DIVERSITY AND VARIABILITY OF INDIA'S RAINFED FARMING

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Abstract

In this study focuses on Diversity and variability of India's arable land is under rain fed farming. Agricultural research and extension, and commercial ventures are designed to supply 'one-size-fits-all' technologies, inputs and advice through uniform administrative apparatus or market protocols. This approach limits their capacity to work with the diversity and variability of rain fed agriculture. But with support that complements the variable nature of rain fed farming tracts, communities can improve farm productivity and sustainability. Farming community reclaiming its knowledge of variability through the revival of mixed cropping and millet production. We argue that decentralised support, with public investments appropriate to each agro-ecological system. In this context, pertaining the study of drying tube-wells and land degradation appearing in the national dailies, we need an overhaul of the policy and support systems for rain fed agriculture, moving from the prevalent approach of uniform disbursement or supply, to one that acknowledges the value of variability and respects local agronomic principles and practices to improving agriculture sector.

Key Words: Decentralised Support, Agro-ecological system, Farming community, Productivity, Variability, Diversity,

I. Introduction

India is considered as one of the fastest growing economies in the world. However, the exclusion problems have not been seriously addressed by the government programmes and strategies. The experience of the economic reforms during the past 15 years indicates that while there have been improvements in economic growth, foreign exchange, IT revolution, export growth, etc., the income distribution has been unequal and only some sections of the population have benefited more from higher growth and prosperity. In other words, real development in terms of growth shared by all sections of the population has not taken place. We have problems of poverty, unemployment, inequalities in access to health and education and poor performance of agriculture sector. The role of agriculture in economic development is well known. Agriculture not only contributes to overall growth of the economy but also provides employment and food security to majority population which in turn reduces. Because of demographic pressures, there has been significant increase in small and marginal farm holdings. These farmers have to face the challenges of globalization. Risk and uncertainty have also increased as cultivation has spread to marginal lands. The diversification of agriculture has also raised concerns on food security. Food prices also increased due to low output stocks. International prices of wheat, rice and maize increased significantly during the past two years. This is another challenge for India in maintaining its food security.

The growth in GDP in agriculture was around 2.2% to 2.5% per annum during 1950-51 to 1980-81. It recorded the highest growth rate of more than 3% per annum in the 1980s. During the post-reform period, the growth rate declined to 2.76% per annum. Growth in agriculture GDP, which was 4.7% per annum during Eighth Plan (1992-97), declined to 2.1% during Ninth plan (1997-2002) and to 1.8% per annum during Tenth Plan (2002-07). Thus, there has been a significant deterioration in the growth rate of agriculture since mid-1990s. However, there are signs of revival of agricultural growth to more than 3% per annum during the past few years. the agricultural performance is based on the aggregate data, and it is also necessary to assess current agricultural potential at farmer level by understanding its production patterns, marketing and other factors that will either constrain or provide opportunities for agriculture' future growth, and thus, to be better understanding the role of such growth in overall economic growth and poverty reduction.

The rest of crop subsector constitutes a wide range of staple and high value crops, reflecting diversified agricultural production and consumption patterns. the agricultural performance is based on the aggregate data, and it is also necessary to assess current agricultural potential at farmer level by understanding its production patterns, marketing and other factors that will either constrain or provide opportunities for agriculture' future growth, and thus, to be better understanding the role of such growth in overall economic growth and poverty reduction.

According to the national level analysis, the crop subsector contributed to 75%–85% of agricultural growth between 1991 and 2006, and within the crop subsector cocoa alone contributed to 15%-30% of total agricultural growth. The rest of crop subsector constitutes a wide range of staple and high value crops, reflecting diversified agricultural production and consumption patterns

II. Concepts

Crop Diversity

Crop diversity is the variance in genetic and phenotypic characteristics of plants used in agriculture. **Crop diversity** loss threatens global food security, as the world's human population depends on a diminishing number of varieties of a diminishing number of **crop** species.

Rainfed Farming

Rainfed Crops are prone to breaks in the monsoon during the crop growth due to water stress. This water stress may be due to variability of rainfall, delay in sowing, diversity in crop management practice and variability of the soil type. The prolonged breaks can result in partial or complete failure of the crops.

Yield Variability Crop

The contributions of sown area and per unit area yield to variability of total yield varied among the major crops. For grains and fruits, the contribution of per unit area yield had the dominant effect, while the opposite was the case for sugar crops and cotton. For oil crops both factors contributed almost equally.

III. Review of Literature

Sen. and Bhatia (2004) opined that based on cost of cultivation data indicates a decline in the growth of farm business income (FBI) over time. This study shows that the all-India rate of growth of real (deflated by Consumer Price Index Number for Agricultural Labourers) FBI per hectare declined sharply from 3.21% per annum during the 1980s to only 1.02% per annum during the 1990s. However, a farmer is interested in farm income per cultivator rather than price-cost ratio or FBI per hectare. Estimates of FBI per cultivator using growth of cultivators and cropped area revealed that the growth rate was 1.78% per annum during the 1980s but it decelerated to 0.03% per annum during the 1990s- indicating almost stagnant FBI per cultivator in the later period.

Delgado and Siamwalla (1999), hold the view that with economic development, diversification also occurred within each sub-sector. **E.g.** agricultural diversification is taking place with each sub-sector (crops, livestock, forestry etc.) and across sub sectors. At the conceptual plane diversification of agriculture could be classified into the following three categories.1) Shift of resources from farm to non- farm activities 2) Shift of resource with in agriculture from less profitable crop or enterprise to more profitable crop or enterprise 3) Use of resources in diverse but in complimentary activities.

Quiro and Valdes (1995), in their study on volatility of commodity prices pointed out that one of the most common rationales for diversification of output mix is to reduce the environmental, ecological and economic risk associated with uncertainty and variation of net income. The extent to which this could be achieved depended largely on the correlation between output and input price as well as the relative effects of climatic variability of production.

IV. Objectives

- To study rain fed area process and diversity in agriculture
- To examine challenges for revival of Indian agriculture
- To analysis growth rates of agriculture SDP: states ranked by percentage of rain fed area
- To suggested the measure of maintaining diversity and variability of rain fed farming in Indian agriculture

V. Rainfed Agriculture

Rainfed production systems are characterised by undulating topography, soil types ranging from shallow red soils to deep black clays, large areas of common land and highly location specific crops, crop varieties and livestock. The criteria of either exclusive dependence on rainfall or an area with assured irrigation are being replaced by typologies that include social, cultural, economic and agro-ecological features. While evidence is available on the many roles of a rain fed system and its interaction with ecosystems, the articulation of production problems and solutions is biased towards individual crops and their isolated outputs.

i. Rainfed Agriculture Process

India's 142 million hectares of arable land is under rain fed agriculture, and accounts for a significant share of the area under major food and industrial crops rice (42 %) pulses (77%) oilseeds (66%), cotton (65%) and coarse cereals (85%). This land also hosts the majority of India's cattle (78%), sheep (64%) and goats (75%). Added to this, stagnant yield growth from irrigated production systems makes productive and sustainable rain fed farming an issue of national importance. Typically, rain-fed production systems are characterised by undulating topography, soil types ranging from shallow red soils to deep black clays, large areas of common land and highly location specific crops, crop varieties and livestock. The criteria of either exclusive dependence on rainfall or an area with assured irrigation are being replaced by typologies that include social, cultural, economic and agro-ecological features... This leaves system components and relationships and overall system productivity ignored, with no relevant data collected, and hampers the wider understanding of rain fed agriculture.

ii. The Diversity in RainfedAreas

Rainfed farming is location-specific knowledge, agronomic principles and choice of practices, timedependent decisions, and the flow of skills and knowledge into the farming system to ensure effective production. Yet farmer 'practice' is the least acknowledged area; the domination of development policy, knowledge and technology over local farming systems and practices typifies the general approach to rain fed agriculture in India, and represents another barrier to helping this system reach its potential. This means investments in bio-physical rain fed farming as well as socio-economic and cultural systems that are more complex and harder to govern. Alongside this, agronomic knowledge or location-specific understanding of how natural resources, plants and humans interact, makes a case against uniform input (of it seeds, tube wells, diesel, pesticides, fertilisers or tractors). Agricultural research on India's rain fed farming conducted in the early 20th century1 and agricultural education paid specific attention to the diversity and inherent variability of farming systems. The immense opportunities that diversity offers for adaptation and shared learning at the village or community level were widely appreciated.

iii. Rainfed Farming in National Planning

India's agricultural policy paralysis and the need for a more decentralised approach were highlighted in 2013 in a policy briefing on the country's rain fed agriculture by IIED and the Indira Gandhi Institute of Development Research.3 It included a call to "build on the knowledge and experience of local understanding knowledge that articulates in favour of an extensive method of integrated natural resource-crop-livestock production system, with in-built synergy and mutual dependence." India's 12th Five Year Plan (the 'Plan') includes a National Programme on Rain fed Farming (NPRF). The NPRF is unusual: it proposes "an integrated, comprehensive and decentralized initiative which can help harness the high inclusive growth potential of rain fed production systems." Indian states with predominantly rain fed agriculture, aiming to scale-up integrated innovation capacities at the local ('Block') 5 level. But three years into the Plan period the NPRF is yet to be implemented. The focus on supply, which characterises national agricultural knowledge and policy, is convenient for administration and for the technology generation that caters to it.7 By ignoring diversity and variability, it sets itself up to fail in rain fed production systems. The yields of rain fed agriculture are too important for policies supporting rain fed farming communities to remain ineffective: capacity must be built to revive the age-old agronomies of resilience. Appropriate public policy and scientific research must guide investments by the government and other stakeholders to strengthen community practices and knowledge of local soil, water and biodiversity**.**

iv. Sustainable Rainfed Agriculture

The farmers noted that the recently introduced changes in practice had taken them back to traditional ways of managing risk. Their wellbeing, marketing strategies and mixed crops for higher and more sustainable yields are all elements of a system that understands and works with local diversity. Their success demonstrates the importance of using location-specific decentralised knowledge and practices. Strong community level capacities for problem diagnosis and decision-making are the key: the integration of diverse components within the farm, and between the farm, the household and the community, would have been inconceivable if implemented as a scheme for crop diversification through conventional input-disbursing extension systems. The farmers' decisions to not sell their manure, to adopt crop diversification, and to sow a winter crop were incentivised by the higher production and productivity of their farming systems, collective pest management and market negotiations.

They worked because the Village Development Committee in each hamlet was trained by the CSOs to manage their own records, conduct monitoring and evaluation. The village has adopted its own rules, one of which is to forbid cutting of trees to ensure soil biomass availability and application, as the basis of soil moisture management.

VI. Total Factor Productivity in Agriculture

In development literature, the assumption is that productivity is lower in agriculture than non-agriculture sector. Here, we look at the Indian evidence on total factor productivity growth (TFP) in agriculture and non-agriculture sectors. The evidence shows that TFP growth has been almost identical (1.13% per annum) in both the sectors during the 50-year period 1950-2000 (Krishna, 2006). The sub-period data indicate that TFP growth in agriculture was the highest during the 1980s at 1.89% per annum, but it declined to 1.68% during the post- reform period (Table 1). On the other hand, non-agriculture sector's TFP growth was higher than that of agriculture in the 1980s and increased marginally during the post-reform period.

VII. Challenges for Revival of Indian Agriculture

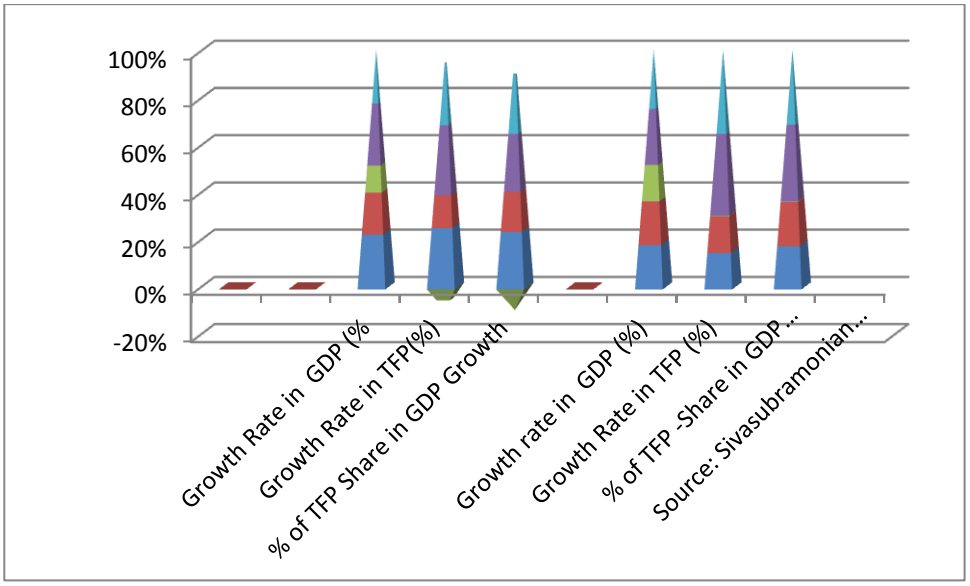
One interesting finding is that in-spite of lower growth in GDP; the TFP contributed more than 50% to GDP in agriculture, whereas in non-agriculture, its contribution to GDP was less than 30% during 1980s and 1990s. It shows the importance of TFP for agriculture during the past two decades.

Table: 1 Total Factor Productivity (TFP) in Agriculture and Non-Agriculture Sectors

	1950-51 to 1960-61	1960-61 to 1970-71	1970-71 to 1980-81	1980-81- to1990-91	1990-91 to1999-2000
		Agriculture Sector			
Growth Rate in GDP (%	3.03	2.31	1.50	3.43	2.97
Growth Rate in TFP (%)	1.65	0.88	-0.35	1.89	1.68
% of TFP Share in GDP Growth	54.5	38.1	-23.3	55.1	56.6
		Non-Agriculture Sector			
Growth rate in GDP (%)	5.34	5.30	4.38	6.77	7.14
Growth Rate in TFP (%)	0.88	0.89	0.01	1.98	2.04
% of TFP - Share in GDP Growth	16.5	16.8	0.22	29.3	28.6

Source: Sivasubramonian (2004)

Figure: 1 Total Factor Productivity (TFP) in Agriculture and Non-Agriculture Sectors



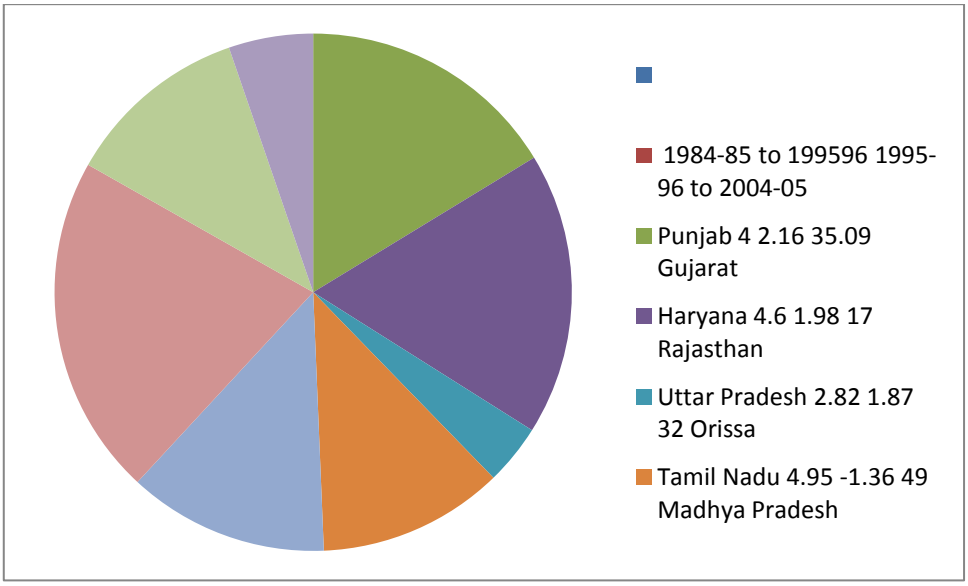
Bihar -1.71 3.51 52 Maharashtra 6.66 0.10 83 Andhra Pradesh 3.18 2.69 59 Kerala 3.60 -3.54 85 All India 3.62 1.85 60 Assam 1.65 0.95 86

Table 2: Growth Rates of Agriculture SDP: States Ranked by Percentage of Rain fed Area

State	Growth Rate in NSDP Agriculture		Rainfed (%)	State	Growth Rate in NSDP Agriculture		Rain fed (%)
	1984-85 to 1995-96	1995-96 to 2004-05			1984-85 to 1995-96	1995-96 to 2004-05	
Punjab	**4.00**	**2.16**	**35.09**	**Gujarat**	**5.09**	**.48**	**64**
Haryana	**4.60**	**1.98**	**17**	**Rajasthan**	**5.52**	**0.30**	**70**
Uttar Pradesh	**2.82**	**1.87**	**32**	**Orissa**	**-1.18**	**0.11**	**73**
Tamil Nadu	**4.95**	**-1.36**	**49**	**Madhya Pradesh**	**3.63**	**-0.23**	**74**
West Bengal	**4.63**	**2.67**	**49**	**Karnataka**	**3.92**	**0.03**	**75**
Bihar	**-1.71**	**3.51**	**52**	**Maharashtra**	**6.66**	**0.10**	**83**
Andhra Pradesh	**3.18**	**2.69**	**59**	**Kerala**	**3.60**	**-3.54**	**85**
All India	**3.62**	**1.85**	**60**	**Assam**	**1.65**	**0.95**	**86**

Source: Planning Commission (2007)

Figure: 2Growth Rates of Agriculture SDP: States Ranked by Percentage of Rain fed Area



NSS Data on Status of Farmers: The National Sample Survey Organisation (NSSO) undertook a comprehensive survey to assess the situation of farmers in the country during 2003 at the request of the Union Ministry of Agriculture. According to the NSS Report (497) on Income and Expenditure of Farmer Households, the average total monthly income of a farmer's household was Rs 2115 (annual income of Rs 25,380). Average monthly income per farmer household from cultivation being Rs 969. Income per farmer household from wages was Rs 819, while income generated from non-farm business was Rs.236 and income from farming of animals was only Rs 91. However, there are large differences in the total income across farm-size classes.

From cultivation, an average household gets a net income of Rs 969 (annual income of Rs 11,628). One household needs more than Rs 20,000 in order to cross poverty line. Here, even an average farmer household is not able to earn half of the income needed to cross the poverty line from cultivation. Incomes of small and marginal farmers will be much lower than that of an average farmer household. Many of the households depend on wages and non-farm businesses to augment their incomes. Even these incomes may not be sufficient to meet the basic necessities including health and education.

Many farmers are shifting to commercial crops. In commercial crops, input intensity is higher than subsistence crops. There is no breakthrough in dry land technology. Cultivation is also being done in marginal lands. Risk is high in commercial crops and marginal lands. The government has identified 32 districts in the four states of Andhra Pradesh, Karnataka, Maharashtra and Kerala and announced a package in September, 2006. Half (16) of these districts are from Andhra Pradesh. Due to this package, these four states would benefit in terms of irrigation projects, bank debt reschedule, writing-off interest, moratorium on loans, support to co-operative banks, increase in new agricultural credit, support to dairy, poultry, fisheries, horticulture, insurance for crops and sheep, etc.. However, it has to be improved from some deficiencies as pointed by the Committee chaired by Radhakrishna (GOI, 2007). First, the design of some of the schemes is not based on the felt needs of households. Second, there is a lack of region- and household-specific flexibility built into these measures. Third, there are implementation and monitoring problems due to lack of proper institutional arrangements

Regional Disparities: There are large regional disparities in output across regions. Certain regions such as Punjab, Haryana, Western Uttar Pradesh, parts of Andhra Pradesh and Tamil Nadu had benefited more during the initial phase of the green revolution than others. This had accentuated regional disparities in the immediate post-green revolution period. An important feature of the 1980s and the early-1990s, however, is that there has been much more equitable spread of agricultural growth. After performing poorly during the early years of the green revolution, many of the states where poverty is widespread. Assam, Bihar, Orissa, Madhya Pradesh and West Bengal have shown significant growth during the 1980s. Oilseeds have also gained in the dry belts of Rajasthan, Madhya Pradesh, Karnataka and Maharashtra. **Table.2** shows high growth rate in agriculture SDP for many states during the period 1984-85 to 1995-96.

However, growth rates decelerated in all the states except Bihar during the period 1995-96 to 2004-05. The deceleration is the highest in the states with greater proportion of rain-fed areas (Gujarat, Rajasthan, M.P., Karnataka and Maharashtra). Agricultural growth in these states was less than one per cent per annum during the previous decade.

VIII. Problems and Reasons for Deceleration in Agriculture

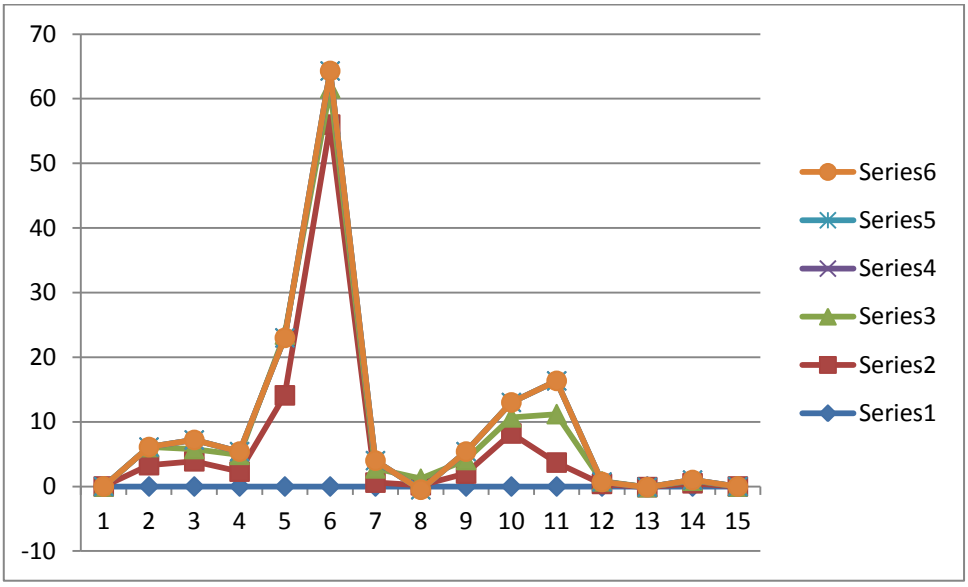
To recapitulate, agriculture sector has many problems. Its growth rate has been less than 2% since the mid-1990s, although there are signs of improvement in recent years. Yield growth has also declined. Farming is becoming a non-viable activity. There are also other problems. Further scope for increase in net sown area is limited. Land degradation in the form of depletion of soil fertility, erosion and water logging has increased. There has been a decline in the surface irrigation expansion rate and reduction in groundwater table. Risk and vulnerability have increased. Disparities in productivity across regions and crops have persisted. Long-term factors like steeper decline in per capita land availability and shrinking of farm size are also responsible for the agrarian crisis. The Steering Committee report on agriculture for 11th Plan (GOI, 2007a) has identified the possible reasons for deceleration in agriculture since mid-1990s. According to the report, the major sources of agricultural growth are: public and private investments in agriculture and rural infrastructure including irrigation, technological change, diversification of agriculture and fertilizers. It looks like that the progress on all these sources slowed down in the 1990s particularly since mid-1990s **(Table 3).**

Table: 3 Trend Growth Rate (percent/year) in Area, Input-use, Credit and Capital Stock in Agriculture during 1980-81 to 2003-04

Particulars	1980-81 to 1990-91	1990-91 to 1996-97	1996-97 to 2005-06
Technology	3.3	2.8	0.0
Public sector net fixed capital stock	3.9	1.9	1.4
Gross irrigated area	2.3	2.6	0.5
Electricity consumption in agriculture	14.1	9.4	-0.5
Area under fruit and vegetables	56	5.6	2.7
Private sector net fixed capital stock	0.6	2.2	1.2
Terms of trade	0.2	1.0	-1.7
Total net fixed capital stock	2.0	2.1	1.3
NPK use	8.2	2.5	2.3
Credit supply	3.7	7.5	5.14
Total cropped area	0.4	0.4	-0.1
Net sown area	-00.1	0.0	-0..2
Cropping intensity	0.5	0.4	0.1

Source: GOI (2008)

Figure: 33 Trend Growth Rate (percent/year) in Area, Input-use, Credit and Capital Stock in Agriculture during 1980-81 to 2003-04



According to the report, the causes of slow down are: increase in subsidies crowding out investment in infrastructure, degradation of natural resources, failure in conservation and improvement of rain-fed land, knowledge gap with existing technology, low market infrastructure and too much regulation, institutions not geared to help women farmers, imperfections in land market and plight of small farmers.

IX. Diversification by Maintaining Food Security

There has been diversification of Indian diets away from food-grains to high-value products like milk and meat products and vegetables and fruits. The increasing middle-class due to rapid urbanization, increasing per-capita income, increased participation of women in urban jobs and impact of globalization has been largely responsible for the diet diversification in India. Hi-value products have caught the fancy of the expanding middle-class and the result is visible in the growing demand for hi-value processed products. There is a growing demand for non-food-grain items in India. The expenditure elasticity for non-cereal food items is still quite high in India. It is thrice as high when compared to cereals in the rural areas and over ten-times as high in urban areas. Per capita consumption of fruits and vegetables showed the highest, growth followed by edible oils. Diversification to high-value crops and allied activities is one of the important sources for raising agricultural growth. Since risk is high for diversification, necessary support in infrastructure and marketing is needed. Price policy should also encourage diversification.

However, diversification should not be at the cost of food grains and other food crops. Efforts should be continued to improve the yields of food crops. Diversification is unlikely to be a feasible strategy all over the country, if it is restricted only to agriculture-related activities like shift from cereals to horticultural crops. The true benefit of diversification will come if more emphasis is given on allied activities like animal husbandry and fisheries. The livestock sector contributes 5.4% to GDP and 22.7% to total output from agriculture sector. Value of milk group (Rest 103804 core) is more compared to paddy (Rs 73965 core) and wheat (Rs 43816 core). Rural women play a significant role in animal husbandry and are directly involved in major operations like feeding, breeding, management and health care. As the ownership of livestock is more evenly distributed with landless labourers, and marginal farmers, the progress in this sector will result in a more balanced development of the rural economy, particularly in the reduction of poverty ratio.

i. Households are engaging in agricultural crop production

Crop producing farmers in India. GLSS5 data shows that not only 70% of surveyed rural households reported owning agricultural land, but also more than one-quarter of urban households own agricultural land. The number of rural households who are engaged in crop production is more than the number of rural households who own the agricultural land, accounting for 86% of survey rural households.

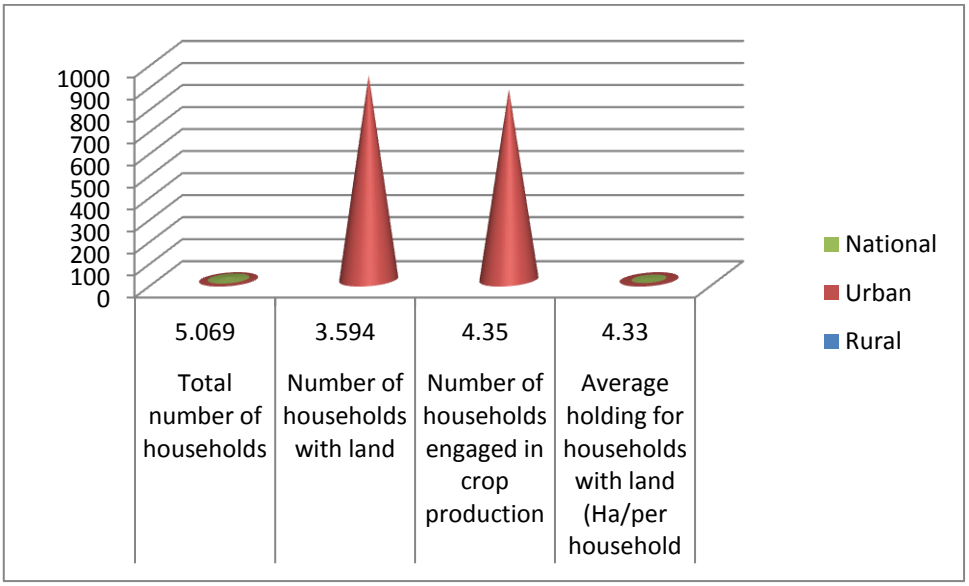
On the other hand, it is an opposite situation for the urban households, for which the number of households who are engaged in crop production is slightly less than those who own agricultural land (Table 4). The fact that there are still 24% of urban households engaged in crop production seems to indicate that agriculture is also an income source for some urban households, though it is not necessary a main source of income.

Table: 4. Household agricultural landholding and engagement in crop production (Ha – hectares)

	Total number of households	Number of households with land	Number of households engaged in crop production	Average holding for households with land (Ha/per household
Rural	**5.069**	**3.594**	**4.350**	**4.33**
Urban	**3.618**	**924**	**859**	**2.69**
National	**8.687**	**4.518**	**5.209**	**3.96**

Source: Calculation using GLSS5 data.

Figure: 4 Household agricultural landholding and engagement in crop production (Ha – hectares)



We also calculate the average holding size of those households who own the land. As shown in Table 4, the average holding size per household is 4.33 hectare in the rural areas and 2.69 hectare is in the urban areas (column 2, Table 4). Among rural households that do own land, Table 5shows that nearly half of landholders own less than two hectares, the size of land smaller than that for an average urban household. On the other hand, about one third rural households own land between two and five hectares, and the remaining 18% own more than five hectares. This 18% of households disproportionately own 64% of total agricultural land; meanwhile the other 82% of households own 36% of total agricultural land.

Table 5. Number of rural households by landholding size

	Number of rural households that own land	% of total rural households with land	% of total land owned by rural households
Less than 2 Ha	**1.803**	**49**	**11**
2 to 5 Ha	**1.201**	**33**	**25**
5 to 10 Ha	**339**	**11**	**16**
More than 10 Ha	**251**	**7**	**48**
Rural Total	**3.594**	**100**	**100**

Source: Calculation using GLSS5 data.

X. Conclusion

- The main challenges are improving productivity and moving towards high-value agriculture and promote rural non-farm sector by maintaining food security for reducing poverty and hunger.
- The criteria of either exclusive dependence on rainfall or an area with assured irrigation are being replaced by typologies that include social, cultural, economic and agro-ecological features
- The government is thinking of big push to education in 11th Five Year Plan. Such a big push is needed for agriculture.
- Given the short-run and urban households engaged in crop production seems to indicate that agriculture is also an income source for some urban households,
- Structural long-term problems in agriculture, the government should give large push to core issues like public investment in infrastructure, land and water management, including rain water conservation and watershed development, research and extension, price stabilization, etc. to make cultivation viable and profitable.
- The rich variety when processed and marketed can help India take care of the health needs of its population besides being major export commodities.
- Sensitization and motivation of farmers to shift to alternative crops in water deficient areas of the state is most required.
- There is a need to concentrate on delivery systems also. India's large number of farmers and poor can benefit if there are right policies and their effective implementation.

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