, the information and communication revolution and the ecotechnology revolution. "Sustainable agriculture in the 21st century will be based on the appropriate use of biotechnology; information technology and ecotechnology." Herein comes the role of training, retraining, re-tooling and re-deployment of both farmers and farm graduates. There is no dearth of agricultural universities[7], research institutes, R&D institutes in the private sector and civil society organizations working on agricultural issues in India. They have to play a crucial role now by optimally utilizing the available resources, clearly identifying the problem and by prioritizing their research agenda rationally. The industry-academia connect in agriculture also needs a fillip to leverage the talent of the students. Besides, there should be alliances of government, NGOs and business sector too. The best example of such an alliance is given by GGA, i.e. Mission 2007 program. The starting of VKCs and e-chaupals are proving to be of great help for Indian farmers under this program as they can access information relating to agro-inputs, crop production technologies, agro-processing, market support, agro-finance, agri-clinics and agri-business through the integrated use of internet, FM radio and mobile telephony. However, there is a need to pay attention to content creation and capacity building too. Further, to encourage the use of genetically modified plants, more and more allocation are required for R&D as they are to be field tested before getting approval for commercial purpose. As has been rightly emphasized by M.S. Swaminathan that there is need to make agriculture/farming intellectually stimulating and economically rewarding so that "educated youth chose to live in villages and launch the new agriculture movement based on the integrated application of science and social wisdom, our untapped demographic dividend will become our greatest strength." To sum up, it is the application of science and modern technologies which can make agriculture intellectually stimulating and economically rewarding. All these steps taken together will definitely make India's rural areas as attractive to investors as its cities are. Then, rural areas will also be generating urban-style employment and help in checking rural to urban migration. India too will be able to harness the demographic dividend through revival of agriculture by using multi-pronged strategies. As has rightly been said by Swaminathan (2010), "The need of the hour is to convert the green revolution into an 'evergreen revolution' by mainstreaming the principles of ecology in technology development and dissemination. India also urgently needs to focus on developing a sustainable and equitable food security system."

Notes

1. The World Food Summit –(1996) defined food security as: "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life." Swaminathan

says that it should include physical, economic and social access to balanced diet, safe drinking water, environmental hygiene, primary health care and primary education. A sustainable food security system is dependent on food production and non-food factors (see www.rites.com/rites-journal-july/PDF/M.%20S.%20Swaminathan%20P65.pdf).The holistic definition of food security should include food availability, food access and food absorption.

2. Based on GOI (2008a), Chand (2008) and Radhakrishna and Chandrasekhar (2008).
3. Financial inclusion means the delivery of banking and other financial services such as credit, savings and insurance at an affordable cost to the disadvantaged and low-income groups.
4. This section draws heavily from Swaminathan (2010, pp. 59-62).
5. This and the following paragraph are based on Mittal.
6. Research studies show that green house gas induced warming would have major impact on agro ecosystem. The global climate change will affect agriculture through its direct and indirect effect on crop, livestock, pests, disease and soil, thereby threatening the food security of many countries (Thomas, 2011, pp. 16-17).
7. There are 50 agricultural and animal husbandry (including fisheries) universities which turn out 20,000 farm graduates including 7,000 post-graduates every year (Swaminathan, 2010, p. 159).

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