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6.1 Introduction

In most of the developing countries like India, crop diversification is considered as an important strategy to improve agricultural development and rural development. It is argued that adaptation of crop diversification not only enhance the agricultural growth but it provides resilience to agricultural production from harmful shocks also i.e., variation in rainfall and temperature. Therefore, this study attempted to delineate the extent and role of crop diversification particularly in Punjab. Therefore, considering the key role of crop diversification, this study dealt with following three specific objectives:- (i) to explore the trend and pattern of crop diversification in Punjab; and identified the factors those determine crop diversification; (ii) to assess the impact of weather shocks on crop productivity; and examine the adaptation benefits of crop diversification against these weather shocks; (iii) to estimate the economic efficiency of crop production in Punjab; and determine the effect of crop diversification on economic efficiency.

6.2 Major Findings

6.2.1 Findings based on third chapter (A Temporal Analysis of Crop Diversification in Punjab's Agriculture)

As the key objectives of this chapter are to explore the trend and pattern of crop diversification in Punjab; and to identify the factors those determine crop diversification in Punjab. The major findings of the analysis are listed below-

- 1) The results reveal that due to the advent of green revolution the cropping pattern has been changing in Punjab since the mid-60s. The green revolution has shifted focus of the cultivators of Punjab towards a few crops mainly wheat-rice rotation due to favourable conditions available for these crops in the state. Wheat and rice crops are being sown on maximum area in Punjab. As these crops involve lower risk and more profitability as compared to other competitive crops. The crops such as maize, sugarcane, potato, and onion also experienced mild growth.
- 2) The both- multiannual version (RCat) and binary version (RCt) of indices have found the declining value from 1 to 0.71 for area, 1 to 0.70 for production, and 1 to 0.91 for productivity implying that the mobility of the crops within the overall distribution is virtually lower.
- 3) It is found that key components responsible for the change in total production are area effect and yield effect for wheat and rice. Thus, it observed that decline in crop diversification has been influenced by the increasing contribution of the area effect and yield effect of land to the total production of crops wheat and rice.
- 4) It is found that the key determinants responsible for increased the degree of crop diversification are number of market per/ha, length of road per/ha, urbanization, and number of tractor per/ha. Whereas amount of fertilizer and intensity of irrigation are negatively linked to degree of crop diversification.

6.2.2 Findings based on fourth chapter (Weather Shocks, Crop Productivity, and Crop Diversification: Adaptation Practices in Punjab)

The objective of this chapter is to assess the impact of weather shocks on crop productivity; and to examine the adaptation benefits of crop diversification against the weather shocks. Cultivators are required to protect themselves against these extreme shocks by adopting several ex-ante and ex-post risk-copping appliances. Therefore, in this context the present

study made an effort not only to assess the effects of weather shocks (delayed monsoon), but to find out the role of crop diversification as an adaptation strategy to cope of with weather shocks (delayed monsoon).

- 1) The estimations show that the weather shocks had a negative impact on crop productivity. It found that one standard deviation delay in monsoon onset lowers 3.94 percent agricultural productivity in comparison to the normal arrival of monsoon day.
- 2) It is found that positive and significant coefficient (0.17) of interaction term of monsoon onset day with crop diversification indicates that the crop diversification assists in the negative effects of delayed monsoon arrival on crop productivity.
- 3) Further, it is found that overall results hold even after controlling other additional variables such as share of crop irrigated area, fertilizer.

6.2.3 Findings based on fifth chapter (Economic Efficiency of Agriculture in Punjab)

The injudicious use of inputs affect sustainability of agriculture especially in developing countries where agricultural resources are scarce; and adopting better technologies is not feasible. The set objectives of this chapter were to estimate the economic efficiency of crop production in Punjab; and to determine the effect of crop diversification on economic efficiency.

- 1) It was found that around 23 percent tehsils in Punjab are operating at flatter portion of long-run average cost curve, and remaining 77 percent tehsils are performing above or below the optimum scale of production.
- 2) Further, it observed inefficiency is resulted from both-poor utilization of inputs mix and inappropriate scale size. But, a greater portion of inefficiency is mainly attributed by scale inefficiency rather than pure technical inefficiency.

- 3) The percentage of potential input reduction and the percentage of potential output addition implies that most of the tehsils needs to reduce inputs such as human labour hours per hectare, use of machine, fertilizer amount, and irrigation hours per hectare.
- 4) Additionally, it is also found that tehsils in Punjab failed to choose a suitable combination of inputs which is necessary to achieve cost minimization. Around 23 percent tehsils in case of wheat; and 15 percent tehsils in case of paddy are found inefficient. Therefore, there is substantial scope for upgrading in the performance of inefficient tehsils by carefully choosing combination of inputs at given input prices and scale size.
- 5) Further, it is observed that crop diversification has a positive and significant impact on the technical efficiency, implying that if farmers become more diversified their economic efficiency significantly increases.

6.3 Policy Implications

The findings of the present study have interesting policy implications as it is already said that crop diversification considered as one of the important strategies for sustainable agriculture in developing economics, policy makers have high expectation on crop diversification an its propagation at increasing pace on the basis of the findings of the present study following polices measures are suggested that can be adopted and implemented for enhancement of level of crop diversifications in Punjab in particular, and in India, in general-

1. Redesigning the MSP Policy:

Farmers are consistently devoting maximum their crop area for wheat and rice crop only.

It is mainly the result of MSP backed agricultural policy. This encourages the farmers to put larger share of their area under two crops wheat and paddy only. Therefore, it is suggested to review the MSP policy. Here, gradual withdrawal for MSP for wheat and

rice crops be sought to reinforce the crop diversification and to demotivate discourage the farmers for doing specialized in cropping of wheat-rice rotation.

2. Providing incentives for Oilseed and Pulses Cultivation:

Especially oilseed and pulses are very vulnerable to climate and other factors. Therefore, it's need of the hour to provide direct incentives to the cultivators of these crops as subsidize insurance policy, low cost inputs, assured prices, and market. Moreover, It also observed the positive and significant coefficient of HHI in regression analysis, therefore it is suggested that to provide more incentives to encourage the farmers for producing multiple crops. It is because if farmers are become more diversified their economic efficiency significantly increases.

3. Educating Farmers:

No doubt area effect and yield effect are showing positive growth trend for the specialized crops; but soon it reaches to the diminishing return due to severe loss of nutrition value of soil and emergence of resistant pests. Therefore, educating the farmers for sowing different crops becomes inevitable. For this, it is suggested to establish training and education centre at tehsil level especially for educating the farmers for growing different crops and its benefits.

4. Crop Diversification Oriented Infrastructure:

Since market per hectare and length of road per hectare are found positively impacting the level of crop diversification, so it suggested that infrastructure aspects in Punjab should be taken on priority. This may include building of connecting roads from farms to markets. Similarly, food processing units should be established at local levels.

5. Region-specific Climate Warning System:

Weather shocks are very challenging for cultivators especially irregularity of monsoon/rains. Weather shocks are crop specific and region specific in nature, therefore, there is a need to strengthen region-specific or crop-specific early warning system to provide farmers timely information on weather conditions, so that, they become better-prepared to choose crops and other agronomic practices in anticipation of a shock.

6. Promoting Climate-resilient Crops and Mix-cropping:

In order to minimize the adverse effects of weather shocks, the government should promote climate-resilient crops not only in Punjab but in India also. Similarly mix-cropping is also need of the hours to reduce the losses in productivity from extreme weather shocks.

7. Crop Diversification as a Primary Tool for Climate Adaptation:

Since coefficient of CEI has been found positive and significant in adaptation analysis in this study, therefore it is suggested that in the formulation of agricultural policy, crop diversification must be given importance as primary tool against climatic shocks.

8. Practice Training Oriented:

The availability of input sources are region-specific; hence there is a need of practical guidance and necessary (soil quality, water requirement etc.) information to inefficient tehsils in selecting the appropriate combination of inputs at given input prices so that they could develop and adopt better allocation of resources and other practices in production process. Therefore, it is suggested to conduct regular practice oriented training programme to the farmers of inefficient tehsils so that farmers can utilise proper technology which would improve their assets quality; and ultimately enhance their technical efficiency and productivity level.

6.4 Limitation and Directions for Future Research

Though the present research entitled '*An Empirical Analysis of Determinants of Crop Diversification in Punjab.*' has been able to accomplish significant results, there are some issues that need to be addressed in future research and limitation of the study.

- 1) In this study, entire analysis is carried out using secondary data at farm level. Further studies can be accompanied using primary data which may drive the results that would have the scope of capturing the true experiences of farmers under study.
- 2) This study is mainly focused on static modelling approaches to see the impact of crop diversification on crop productivity in the presence of weather shocks, but do not emphasize on the dynamic relationships that exist in the production process. Farmers' current year decisions on the choice of crop pattern and resources use are influenced not only by the anticipated weather conditions but also by their past experiences. Therefore, for further analysis it can be estimate the dynamic impact of the variables.
- 3) This study is analyzed the impact of weather shocks on crop productivity in aggregate and district level, further it can be seen on disaggregate level such as household level or farmers size of land holding.
- 4) In this study only estimated the linear impact of the variables on crop productivity, further it can be seen the non-linear impacts of the variables by adding square term in the analysis.