

Sustainable agriculture in India : Current situation and future needs

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ABSTRACT

Indian agriculture is facing with an array of problems such as water scarcity, reduction in cultivable land/capita, high cost of crop inputs, lack of marketing network and avenues for value addition of farm produce and fluctuating market prices. Current conventional farming can however be improved by adopting appropriate technologies of crop production, post-harvest processing and by improving quality so that agriculture becomes not only sustainable in long term but a profitable business also by linking production with consumerism. The future trends and means of sustainability are discussed.

Key words : Inoculation, *Azospirillum*, *Azotobacter*, Growth attributes, Yield attributes, Economics.

INTRODUCTION

In India, >65% of the population is dependent directly or indirectly on agricultural activities.

As in earlier plans, Central Government envisaged in the tenth 5-yr plan (2002-07), at least 3.5-4 per cent growth rate per annum in agriculture from the present rate of 2 per cent with emphasis on food security and employment opportunities in rural areas. Also, irrigated area increased from 22.5 m ha to 97 m ha during last 50 years. The national agricultural policy aimed to strengthen current economic growth through efficient marketing to accelerate foreign trade from the major crop growing areas where technical know-how and facilities for export have been established. There is a shift from sustainable to commercial agriculture in some areas where farmers can avail the opportunities to increase their income in agriculture. The increasing demand for organic foods and fibre, and the by-products would certainly open a new vista in consumerism. In future, the agricultural production on a large scale by adopting improved farming techniques would transform small farmers into viable commercial producers, link production with consumption would bring about real economic changes in the present conventional non-sustainable agriculture.

Present situation :

At present, the total area available for cultivation accounts for 180 m ha, of this 122 m ha (65%) is in dry land areas from where 42-44 per cent of total food and 75 per cent of cotton is produced. The characteristics of these areas are: shallow/light to deep/black alluvial soils with poor fertility levels and low moisture retention capacity, poor crop stand, erratic weather, inadequate crop inputs and farming infrastructure, uncertain and low

rainfall (500 mm or less/year) coupled with late onset and early cessation of rains or prolonged dry spells during crop season, subsistence/conventional farming, lack of improved technology, soil salinity or alkalinity, water and soil erosion, low productivity of cattle and lack of fodder and minimum crop yields. These situations result in socio-economic constraints such as, poverty, illiteracy and poor standard of living. In reality, concerted efforts for maintaining sustainability in these areas are urgently needed.

Sustainability :

Sustainable agriculture is often restricted to conventional/traditional farming and creates confusion. In fact, it helps to improve soil health by integrating all possible measures so that crop productivity is maintained for a longer time. According to United Nations Development Programme, sustainable development means national food security, upgrading living standard of farmers, and conservation of the natural resources. Therefore, various traditional and modern methods of cultivation are included in sustainable agriculture. Nevertheless, unless scientific agriculture is practiced, average per capita income will not attain to a desirable level and disparity between rich and poor would widen further. For example, government declared in 1999-2000 the population below poverty line (BPL = \$ 1/day) at 28.6 per cent whereas international survey reported it at 35.3 per cent (\$1/ day) and 80.6 per cent (\$2/day) (World Development Report, 2005). Similarly, the National Sample Survey Organization reported the average per capita expenditure of Rs. 503 only (lowest being Rs. 225 in Madhya Pradesh); of which 50 per cent is spent on food alone. These figures denote the present economic

status of farmers' families in dry land areas where 60 per cent of the potential remains unexploited for the future needs. Poverty alleviation may be possible only when more broad based approach of village improvement reaches out to these people.

With introduction of the Green Revolution (GR) in Indian agriculture in the seventies, there had been considerable increase in crop production from 50-8 m t in post-independence period to 210 m t in 2000. Unfortunately, its success had been confined to few states and few crops probably because of vast heterogeneity reflected to 15 agro-ecological zones. Subsequently, the growth rate lowered from 3.54 per cent in 1980 to 1.92 per cent in 2000-01, and share of agriculture that contributes roughly 23 per cent to the national Gross Domestic Product (GDP) has been falling consistently over the last years, which is attributable to number of farming challenges. For example, high cost of farm inputs and nearly stagnant market price of harvested produce made the dry land cultivation unprofitable. In future, sustainable agriculture should be improved and farmers should be encouraged to adopt proper technologies and not to abandon crop cultivation particularly in dry land areas.

Current situation :

Overuse of land:

The available cultivable land is presently overused mainly due to fragmentation, e.g. nearly a half of the population in farming communities own only 0.01-0.04 ha of land, respectively (Table 1). These lands had been exploited through intensive agriculture introduced during GR era. Cropping system with monoculture became predominant as it replaced the traditional systems of

Table 1 : Farms owned by farmers (Economic Survey, 2005)

Farm Size (ha)	Farmers (%)
0.01 - 0.40	48.7
0.41 - 1.00	18.8
1.01 - 2.00	11.2
2.01 - 4.00	07.1
4.01 - >	03.9

intercropping, mixed cropping, crop rotations, and made the soil infertile. Fields were used for 2-3 crops/year without rest. This system yielded in higher production and greater profits than in conventional farming but failed to sustain for a longer time. Also, this concept was successful only in fields of progressive farmers who could cope up with yield losses and natural calamities.

Low crop productivity:

Although soil fertility decreased to a greater extent, farm inputs are not applied in required quantity and at proper stage of plant growth natural calamities are frequent. As a result, crop production remains standstill. The average productivity of major crops is below global average (Table 2) even after putting some wasteland under cultivation and with irrigation facilities.

Table 2 : Global ranking in area, production and productivity of Indian crops

Crop	Area	Production	Productivity
Wheat	3	3	32
Rice	1	2	51
Maize	5	9	105
Sorghum	1	2	51
Potato	3	6	51
Pulses	1	1	118
Sugarcane	2	2	34
Cotton	1	3	57

Looking at the present situation of availability of food and fodder, it is evident that requirement for essential goods and foods has increased and it would be difficult to feed ever-increasing population of over 109 crore because the population is growing at 1.9 per cent annually as against the 1.5 per cent growth in food grain production. At present, food availability is only 400 g per capita against normal quota of 500 g and pulses (major source of protein) are available only at 26 g per capita. Country may therefore face the hunger due to non-availability of essential foods. Also, farmers need income support through agriculture although a fourth of the rural population is landless and needs help to survive.

Market imperfection, and lack of capital and industrialization:

With international agreement signed by the government for liberalization, globalization and privatization of the trade and commerce through World Trade Organization (WTO), it is now imperative for Indian Government to follow certain guidelines to enter in the international market/trade. In India, import of various items including those based on agriculture and related fields has nearly doubled during last decade, e.g. US \$23.32 billion in 1994 to US \$ 42.2 billion in 2000. On the contrary, export is <1% compared to 12, 7% of the USA, 7% of France, 6% of Netherlands and Canada, 5 per cent Germany, 4% of Belgium, 3% of U.K., Spain, Italy, Brazil and Australia, and 2% of Thailand, Denmark and

Argentina. It means some of the developing countries are ahead of India. Under such circumstances, national economy may be jeopardized and may face difficulties to compete with other developing and developed countries.

Imbalance between prices of farm inputs and market sale:

With GR philosophy, farmers have become totally dependent on others. Unless they buy these inputs, land cultivation is impossible. The « Swadeshi Movement » had disappeared fast and farmers have to buy at least seeds, fertilizers and pesticides at enormous price. Apart from these inputs, labour cost has gone up in rural areas also. To compensate these costs, farmers expected the proportionate rise in the Minimum Support Price (MSP) of farm produce and commodities but again they were disappointed as input rates are increasing every year reaching up to 300 per cent whereas prices of farm produce increased up to 60 per cent (Table 3).

Table 3 : Minimum support price (Rs./q) of major food crops

Crop	1998-99	2003-04	% increase
Cotton	1140-1650	1725-1925	15-20
Soybean	795	930	19
Wheat	550	630	15
Paddy	440	550	25
Chick pea	895	1400	56
Mustard	1000	1600	60

Inadequate loan facilities:

Marginal and small farmers earn and live. No extra amount is generally generated for savings. Under such situation, they borrow cash from money lenders in the villages for planting of next year crops. If natural calamities occur during the period of crop cultivation and crop failure is eminent, they again borrow money for necessary field operations and family expenses. At present, loan facilities by govt. agencies, nationalized and cooperative banks are available only in towns and at quite higher interest rates. Farmers are therefore unable to

repay the loans to avail the new loans as the terms and conditions are dictated by financial firms.

Lack of extension at grass root level:

Awareness and provision of information on new/improved technologies of crop production is very poor among farmers. The interaction between farming community and research institutions and development agencies seems to be too weak to reach the recent technologies at the grass-root level. Though the results under controlled conditions are better, the same potential could not be attained in farmers' fields (Table 4). It means that innovation does not take place in tune with ground reality. Probably because firstly, only 0.9% of the farmers

Table 4: Present status of crop productivity efficiency (%) at different locations

Crop	Research station	Demonstration field	Farmer field
Rice	50	40	15
Cotton	35	28	08
Maize	100	80	11
Wheat	60	40	09

have access to information from Krishi Vigyan Kendras, Agricultural extension farms and village libraries. Secondly, experimental farms operate without constraints of capital, land and inputs.

Future needs :

Diversification in agriculture:

Any cropping system comprising crops with varied maturity period, crop canopy, high yielding potential is today's need for an average farmer. Single crop system consisting of red gram, cluster beans, frenchbeans, castor, setaria, groundnut, pearl millet, ragi, mustard, sunflower are best suited. However, several cropping systems depending upon the soil type, total rainfall and commencement of the rains in the region have to be executed (Table 5, 6, 7) so that soil and water conservation, full utilization of ground water, maintenance

Table 5: Cropping pattern as per soil type

Soil	Depth (cm)	Available soil moisture (mm)	Crops
Shallow	> 22.5	15-35	Ber, tamarind, custard apple, grasses, agroforestry
Medium	22.5 - 45	35-60	Pearl millet, castor, sunflower, pigeon pea
Medium-deep	45-60	60-90	Sunflower, groundnut, castor, pearl millet, pigeon pea, <i>rabi</i> sorghum, safflower, chick pea
Deep	60 - 90	90 - 105	<i>Rabi</i> sorghum, safflower, sunflower, chick pea
Very deep	> 90	140-180	Green gram, black gram, <i>rabi</i> sorghum, safflower, sunflower, chick pea

Table 6: Cropping pattern as per rainfall

Rainfall (mm)	Land slope Soil depth	High slope < 10 cm deep	Medium slope 10-20 cm deep	Low slope > 30 cm deep
750 - 1250	Fruit trees	Cashewnut, aonla, <i>Eugenia jamolana</i> , <i>Carissa carandas</i> , Drum stick, jujube	Mango	<i>Dalbergia sissoo</i>
	Trees	<i>Acacia nilotica</i> , <i>Melothria edule</i>	Neem, Eucalyptus, Silver oak	Bamboo, <i>Acacia rugata</i>
	Grasses	Marwel-8, Big pawana 100-5, Stylo hamata	Dashrath, Marwel-8, Setaria, <i>Cenchrus retigerus</i>	Marwel
	Crops	--	Horse gram, Minor millets	Sorghum, pearl millet, Groundnut
< 750	Fruit trees	Phalsa, Jujube, <i>Limonia acidissima</i>	Tamarind, <i>E. jambolana</i>	Mango, Aonla
	Trees	Subabhul, Australian babhul	<i>Melothria edule</i> , <i>Abutilon catechu</i>	Neem, <i>Ficus religiosa</i> , <i>Ficus benghalensis</i> , <i>Ficus glomerata</i>
	Grasses	Big Pawana 100-5, Stylo hamata	Arjun, Setaria Marwel-8	Dashrath, Gokarna
	Crops	--	<i>Dolichos uniflorus</i> , Minor millets	Sorghum, Pearl millet, Groundnut, irrigated crops

Table 7: Cropping pattern as per commencement of rains

Period of commencement	Crops to be planted
Second fortnight of June	Pearl millet, groundnut, sunflower, castor, pigeon pea
First fortnight of July	Pearl millet, castor, pigeon pea
Second fortnight of July	Sunflower, castor, pigeon pea
First fortnight of August	Sunflower, castor, pigeon pea
Second fortnight of August	Sunflower, castor, pigeon pea
First fortnight of September	Rabi sorghum as fodder crop

of soil fertility is possible.

Although the cropping systems would depend upon the agro-climatic factors, it is certainly profitable to adopt double cropping, intercropping and mixcropping since these systems help to increase land use efficiency. In fact, any cropping system comprising crops with varied maturity period and crop canopy, having high yield potential is today's need in dry land areas where double crop system proved to be potential and cost-effective (Table 8).

Table 8: Double crop system in dry land cultivation

Kharif season	Rabi season
Rainfed	
Green gram/black gram	Safflower/rabi sorghum
Sunflower	Chick pea
Limited irrigation	
Pearl millet	Chick pea/safflower
Sorghum/maize	Sunflower
Sorghum	Chick pea/wheat/mustard/ sunflower
Soybean	Chick pea/wheat/sunflower
Green gram/black gram	Safflower/rabi sorghum
Sunflower	Chick pea

Intercropping helps to enrich soil fertility, retain soil moisture, reduce the incidence of weeds, pests and diseases, make fodder available throughout year fodder, and to obtain additional money. The recommended intercrops with number of rows are as follows:

Cotton : green gram/black gram (1 :1), Sorghum : green gram/pigeon pea (3 :3), Pigeon pea : green gram/black gram (1 :2 or 2 :4), Pigeon pea : Soybean (1 :2), Cotton :sorghum : pigeon pea : sorghum (6 :1 :2 :1), Pearl millet: pigeon pea (2:1), Sunflower: pigeon pea (2:1 or 2:2), Pigeon pea: cluster bean (1:2), Sorghum: pigeon pea (2:1), Castor: cluster bean/ridge gourd (1:2)

The present overgrazing is leading to land degradation. On the contrary, number of cattle/village is decreasing because India has 20 per cent of the world's livestock population (450 million) but only 13 m ha of grazing land is available.

Appropriate technologies:

The low cost technology is essential considering the financial burden for a marginal farmer whose earning source is only farming. Farmer has to arrange for seed procurement, seed treatment, growing green manuring crops, preparing compost from farm waste or vermicompost from vermiculture, purchase of biofertilizers, biocontrol agents, biopesticides, chemicals etc. with his limited financial resources.

Organic farming is proved to be economical as many inputs are prepared on the farm itself by the farmers (Table 9). This strategy needs to be verified and advocated for varied cropping systems in both rainfed and irrigated agriculture in which it can be profitable. Farmer should however, be able to bear the yield losses that are incurred

Table 9 : Organic farming : example of cotton

Year	Production (q/ha)	Net return (Rs./ha)	Profit (+)/loss(-) (Rs./ha)
First	5.00	750	-8250
Second	5.75	3750	-5250
Third	6.25	7000	-1500
Fourth	7.50	10500	+1500
Fifth	8.75	13500	+4500
Sixth	10.00	16500	+7500

during first few years.

Market driven production:

Quality products can be marketed either by exporting them or by local sale. Therefore, quality parameters have become important for fetching reasonably higher price. There are several agencies involved in this business and are ready to help farmers. Recently, Central Government established a few number of agri-export zones to facilitate the export of agricultural products and commodities. Also, efforts are needed for the network of the retail marketing in India because present share of 2 per cent would not be sufficient to compete with other countries, such as, USA (85%), Thailand (40%), Brazil (35%), China (20%).

Agri-Export Zones :

A.P. = Mango pulp, fresh vegetables, grapes
Assam = Fresh and processed ginger, Bihar = Litchi,
H.P. = Apple, J.K. = Apple, walnut, Jharkhand =
Vegetables, Karnataka = Gherkins, flowers, Kerala =
Horticultural products, M.P. = Potato, onion, garlic, seed
spices, M.S. = Mango, grape, onion, flowers, orange,
Orissa = Ginger, turmeric, Sikkim = Flowers (orchids),
cherry pepper, Uttaranchal = Litchi, flowers, medicinal
and aromatic plants, U.P. = Mango, potato, vegetables,
W.B. = Litchi, pine apple, potato, mango, vegetables.

When the potential and constraints are considered by SWOT analysis (Table 10), it is certain that vegetables could be taken up *a priori*. Different types of vegetables are available in India and can be exported or processed for value addition.

Table 10: Numerical SWOT Analysis (ranking of 1-10) of food crops in India

Criterion	Cereals	Pulses	Oilseeds	Vegetables
Strength	+1	+2	+3	+6
Weakness	?	+2	+2	-2
Opportunities	?	+2	+2	+4
Threats	+2	+2	+2	+4

Strengths:

Export is progressing. International and national certification gaining importance. Government support increasing. Strong agricultural base.

Weaknesses:

Low information and awareness levels. Less quality consciousness. Low marketing skills. Domestic marketing not easy. Weak research base.

Opportunities:

Increasing demand for farm produce in national and international markets. India is recognized as international agriculture hub. Acceptance of biotechnology in agriculture.

Threats:

Over dominance of foreign companies. Failure to keep up rapid pace of development with respect to other agriculture-based economics.

Another avenue for market driven agriculture is the adoption of contract farming. In this system, farmers are given technical guidance, arrangements are made for the supply of quality inputs at reasonable rates, purchasing (without intermediates) is done directly by buyer companies. In India, Corporate world is coming forward to compete with world market as the farm sector should turn buoyant. For this, several Small and Medium Enterprises (SME) in agriculture processing and service sectors have to be promoted to add value to crop produce and increase quota to GDP to improve living standards of farmers. Central Government had already initiated this venture in several states, particularly for cotton through technology mission on cotton (Table 11). Also, many international and national companies such as, Pepsi Foods for pineapple, Mahindra Subhlabh for vegetables, Appachi Cotton Mills and Super Spring Mills for cotton, are actively participating in this cooperative programme.

Approach and technology interaction:

An innovative farming approach (*i.e.*, adoption of improved production technology including integrated pest management, soil and water conservation measures, plant nutrient management and contract farming) no doubt will enhance crop yield but that will not be enough for the sustenance of small and marginal farmers with small land holdings, and his family. From our experience in contract farming in Vidarbha (Maharashtra) during past two years, we have not been able to improve the yield beyond 60-70% from rainfed cotton. Thus, when yield is improved from present average, while considering the vagaries of

Table 11 : Experience of contract farming in cotton cultivation

State	Districts	Area (ha)	No. of farmers	Hybrids	Production (q/ha)	Exp. (Rs./ha)	Profit (Rs./ha)	(%)
2002-03								
M.P.	Chhindawara	100	82	Ankur-651 Bunny	12.50/0.30	8175/9250	18776/10800	73.8
A.P.	Adilabad	520	161	Bunny	9.48/8.60	4500/5500	14680/11872	22.3
2003-04								
M.S.	Nagpur	1211	524	Ankur-651 Bunny	11.09/8.23	9635/10066	15665/8334	87.0
2004-05								
M.S.	Wardha	2270	2198	Ankur-651	8.19/7.94	6072/7791	12765/18262	17.9

weather, is it possible to make a livelihood with just Rs. 2000-3000 a month, not to speak of his expenses towards education and marriages of his sons and daughters. The answer is emphatic "no". It is therefore necessary to go for integrated farming apart from improving the yield and profitability by providing irrigation and quality inputs, loan from NABARD and associated regional rural banks, and last but not the least, providing know-how by extension services. However, farmer has to look to other areas for subsistence, viz. livestock farming, dairy, poultry, sericulture etc. We need to address the long term issues of enhancing livelihood by providing additional avenues of income and improving the prospects for agriculture so that it can be a viable enterprise. After crop harvest, by-products should be utilized by establishing agro-industries in the neighbouring areas of farmland and this with other rural industries can provide jobs to at least one member of the distressed farming families so that he is not entirely dependent on agriculture alone.

Infrastructure development and reforms of agricultural policies:

In terms of investment in rural infrastructure, India comes next to the US, but there is a dearth of storage godowns, distribution network and services critical to a comprehensive and integrated food security system. Post harvest losses up to 40 per cent in vegetables and other perishable goods has been reported. The value addition through processing may help raise the farmers' income. Thus, Food parks, Agro-based industries, cold storage structures etc. should be established in crop growing zones. In Maharashtra, the government adopted resolution to change the present acts of Agriculture Produce Marketing Committee into Model Act which may be an ideal step towards marketing in rural areas.

Flexible institutional credit:

Farmers need financial help before the crop season

starts so that farm inputs can be purchased and stored for timely utilization. Credit facilities give a livelihood security to farmers. The easy system of recovery and subsidy on farm inputs has been started through kisan credit cards and soft loans. However, the financial allocation to farm sector has not yet been elevated substantially during last decade; e.g. 15 per cent in 1992, 11.72 per cent in 1998 and 11.62 per cent in 2003.

Preservation of biodiversity:

Management of wasteland, indigenous fauna and flora, unmanaged disturbed habitats would help to maintain biodiversity in dry land areas. Degradation of biological phenomenon is a serious concern for all living on the earth. Therefore, natural calamities are probably increasing day by day, particularly drought during crop season. Forecasting of weather through GIS, LANDSAT and other space satellites would facilitate planting of rainfed crops. Accessibility of weather data in remote areas is a major constraint in planning of farm operations for which meteorological stations may be established at appropriate sites in crop growing areas. The energy conservation needs to be targeted in coming years so that it would influence positively the quality of life of rural masses.

Conclusion:

- The central state government should provide farmers who are ready to practice with improved technologies, should establish remunerative marketing links for sale of farm produce, introduce strong extension activities, impart training to progressive farmers, initiate post-harvest processing of farm produce etc. Special attention to disaster management is needed particularly in the hilly areas and drought-prone zones.

- Improvement in the existing infrastructure facilities such as, electricity supply, meteorological stations, irrigation resources would encourage farmers to cultivate farms in dry land areas.

For this, it is expected that government may create a separate department for dry land agriculture to do research and development although Central Research Institute for Dryland Agriculture, International Crops Research Institute for the Semi-Arid Tropics and other institutions are actively participating in farmer-oriented programs.

- Working of Agri-clinics in selected villages should be able to solve farmers' difficulties by "on spot examination" and give recommendations to farmers.

- There is urgency to assess systematically the economic and social status relevant to local needs, conditions and resources. This study would reveal the ways and means to make agriculture not only sustainable but also as profitable business.

- Farmers are apt to follow the recommendations from all concerned agencies and institutions for the crop management practices. Concerted and intensive efforts are however needed from farming communities and government agencies, non-government organizations and farmers' cooperative societies. This strategy would certainly fulfill the dreams of down-trodden villagers including farmers through integrated village development.

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