

Crop diversification

for climate resilient agriculture: Opportunity and challenges

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Crop diversification is an effort to increase crop diversity by temporal and spatial cropping system to enhance productivity, sustainability and maintain the ecological balance. It is recognized as one of the most feasible, cost-effective and rational ways of developing resilience to the changing climate. Adoption of crop diversification can help to increase the income of small landholder farmers, conservation of natural resources, many agronomic benefits in pest management by breaking insect habitats and disease cycles, reducing weeds and soil erosion, and conserving soil moisture. The major challenges observed for the adoption of crop diversification are; maximum cropped area of the country is dependent on rainfall, sub-optimal and over-use of resources like land and water, inadequate supply of seeds and improved plants materials, fragmentation of land holding and inadequate post-harvest infrastructure for perishable produce.

Keywords: Crop diversification, Cropping pattern, Economic stability, Natural calamities

CROP diversification is largely dependent on technology advancements aimed at achieving sustainable intensification and greater productivity while lowering input costs and thus increasing farmer's income. Diversification's dynamic feature includes accommodating new crops or cropping patterns that are best suited to current eco-regional circumstances while ensuring increased productivity and profitability. Agricultural intensification has already aided us in achieving food security, but there is a need to reorient existing agricultural systems to be more sustainable, which continue to address household food, nutrition and environmental security.

Crop diversification aims to provide farmers more options for growing a range of crops in climate-resilient areas and reducing the risk of crop failure due to drought or excess rains. In India, crop diversification is often considered a shift away from less profitable crops toward more profitable crops

and from traditionally grown less remunerative crops to more remunerative crops. Due to the diverse agro-climatic conditions in the country, a large number of agricultural products are produced in country. It depends on geo-climatic, socio-economic conditions and technological development in a region. Crop diversification is intended to promote technological innovations for sustainable agriculture and enable farmers to choose crop alternatives for increased productivity and income.

Crop diversification is one of the most cost-effective ways of reducing income uncertainty, particularly among poor smallholder farmers. Crop diversification's goal is to achieve the sustainable development while also taking into account other aspects of poverty, such as gender equality, food security and nutrition, and vulnerability to climate change.

Component of crop diversification

Organic agriculture: It is a production system that promotes

soil, ecosystem and human health. It is based on ecological processes, biodiversity and cycles that are suited to local conditions, rather than the use of harmful inputs.

Green agriculture: It is an environmental rejuvenation technique that helps to reduce environmental damage while also contributing to poverty reduction and long-term agricultural development.

Eco-agriculture: It is a strategy for increasing and sustaining soil productivity while minimizing environmental impact. It includes biodynamic agriculture, bio-intensive agriculture, permaculture, natural farming and holistic management.

Types of agricultural diversification

Temporal crop diversification

A static, rule-based process to optimize crop rotations based on agronomic, economic, social, or environmental indicators. It is discussed in the following heads:

Crop rotation: Cultivating two or more types of crops in consecutive



Crop rotation

Source: <https://www.permaculturenews.org>



Catch cropping

Source: Struik P C and Bonciarelli F (1997)

growing seasons.

Multiple cropping: Cultivating two or more than two types of crops in a single growing season.

Catch crops: The practice of growing a minor crop with the main crop harvest to increase soil fertility, prevent soil erosion and weeds, pests and diseases, and preserve biodiversity in agro ecosystems.

Relay cropping: The practise of sowing seeds from one crop into another standing crop in order to grow two crops simultaneously.

Spatial crop diversification

Spatial crop diversification can be achieved by growing different crop cultivars and species in different configurations at the same time in a given field. It is discussed in the following heads:

Alley cropping: Growing arable and perennial crops in different broader strips at the same time.

Bee culture: Beekeeping is an agricultural enterprise that generates additional income with commercial and non-commercial crops. Honey

and wax are two economically valuable products.

Companion crops: Growing at least two crops at the same time.

Intercropping: Growing at least two crops in different but adjacent rows at the same time.

Mixed cropping: Growing at least two crops in the same field at the same time, but not in rows.

Trap crops: The cultivation of both commercial and noncommercial crops on the same field in order to control pests and diseases.



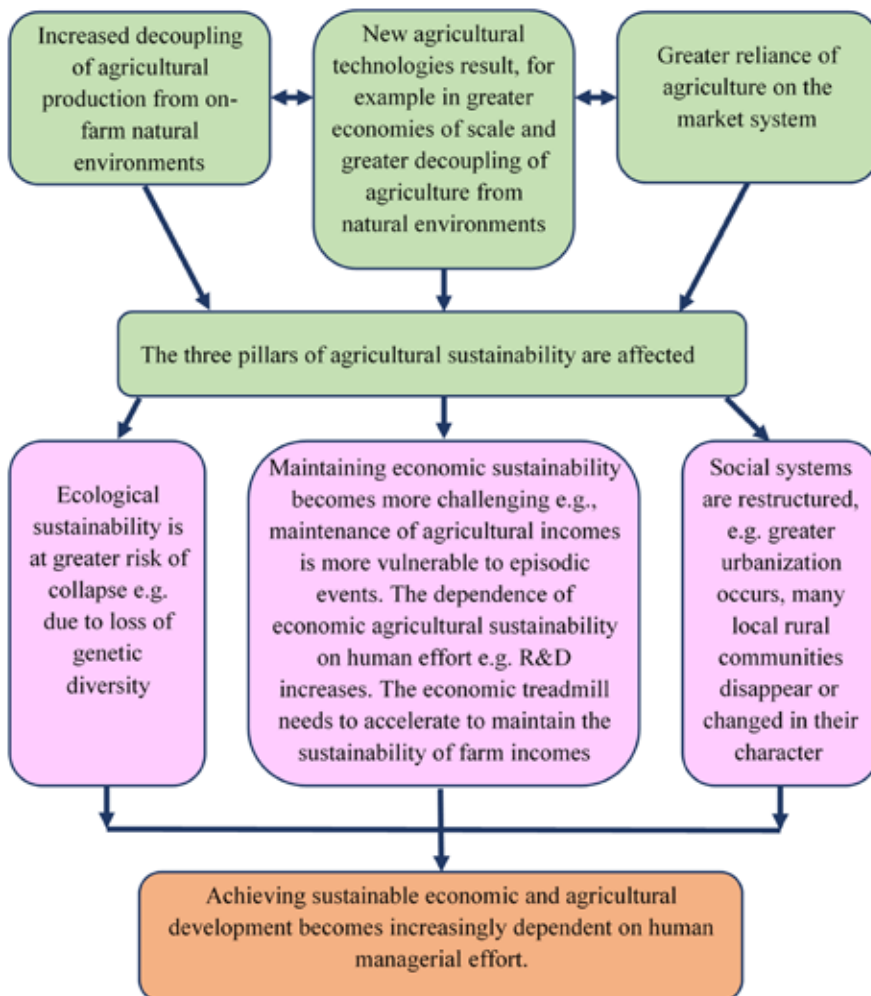
Alley cropping

Source: The Centre For Agroforestry.org



Intercropping

Source: Muoni et al. (2019)



Complex interaction of sustainable factors of crop diversification

Source: Tisdell et al. 2019

Benefits from crop diversification

Economic status of farmers: Crop diversification helps to increase income of small land holding farmers and they can better tolerate the ups and downs in price of various farm products and may ensure economic stability of farming products. At present, 70–80% farmers have land below 2 hectare. To overcome this, existing cropping patterns must be diversified with high value crops such as maize, pulses, etc. The Government of Haryana has also supported this by announcing that farmers switching to other alternate crops instead of paddy will be paid ₹7000 per acre incentive (*Mera Pani - Meri Virasat Scheme*).

Balance food demand: Most of the Indian population suffers from

malnutrition. Crop diversification including crops like pulses, oilseed, horticulture and vegetable crops can improve socioeconomic status by adding quality to the food basket and also improve soil health with the aim of food safety and nutritional security. The Government of India has now targeted to increase the area under pulses and oilseeds through National Food Security Mission (NFSM).

Employment generation: Employment generation is a significant role of agriculture. But adopting the conventional cropping system like rice-wheat generally leads to lack of employment during off seasons. According to a number of studies, there is a serious problem of seasonal unemployment in different regions of our country, which leads to seasonal migration of labours/farmers to surrounding cities/towns in quest of contractual work. Crop diversification helps rural households to have more opportunities of full-time employment.

Conservation of agricultural resources: Adoption of crop diversification helps in conservation of natural resources like introduction of legume in rice-wheat cropping system has the ability to fix atmospheric nitrogen to sustain soil fertility. Soil Health Card (SHC) provides information to farmers on nutrient status of their soil along with recommendations on appropriate dosage of nutrients to be applied for improving soil health and its fertility.

Risk reduction: Crop diversification is very much responsive to climatic and biotic vagaries, particularly in fragile ecosystems by expanding locally adapted or introducing novel varieties and related production systems will help resource-poor farmers to improve their food security and income generation while also protecting the environment. Under sudden

adverse weather conditions like erratic rainfall, drought, hail, incidence of insect and pest disease crop diversification through mixed cropping may be useful.

Challenges of crop diversification

Crop diversification in the country is taking the form of increased areas under commercial crops. The major problems and constraints in crop diversification are as follows:

Suitability for some crops: The majority of cropped area in the country is completely dependent on rainfall therefore some crops may not be able to survive.

Overuse of resources: Over-use of land and water resources, causing a negative impact on the environment and sustainability of agriculture. Animal husbandry is the second largest contributor to human-made Greenhouse Gas (GHG) emissions after fossil fuels and is a leading cause of deforestation, water and air pollution, and biodiversity loss.

Lack of concept of crop diversification: Though there are hundreds of scientific papers in the field of agronomy on agricultural diversity such as crop rotation or intercropping, only a small percentage of these studies are about diversification as a concept.

Lack of knowledge and training: In addition to weak research-extension-farmer linkages, trained human resources together with persistent and large-scale illiteracy amongst the farmers are major challenges to diversification.

Future prospects

Agriculture in the 21st century will increasingly be a farmer's entrepreneurship, utilizing technology to maximize the profits on his land and investments. Technologies, viz. poly-bag nursery farming, micro-irrigation, aquaponics and urban farming, vertical farming, soil and water sensors, weather tracking, satellite imaging, pervasive

automation, minichromosomal technology, decision support systems, governmental policies, geographic information system (GIS), application of information technology will lead crop diversification to primarily on economic considerations. There is a need to identify crops and varieties that may suit a range of environments and farmers' preferences.

Farmers must be constantly inspired and encouraged to explore crop diversification options to improve their sustainability, revenue and employment prospects. There is a need for increased investment in R&D and scaling of innovations linked to sustainable farming systems that are best suited to varying agro-ecologies and it will have a positive effects on income, employment, conservation and use of natural resources.

SUMMARY

Crop diversification is one of the most effective ways to boost farm revenue, resulting in increased food, nutrition and environmental security, as well as poverty reduction in developing countries. It creates a tremendous impact on agro-socio-economic gains. It increased the flow of income throughout the year and offers opportunity to produce crops according to market demand. Crop diversification has the potential to maintain cropping system productivity while also reducing negative environmental consequences and biodiversity loss, but there is a lack of a common understanding of crop diversification, as well as approaches to more systematic research. Crop diversification, on the other hand, must be done in such a way that it does not disrupt the present environmental balance in terms of available natural resources.

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