SUSTAINABLE CROP DIVERSIFICATION TO STABILIZE PRODUCTIVITY AND PROFITABILITY

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Abstract

India has diverse agro-climatic conditions; a large number of agricultural items are produced. Broadly, these can be classified into two groups - food grains crops and commercial crops. Due to the challenge of feeding our vast population and the experience of food shortages in the pre-independence era, 'self reliance' in food grains has been the cornerstone of our policies in the last 50 years. Around 66 percent of the total cultivated area is under food grain crops (cereals and pulses). Concurrently, commercial agriculture developed for whatever reasons in the pre-independent phase also kept flourishing during the post independent period. Commercial agriculture not only catered to the domestic market but has also been one of the major earners of foreign exchange for the country. Crop diversification is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk. Crop diversification in India is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops.

Keywords: self reliance, commercial agriculture, domestic market, crop diversification, remunerative.

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Introduction

Crop diversification refers to the addition of new crops or enterprises with or without the addition a shift from one crop or enterprise in a production system. It needs to sustain the production system of the region by enhancing the soil health, reducing biotic and abiotic stresses and increasing employment generation. The main goal of crop diversification is to stabilize farm income and promote better farm linkages among primary, secondary and tertiary sectors of economic activity. The main form and the commonly understood concept is the addition of more crops to the existing cropping system, which could be referred to as horizontal diversification. The other is vertical crop diversification in which various other downstream activities are undertaken India is a country of about one billion people. More than 70 percent of India's population lives in rural areas where the main occupation is agriculture. Indian agriculture is characterized by small farm holdings. The average farm size is only 1.57 hectares. Around 93 percent of farmers have land holdings smaller than 4 ha and they cultivate nearly 55 percent of the arable land. On the other hand, only 1.6 of the farmers has operational land holdings above 10 ha and they utilize 17.4 percent of the total cultivated land.

Crop diversification is intended to give a wider choice in the production of a variety of crops. The crop shift (diversification) also takes place due to governmental policies and thrust on some crops over a given time, for example creation of the Technology Mission on Oilseeds (TMO) to give thrust on oilseeds production as a national need for the country's requirement for less dependency on imports. Market infrastructure development and certain other price related supports also induce crop shift. Often low volume high-value crops like spices also aid in crop diversification.

Higher profitability and also the resilience/stability in production also induce crop diversification, for example sugar cane replacing rice and wheat. Crop diversification and also the growing of large number of crops are practiced in rainfed lands to reduce the risk factor of crop failures due to drought or less rain. Crop substitution and shift are also taking place in the areas with distinct soil problems. For example, the growing of rice in high water table areas replacing oilseeds, pulses and cotton; promotion of soybean in place of sorghum in vertisols (medium and deep black soils) etc. . Crops may vary in seed size, branching pattern, in height, flower color, fruiting time, or flavor. They may also vary in less obvious characteristics such as their response to heat, cold or drought, or their ability to resist specific diseases and pests. It is possible to discover variation in almost every conceivable trait, including nutritional qualities, preparation and cooking techniques, and of course how a crop tastes. And if a trait cannot be found in the crop itself, it can often be found in a wild relative of the crop; a plant that has similar species that have not been farmed or used in agriculture, but exist in the wild.

Agricultural diversification

In the agricultural context, diversification can be regarded as the re-allocation of some of a farm's productive resources, such as land, capital, farm equipment and paid labour, into new activities. These can be new crops or livestock products, value-adding activities, provision of services to other farmers and, particularly in richer countries, non-farming activities such as restaurants and shops. Factors leading to decisions to diversify are many, but include; reducing risk, responding to changing consumer demands or changing government policy, responding to external shocks and, more recently, as a consequence of climate change. **(**Singh, 2006)

OPPORTUNITIES

Changing consumer demand

As consumers in developing countries become richer, food consumption patterns change noticeably. People move away from a diet based on staples to one with a greater content of animal products (meat, eggs and dairy) and fruits and vegetables. In turn, more dynamic farmers are able to diversify to meet these needs.

Changing demographics

Rapid urbanization in developing countries has an impact on consumption patterns. Moreover, a smaller number of farmers, in percentage terms at least, has to supply a larger number of consumers. While this may not imply diversification it does require adaptation to new farming techniques to meet the higher level of demand.

Export potential

Developing country farmers have had considerable success by diversifying into crops that can meet export market demand. While concern about food miles, as well as the cost of complying with supermarket certification requirements such as for Global GAP may jeopardize this success in the long run, there remains much potential to diversify to meet export markets.

Adding value

The pattern witnessed in the West, and now becoming widespread in developing countries, is for consumers to devote less and less time to food preparation. They increasingly require ready-prepared

meals and labour saving packaging, such as pre-cut salads. This provides the opportunity for farmers to diversify into value addition, particularly in countries where supermarkets play a major role in retailing.

Changing marketing opportunities

The changing of government policies that control the way in which farmers can link to markets can open up new diversification possibilities. For example, in India policy changes to remove the monopoly of state "regulated markets" to handle all transactions made it possible for farmers to establish direct contracts with buyers for new products [4].

Improving nutrition

Diversifying from the monoculture of traditional staples can have important nutritional benefits for farmers in developing countries.

Threats

Urbanization

This is both an opportunity and a threat, in that the expansion of cities places pressure on land resources and puts up the value of the land. If farmers are to remain on the land they need to generate greater income from that land than they could by growing basic staples. This fact, and the proximity of markets, explains why farmers close to urban areas tend to diversify into high-value crops.

Risk

Farmers face risk from bad weather and from fluctuating prices. Diversification is a logical response to both. For example, some crops are more drought resistant than others, but may offer poorer economic returns. A diversified portfolio of products should ensure that farmers don't suffer complete ruin when the weather is bad. Similarly, diversification can manage price risk, on the assumption that not all products will suffer low prices at the same time. In fact, farmers often do the opposite of diversification by planting products that have a high price in one year, only to see the price collapse in the next, as explained by the cobweb theory.

External threats

Farmers who are dependent on exports run the risk that conditions will change in their markets, not because of a change in consumer demand but because of policy changes. A classic example is the Caribbean banana industry, which collapsed as a result of the removal of quota protection on EU markets, necessitating diversification by the region's farmers.

Domestic policy threats

Agricultural production is sometimes undertaken as a consequence of government subsidies, rather than because it is inherently profitable. The reduction or removal of those subsidies, whether direct or indirect, can have a major impact on farmers and provide a significant incentive for diversification or, in some cases, for returning to production of crops grown prior to the introduction of subsidies.

Climate change

The type of crop that can be grown is affected by changes in temperatures and the length of the growing season. Climate change could also modify the availability of water for production. Farmers in several countries, including Canada, India, Kenya, Mozambique and Sri Lanka have already initiated diversification as a response to climate change. Government policy in Kenya to promote crop diversification has included the removal of subsidies for some crops, encouraging land-use zoning and introducing differential land tax systems.

Opportunities for diversification

In making decisions about diversification farmers need to consider whether income generated by new farm enterprises will be greater than the existing activities, with similar or less risk. While growing new crops or raising animals may be technically possible, these may not be suitable for many farmers in terms of their land, labour and capital resources. Moreover, markets for the products may be lacking. The United Nations Food and Agriculture Organization (FAO) has been one of the development organizations promoting diversification by small farmers. So far, it has produced booklets identifying beekeeping, mushroom farming, milk production, fish ponds and sheep and goats, among others, as diversification possibilities.

Pattern and trends in crop diversification in India Compositional changes in cropped area (percent)

Year	Cereals	Pulses	Oilseeds	Fibers	Sugar cane	Fruits & Vegetables	Others
1980-91	60.63	13.9	9.0	5.5	1.6	3.2	1.1
1990-00	56.5	13.3	10.6	5.5	1.8	3.8	1.3
2000-01	43.3	13.0	12.9	4.7	2.0	5.6	1.5
2001-05	39.1	9.4	14.8	5.2	2.2	6.2	1.9

***(Source:** National accounts statistics of India)*

Need For Crop Diversification (Singh,2006)

- To break the monotony of the traditional system of cultivation.
- Present market scenario and environmental concerns necessitates urgent need to diversify systems using high-value and less water demanding crops.
- The existing cropping pattern may not be economically viable due to changing rainfall pattern over years, ground water depletion, and hike in labour wages.
- Fight hunger and malnutrition.

During the late 60s and 70s, for example, the Green Revolution drew the entire world's attention to the power of new technologies to accelerate agricultural development. Massive famines, considered inevitable by some, were narrowly avoided through the hard work and dedication of international and national researchers working closely with government officials. With the food problem seemingly under control, the world's attention shifted to other issues such as environmental degradation and social equity. Some people even became suspicious of the Green Revolution, noting that while wealthier farmers with larger, high-quality land holdings and access to inputs were capable of capitalizing on the new technologies, the rural poor were left further behind than ever.

Catalysts for Crop Diversification

- Demand
- Supply response
- Price

- Market mechanism
- Competitiveness
- Sustainability
- Response for efficient resource use

Food demand in developing countries is essentially a function of population growth and income increase. As regards population, with 4.44 billion people in 1995/97, developing countries accounted for 77 percent of the world population. In 2030, the proportion will increase to 83 percent with an estimated population of 6.7 billion. South and Southeast Asia together will continue to account for more than 50 percent of the world's population, 53 and 52 percent towards 2015 and 2030, respectively, although the rates of growth will decelerate considerably, especially in East Asia. Given the high base level population and not-so-low growth rate, the share of South Asia in the world's population will increase from the current level of 22 percent to 24 percent in 2030, annually adding 19 million towards 2015 and 16 million people towards 2030. The corresponding increments for East Asia were 16 and 9 million. During the next 30 years, nearly one billion additional people will be added to the population of South, Southeast and East Asia, and half of this addition will take place in India and China. (Rajiv Mehta, 2005**)**

Factors Influencing Crop Diversification

- Resource related factors
- Technology related factors
- Household related factors
- Price related factors
- Institutional and infrastructure related factors
- Risk factors
- Cost of labour
- Incidence of Pest and Diseases
- Socio-economic factors

Crop Diversification

Aims at:

- ✓ Food & nutrition security,
- ✓ Income growth,

- ✓ Poverty alleviation,
- ✓ Employment generation,
- ✓ Judicious use of land and water resources,
- ✓ Sustainable agricultural development, and
- ✓ Environmental improvement.

Malnutrition, in india, is still an issue of national urgency with considerable damage to the health and survival of the most vulnerable group i.e., children and women. Though food production has increased over the last few decades, a downward trend in the intake of calories per person per day has resulted in widespread chronic dietary deficiency. The consumption of food items other than the cereals is much less than the minimum requirements. Further, the composition of the diet is not balanced as 85 percent of the calorie and 60 percent of the protein intake is derived from cereals. The main reasons for such a situation are mainly the low diversification of crops, inadequate nutritional knowledge, inequitable distribution of income, and low purchasing power. To address food and nutritional security, a number of projects including TCTTI and CDP have been undertaken in the agriculture sector for increased production of different food items through developing HYVs of cereal crops as well as of pulses, vegetables, fruits, etc. In doing so, the nutritional aspects are given high priority to minimize the existing nutritional deficiency.

The introduction of CDP in the agriculture sector has had a positive effect on raising the production of potato, oilseeds, pulses, fruits and vegetables in the CDP areas as compared with in non CDP areas. The CDP still continues to play a very important role in the economy of the country. Presently, the agriculture sector contributes about 32 percent to the national GDP, nearly 62 percent to the national employment with 57 percent of the labour force in the crop sector alone. It is still the single largest contributor to additional income and employment generation required to reduce rural poverty and to attain sustainable economic development. The TCTTI project has ensured sustainable intensification of rice production in Bangladesh and raised possibilities for expanding crop diversification in the highlands and medium lands during the Rabi season.

The area suitable for crop production is estimated to be a little over 9 million hectares. With the growth in population and other infrastructure development, the cropped areas have been steadily declining. To ensure food and nutrition for the ever increasing population, suitable cropping patterns were introduced based on the concept of crop diversification depending on soils and other agro-climatic conditions, which raised cropping intensity to 185 percent in 1997 from 100 percent in 1979. As agricultural production is seed-fertilizer-water based, so more than 152 production technologies for crops

including varieties and management practices have so far been developed. Private traders/distributors were given permission to have a direct access to the bulk purchase of chemical fertilizers as well as to import TSP and MP fertilizers freely which has led to increased availability and wider adoption of chemical fertilizers at the farm level. Irrigation water was ensured through removing the restriction on the imports of small diesel engines, withdrawal of customs duty, and the abolition of tube-well siting restriction in non-surface irrigation areas, which led to a tangible effect on the demand for irrigation equipment and the rate of increase in area under minor irrigation.

The strategy for sustaining agricultural growth is based on changing the nature of Bangladesh agriculture from a relatively high risk monsoon based to lower risk irrigation based cropping system. Sustaining the growth of rice production and emphasizing and stimulating crop diversification are the key strategies to be pursued in future. This will come from rapid application and expansion of HYV seed-fertilizer-irrigation technology, relying more on competitive markets for inputs delivery, stabilizing soil fertility etc. In order to combat environmental degradation due to pesticide use and ensure effective pest management, the practice of integrated pest management (IPM) will continue to be pursued. A capability is being developed to monitor changes in the environment, particularly of soils and surface and ground water with a view to ensure sustainable agricultural development and environmental protection..

Forms of Crop Diversification

- From low value to high value crops.
- From water loving crop to water saving crop.
- From single crop to multi / mixed crop.
- From crop alone to crop with crop – livestock – fish – apiculture.
- From agriculture production to production with processing and value addition.

Sustainable Resource Management Practices for Crop Diversification (Subbaian, 2007)

It is known fact that there is little scope for further expansion of the net sown area (142 m/ha) and that land scarcity will become an acute feature of the rural economy. Water is a precious national asset and there are several concerns regarding water resources in the country. Therefore, a judicious use of land and water resources will have to be the central theme for sustainability of agricultural growth. There has been a growing concern in recent years about the deteriorating conditions of soil health and water resources due to improper management and pollution. The deterioration in land and water resources has been in the form of land degradation, waterlogging and decline in watertable. There is a greater need to

have an integrated approach in the management of plant nutrients, chemicals and taking effective measures to deal with the overall pollution problems. There are several possible technologies and alternatives to reduce the use of chemicals in agriculture. These alternatives are not perfect substitutes to chemicals but adoption of these can substantially reduce the adverse impact on environment. Proper land and water management policies would reduce environmental degradation. Community and village institutions should be encouraged to participate in protecting natural resources from degradation. Programmes for regeneration of land and water resources will be strengthened.

Effective Irrigation Management

- Where water is scarce, high value but low water requiring crops should be promoted.
- Among several possible approaches, the important approach that could be implemental is adoption of improved water saving technologies including micro irrigation.

Fig: 1

Fig: 2

Cultivation of Water Saving Crops

- Sweet sorghum and Sugar beet requires far less water than costly irrigated sugarcane, making it more accessible to the poor, excellent supplementary crop in sugar cane based industry area.

Fig: 3

Fig: 4

Alternate Cropping System

- Replacement of rice-wheat area by maize-potato-onion system or maize-potato-summer mungbean as alternative crop rotations .
- Saving of irrigation water – 92cm to 117cm.
- Net return
- Maize-potato-onion – Rs.65,243/-
- Rice - wheat – Rs.40,776/-
- Improvement in organic carbon status of soil due to application of FYM to maize and potato. (Sharma , 2010)

Grey to Green Agriculture

- Waste lands can be brought under Jatropha & Pungamia plantations mainly to improve the land.
- Once the plants have established themselves their shade can be used for intercropping of shade loving vegetables that can provide additional income to farmers.
- In addition the tree cover protects the waste & marginal agricultural lands from further degradation by water & wind erosion.

Supplementary cropping

- Sugar beet is an excellent supplementary crop in sugar cane based industry area
- It is short duration crop and also requires less water
- Can also be grown in saline conditions

Increase in cropping intensity

- E.g. one sugar beet and two crops of sweet sorghum can be cultivated in a year.
- Sorghum-Sunflower-Pulses in place of Sugarcane
- More employment opportunities
- Less water requirement
- More area under cultivation



Fig: 5 Fig: 6 Fig: 7

Waste Land Development

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- Intercropping with shade loving vegetables that can provide additional income to farmers.
- Tree cover protects the waste & marginal agricultural lands from further degradation by water & wind erosion.


Fig: 8 Fig: 9

Crop Diversification and Agro Forestry

- Agro-forestry on farmlands can be used for promoting bio fuel plantation without affecting crop production
- The Planning Commission estimated that 3.0 mha of land can be brought under bio fuel plants by planting them as protective hedge around agriculture fields
- It would be possible to cover 13.4 mha of land with *Jatropha Curcas* by the year of 2012

Diversification through Integrated farming systems

Wetlands

- Crop + Fish + Poultry + Mushroom + Pigeon

Irrigated uplands

- Crop + Dairy + Mushroom + Sericulture + Biogas

Dry land

- Crop + Tree + Goat.
- Higher productivity and net return
- Resource recycling
- Soil fertility and environ. Quality
- Employment

Crop Diversification in India (Singh, 2006)

States	Traditional crop grown	Crop to be promoted
Punjab	Rice ,Wheat	Pulses, oilseeds, Fruits, and Vegetables
Haryana	Rice, Wheat	Cotton ,Maize, Arhar, Moong, Fruits, and Vegetables
Uttar Pradesh	Paddy, Wheat	Basmati, Scented paddy, Rabi Maize, Pulses, Mustard, Soybean, and Vegetables,
Rajasthan	Bajra, Cotton, Pulses	Bajra, Pulses, Oilseeds, Green fodder crops, Spices and Horticultural crops
Gujarat	Upland paddy, Coarse cereals	Maize, Sesame, Date palm, Medicinal plants, Spices and Fodder
Tamil Nadu	Rice ,Groundnut, Millets	Pulses, Oilseeds, Onion, and Sugarcane
Karnataka	Groundnut, Cotton, Castor Soybean, and Millets	One on the same

Andhra Pradesh	Cotton, Paddy, Jowar, Groundnut, and Rabi Paddy,	Castor, Red gram, Soybean ,Maize, Sunflower, Sesame, Pulses, Vegetables, and Horticultural crops
Maharashtra	Jowar, Groundnut, Cotton, Mungbean, and Pieeon pea.	Pulses, Oilseeds, Vegetables, and Horticultural crops

Consequences of Crop Diversification

Cropping pattern changes have increasing tendency towards crop specialization and commercialization of agriculture.

Positive changes:

- Increase in land and labour productivity.
- Increase in net farm income.
- New sets of rural non-farm activities.
- Strengthening the rural urban growth linkages.

Negative impacts:

- Weakening of the traditional inter sectoral linkages between the crop and livestock sectors.
- Environmental consequences such as ground water depletion, soil fertility loss, water logging and salinity etc.,

Constraints in Crop Diversification

Crop diversification in the country is taking the form of increased areas under commercial crops including vegetables and fruits since independence. However, this has gained momentum in the last decade favouring increased area under vegetables and fruits and also to some extent on commercial crops like sugar cane, cotton and oilseeds crops specially soybean. The major problems and constraints in crop diversification are primarily due to the following reasons with varied degrees of influence:

- Over 117 m/ha (63 percent) of the cropped area in the country is completely dependent on rainfall.
- Sub-optimal and over-use of resources like land and water resources, causing a negative impact on the environment and sustainability of agriculture.

- Inadequate supply of seeds and plants of improved cultivars.
- Fragmentation of land holding less favouring modernization and mechanization of agriculture.
- Poor basic infrastructure like rural roads, power, transport, communications etc.
- Inadequate post-harvest technologies and inadequate infrastructure for post-harvest handling of perishable horticultural produce.
- Very weak agro-based industry.
- Weak research - extension - farmer linkages.
- Inadequately trained human resources together with persistent and large scale illiteracy amongst farmers.
- Host of diseases and pests affecting most crop plants.
- Poor database for horticultural crops.
- Decreased investments in the agricultural sector over the years.

Conclusions

Besides developing technologies for promoting intensification, the country /state must give greater attention to the development of technologies that will facilitate agricultural diversification particularly towards intensive production of fruits, vegetables, flowers and other high value crops that are expected to increase the income growth and generate effective demand for food. Thus, accelerating the pace of crop yields (through technological change) and crop diversification (in favor of high-value commodities) are the options to provide sustainable sources of agricultural growth in future.

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