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Determinants of Crop Diversification towards High Value Crops in Pakistan

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Abstract

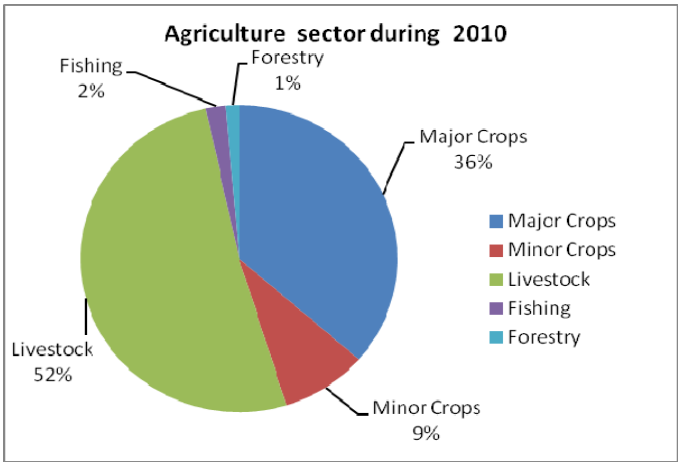
The Generalized Least Square (GLS) technique with fixed-effect model was applied to examine the impact of different forces on crop diversification in Pakistan for the period 1980 to 2011. The study suggested that Crop diversification was needed from low value to high value crops; from single crop to multiple crops and from agriculture production to production with processing and value additions, besides developing technologies for promoting crop diversification, the country must give greater attention to the development of technologies that would facilitate the agricultural diversification particularly towards intensive production of fruits, vegetables and other high value crops that would increase the income growth and generate effective demand for food. Diversification towards high value and labor intensive crops could provide adequate income and employment to the farmers. To capture the effect of infrastructural development, length of roads was included in the model it yielded positive and significant impact on crop diversification. Similarly, the demand-side factors such as per-capita income showed a positive and significant impact, whereas the regression coefficient of population showed a negative and significant impact on crop diversification towards HVC. Fertilizer and number of tube wells that turned-out to be significant, the regression coefficient of both variables showed a positive relationship, it meant that the crop diversification in favor of horticultural commodities enhanced with increase in the use of fertilizer, number of tube wells. Availability of water for the irrigation purpose, which turned-out to be significant and showed a positive relationship, It showed that the crop diversification in favor of horticultural commodities boost up with the availability of water. Rainfall was also significant with negative sign, indicating that crop diversification was limited in areas with higher rainfall. The farmers in these areas naturally preferred cultivating rice, and it was only in the medium and low rainfall areas that farmers wanted to diversify to increase their income and minimize risks.

Keywords: Crop diversification, High value commodities, minor crops, yield, horticulture labor intensive,

INTRODUCTION

Traditionally, agricultural diversification referred to a subsistence kind of farming wherein farmers were cultivating varieties of crops on a piece of land and undertaking several enterprises on their farm portfolio. Household food and income security were the basic objectives of agricultural diversification. Diversification at the farm level is supposed to increase the farm income; the utility of diversification as risk management practices however, remains. At the country level, diversification is supposed to increase the extent of self-sufficiency for the country. At the regional level, diversification is being promoted to mitigate negative externalities associated with mono-cropping. The high value usually refers to fruits, vegetables and many agricultural exportable commodities. Considering the multidimensional importance of agricultural diversification, it is important to understand the drivers of agricultural diversification in the country. The determinants of resource diversification have been studied at the macro levels. At macro-level, resource diversification has been studied for the country. Factors responsible for agricultural diversification depend on the way we define and measure agricultural diversification and also the region for which agricultural diversification are being studied. Pingali and Rosegrant (1995) defined diversification as “change in product (or enterprise) choice and input use decisions based on market forces and the principles of profit maximization”.

In Pakistan, major crops and minor crops accounting for 36 percent and 9 percent respectively of agricultural value added, *Livestock,* fishing and forestry sector having 52 percent, 2 percent and 1 percent respectively stake in the agriculture sector as given in diagram 1(Economic survey of Pakistan 2010-11).



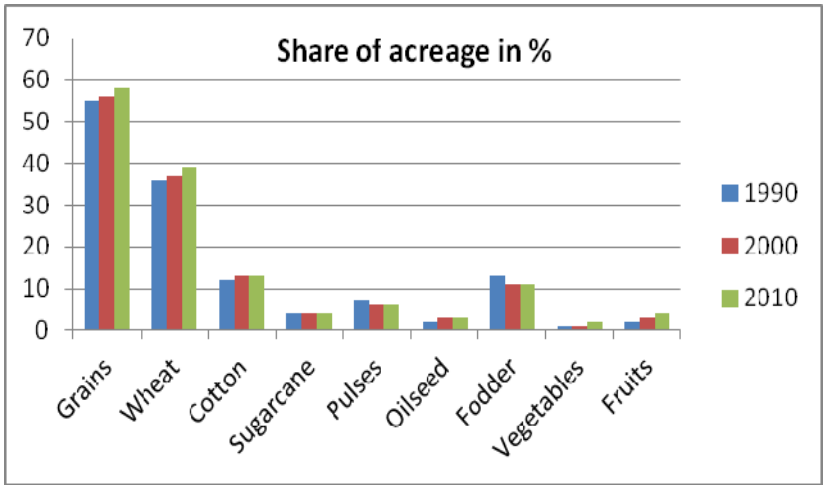
During the year 2010, six major crops (wheat, rice, sugarcane, maize, gram and cotton) account for 76.37 percent of total cropped acreage while other minor crops account for 23.63 percent of the crop acreage, which shows that there is room for diversification towards high value crops at some extent to increase the income of poor masses.

Diversification of agriculture is advocated as one of the important strategies to stabilize and enhance farm income, increase employment opportunities and conserve natural resources. However, the returns from diversification depend on the availability of such infrastructural facilities as irrigation, electricity, transportation, storage, markets, etc. Agricultural diversification encompasses change in production portfolio from low-value to more remunerative and high-value commodities like fruits, vegetables, milk, meat, eggs and fish that expand farm and non-farm sources of income. It not only involves production processes but also new marketing and agri-business-based industrial activities that expand the income sources of rural households and stimulate the overall rural economy. Changes in the share of different commodities in the value of agriculture are used as a proxy of agricultural diversification. Diversification reflects a change in business activities based on the flexible and differentiated response to changing opportunities created by new production technology or markets signals. Market infrastructure development and certain other price related supports also induce crop diversification. Often low volume high-value crops like spices, vegetables, oilseeds and fruits also aid in crop diversification, higher profitability and stability in production also induce crop diversification.

There are two different aspects of diversification. One is to plan under an assumption of perfect knowledge and the second is to minimize the variance of an outcome by attempting to put a floor under the income level or by preventing the occurrence of undesirable outcomes (Dorsey, 1999). Farmers and farm managers, faced price and yield variability, may wish to select a combination of enterprises that reduce the variability of farm income (Mishra and El- Osta, 2002). Diversification is a frequently used risk management strategy that involves participating in more than one activity. It has the added advantage of mitigating price risk as well as fluctuations in outputs. The advantages of engaging in different production systems at the farm level depends upon the level of within-farm heterogeneity in soil and land resources, biological and economic factors, the extent of the sustainability effects, and the gains in fuller utilization of resources in the diversified production system. Such diversification may be constrained by the skill requirement to manage diverse entrepreneurs (Jill and Erin, 2005). Crop diversification intends to give a wider choice in the production of variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk (Imbs and Wacziarg, 2003).

CROP DIVERSIFICATION IN THE PAKISTAN PERSPECTIVE

With the advent of modern agricultural technology, there is a slow pattern of diversification for agriculture in terms of grains, wheat, cotton, sugarcane, pulses, oilseed, fodder, vegetables and fruits, primarily on economic considerations during 1990, 2000 and 2010 as shown in graph 1.



Historically Diversification has been slowed during last two decades in Pakistan, the share of different crops to total cropped area in 1990, 2000 and 2010 are summarized in table 1.

Table-1 Share of Different crops in Total Cropped Area during 1990, 2000 and 2010

	All farms		
Years	**1990**	**2000**	**2010**
Total cropped area (000 ha)	21,820	22,040	23,670
Grains	55	56	58
Wheat	36	37	39
Cotton	12	13	13
Sugarcane	4	4	4
Pulses	7	6	6
Oilseed	2	3	3
Fodder	13	11	11
Vegetables	1	1	2
Fruits	2	3	4
Source: Agricultural Statistics of Pakistan (Various issues)			

From a much generalized perspective, Pakistan's agriculture is increasingly getting influenced more and more by economic factors. This need not be surprising because irrigation expansion, infrastructural development, penetration of rural markets, development and spread of short duration and drought resistant crop technologies have all contributed to minimizing the role of non-economic factors in crop choice of even small farmers. What is more, the reform initiatives undertaken in the context of the ongoing agricultural liberalization and globalization policies are also going to further strengthen the role of price related economic incentives in determining crop composition both at the micro and macro levels. Obviously, such a changing economic environment will also ensure that government price and trade policies will become still more powerful instruments for directing area allocation decisions of farmers, aligning thereby the crop pattern changes in line with the changing demand-supply conditions. In a condition where agricultural growth results more from productivity improvement than from area expansion, the increasing role that price related economic incentives play in crop choice can also pave the way for the next stage of agricultural evolution where growth originates more and more from value-added production.

The overall objective of the study is to assess the factors that are promoting and/or retarding the process of diversification, to ascertain that diversification towards high value crops can provide adequate income and employment to the farmers and to recommend policy prescriptions for the promotion of minor crops based on findings of the study.

REVIEW OF LITERATURE

A number of studies are available wherein different aspects of crop sector have been analyzed and discussed. Therefore, instead of presenting studies chronologically are being arranged under major headings addressed in these studies. However, a chronological order has been maintained under each heading to understand the state of affairs of the crop sector over the study period (1980-2011).

Availability of resources

Walker *et al.* (1983) has found that the kind of diversification and its consequences and implications are strongly conditioned by different regional agro-climatic and soil environments. Differences in the quantity and quality of resource basis were largely responsible for variation in diversification. Gupta *et al.* (1985) found that irrigation intensity, farm net worth, price risk, and farm size were strong variables affecting the level of crop diversification. Singh *et al.* (1985) at micro-level has found diversification inversely related to the size of farm.

Ali and Flinn (1989) used a stochastic profit frontier of modified translog type for Basmati rice farmers in Pakistan's Punjab. Factors significantly contributing towards profit losses included level of education, off-farm employment, unavailability of credit and various constraints associated with irrigation and fertilizer application. Anosike *et al.* (1990) has found land tenures, off-farm work, education and environmental variation as important determinant of diversification at the farm level. Lass and Gempesaw (1992) used random coefficients regression methods to determine firm-varying production technologies for a sample of Massachusetts's dairy farms. Results showed that hired labour, land, and machinery inputs were used in excess of efficient levels. All farms underutilized livestock supplies. Although estimated means were closer to optimal levels, efficiencies of feed, crop materials, fuels, and utilities varied. Mahmud *et al*. (1994) concluded that there was an apparent paradox in that many non-cereal crops (e.g., potatoes, vegetables, onions and cotton) were more profitable (both in economic and financial terms) than modern rice cultivation, which was mainly attributed to high risk as well as incompatibility of the existing irrigation system to produce non-cereals in conjunction with rice.

Timmer (1997) stylized the contrast between the diversification of national food production and that of farm-level production for Asian agriculture. He speculated that, as agricultural transformation continued further, the diversification level of national production might go up again because improved commercialization of agriculture allowed ecologically diverse regions to pursue their comparative advantage. But the diversification level at the farm level was likely to go down, since the principle of comparative advantage continued to work, driving each farm to specialize in the activity it could perform the best. Kar *et al.* (2004) concluded that crop diversification in upland areas served as a good measure to mitigate drought as well as increase water use efficiency, while increasing the overall yield of the cropping system in India. Joshi, P.K (2005) evaluated that Indian agriculture was gradually diversifying in favor of high value food commodities, and the production in particular of fruits, vegetables, milk, meat, poultry, and fish had increased remarkably. His study showed that agriculture diversification towards high value food commodities augmented income, generated employment opportunities, empowered women farmers and conserved natural resources. Promoting agricultural diversification towards high value commodities, doing value addition through their processing and creating appropriate markets for them can be used as effective measures to alleviate rural poverty, generate rural employment and conserve natural resources in the niche areas.

Supply side factors

Anderson *et al*., (1982) concluded that in Africa, rural road construction has been found to be associated with increases in agricultural production, especially in non-food export crops, expanded use of agricultural credit, increases in land values, proliferation of small shops and expansion of rural markets. Chand (1995) concluded that there was strong evidence that it was not the farm size, but infrastructure like access to motor able road, market and irrigation which determine the extent, success and profitability of diversification through high paying crops like off-season vegetables. Gannon and Liu (1997) concluded that infrastructure development in poorer regions reduced production and transaction costs. Smith *et al.* (2001) concluded that in poor rural areas infrastructure expanded job opportunities for the less advantaged by reducing the costs to access product and factor markets. Estache (2003) concluded that Infrastructure helped poorer individuals and underdeveloped areas to get connected to core economic activities, thus allowing them to access additional productive opportunities. Joshi *et al.* (2007) found that urbanization was the most important factor behind the growth of high value crops. Further, on the supply side, diversification is influenced by improvement in infrastructure: (roads and markets) and technology.

Ashfaq, M *et al. (*2008) evaluated that the main factors affecting diversification were size of land holding, age of respondent, educational level of respondent, farming experience of respondent, off farm income of respondent, distance of farm from main road and distance of farm from main market and farm machinery. Rahman , Sanzidar (2008) concluded that crop diversification should be a desired strategy for agricultural growth in Bangladesh. Development of the rural infrastructure was also essential as this would not only improve technical efficiency but might also synergistically promote diversification by opening up opportunities for technology diffusion, marketing, storage and resource supplies.

Demand side factors

Guvele (2001) concluded that crop diversification reduces variability in income in Sudan. Birthal, P.S *et al.* (2007) concluded that agriculture diversification towards high-value crops can potentially increase farm

incomes, especially in a country like India where demand for high-value food products had been increasing more quickly than that for staple crops. Van den Berg *et al*. (2007) concluded that diversification into high-value vegetable crops and away from rice will enable Chinese farms to sustain a reasonable income level given present farm-size distributions. Abro, Asif & Sadaqat, Mahapara (2010) concluded that Diversification towards high value and labor intensive crops could provide adequate income and employment to the farmers. Crop diversification towards high value crops indicated that greater attention must be devoted to that avenue for rural income growth and offered an opportunity to augment income, generated employment opportunities, empowered women farmers, and alleviated poverty.

ANALYTICAL FRAMEWORK

The overall objective of the study is to assess the factors that are promoting or retarding the process of diversification, to ascertain that diversification towards high value crops can provide adequate income and employment to the farmers and to recommend policy prescriptions for the promotion of minor crops based on findings of the study.

Framework for decomposition of Agricultural growth

Agricultural growth is a function of the level of technology, government policies, cropped area and production-portfolio. A temporal change in agricultural growth is therefore the cumulative effect of changes in all these components. We have decomposed the effect of different sources on the value of crop output. Since crop sector is the main constituent of agricultural gross domestic product (AgGDP), the value of its output was considered as a proxy of income from agriculture. And crop yields were used as a proxy of the level of technology, real prices as proxy for government policies, gross cropped area for area expansion, and change in production-portfolio (i.e. crop substitution) for agricultural diversification.

Changes in the gross income from a single crop can be decomposed into changes in sown area, changes in yield, changes in price, and a residual that represents the interaction of these three sources of growth. Changes in the gross income of total crop production can be similarly decomposed, except that there is a fourth source of growth: changes in the crop mix toward higher-value crops. A key contribution of this thesis is estimating the contribution of diversification into higher-value crops to the growth in crop income in Pakistan. Each of these sources of growth is, in turn, influenced by various policy and non-policy factors. For example, changes in total crop area reflect changes in weather, population growth, and migration, among other trends.

Yields are affected by the introduction of new varieties, changes in the location of crop production, irrigation investment, and rainfall. Prices are be influenced by trade policy and world prices (in the case of tradable crops), shifts in domestic supply and demand (in the case of non- tradable), agricultural price policy and other variables.

Finally, the share of land allocated to each crop is influenced by relative prices, input costs, extension programs, and other factors. We calculate the contribution of area, yield, prices, and diversification to the growth in gross crop income using the method described by Minot (2003). If A_i is the area under crop i , Y_i is its production per unit area, and P_i is the real price per unit of production, then the gross income or revenue (R) from producing n crops is:

$$R = \sum_{i=1}^{n} A_i Y_i P_i \qquad (1)$$

Expressing Ai as share of crop i in the total cropped area, ai = (Ai/ΣiA i), equation (1) can be rewritten as:

$$R = \left(\sum_{i=1}^{n} a_i Y_i P_i \right) \sum_{i=1}^{n} A_i \qquad (2)$$

To measure the change in gross crop income, we take total derivatives of both sides of equation (2), yielding:

$$dR \cong \left(\sum_{i=1}^{n} a_i Y_i P_i \right) d\left(\sum_{i=1}^{n} A_i \right) + \left(\sum_{i=1}^{n} A_i \right) d\left(\sum_{i=1}^{n} a_i Y_i P_i \right) \qquad (3)$$

This equation holds only approximately because it excludes the interaction Term.

The second term on the right-hand side of equation (3) can be further decomposed from a change in sums to the sum of changes, as follows:

$$dR \cong \left(\sum_{i=1}^{n} a_i Y_i P_i \right) d\left(\sum_{i=1}^{n} A_i \right) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} d(a_i Y_i P_i) \qquad (4)$$

Further expansion of the second term in equation (4) gives the following expression:

$$dR \cong \left(\sum_{i=1}^{n} a_i Y_i P_i \right) d\left(\sum_{i=1}^{n} A_i \right) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} a_i Y_i dP_i + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i P_i dY_i) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (Y_i P_i da_i) \qquad (5)$$

The first term on the right-hand side of equation (5) denotes the change in the gross crop income due to changes in total cropped area. The second term gives the effect of changes in real prices. The third term captures the effect of change in crop yields. And the fourth term describes the change in gross crop income associated with changes in the area composition of crops over time. If the fourth term is positive, this indicates a reallocation of cropland from lower-value crops to higher- value crops, so this term represents the effect of crop diversification on gross crop income. Dividing both side of equation (5) by overall change in gross crop income (dR) gives the proportional contribution of each component in the growth.

The pattern in the sources of growth has implications for the agricultural development policies (Minot, 2003). For example, if a large share of the growth in crop income is associated with area expansion, this may reflect an unsustainable trend, particularly if arable land is limited. Similarly, a pattern in which much of the growth is related to price increases may reflect changes in policy or reduced transportation costs, but it is probably not sustainable in the long run. In either case, the implication is that greater efforts should be made to improve yields and help farmers diversify into higher-value crops.

Several forces influence the nature and speed of agricultural diversification from staple to high-value food commodities. The earlier evidence suggests that this process of diversification was triggered by the rapid technological change in agricultural production, improved rural infrastructure, and changing consumers' preferences (Pingali and Rosegrant 1995). These are broadly classified as demand and supply forces. The demand side forces that have been hypothesized to influence the agricultural diversification include per capita income and urbanization. On the supply side, this diversification is largely influenced by infrastructure (markets and roads), technology (fertilizer, Tube wells and risks in different commodities), resource endowments (water) and socio-economic variables (pressure on land and literacy rate). In this section, we have identified the key drivers of agricultural diversification. The model used to identify the determinants responsible for crop diversification has been described first and then the results have been presented.

The Generalized Least Square (GLS) technique with fixed-effect model is applied to examine the impact of different forces on crop diversification in Pakistan. The procedure of transforming the original variables in such a way that the transformed variables satisfy the assumptions of the classical model and then applying OLS to them is known as the method of generalized least squares (GLS). In short, GLS is OLS on the transformed variables that satisfy the standard least-squares assumptions. The estimators thus obtained are known as GLS estimators, and it is these estimators that are BLUE. (Page-419 of Gujrati 2004)

The following econometric model is used to analyze the data to examine the determinants of crop diversification towards high value commodities in Pakistan;

IHVC = f (Tech, Infer, Res, Dema, Rain, ϵ)

The dependent variable, IHVC was defined as the Index of output values of High value commodities at constant prices with 1980-81 as the base. The independent variables were broadly grouped into (i) technology (TECH) related, (ii) infrastructure (INFR) related, (iii) resources and information (KNOW) related, (iv) demand (DEMA) side, and (v) climate (RAIN) related. To capture their impact, few proxy variables were used in the model. For technology (TECH), these included: Number of tube wells/1000 cropped area of minor crops in hectares, for mechanization (production of tractors in numbers/1000 cropped area of minor crops in hectares, Fertilizer use (kg/ net area sown in million) and Net Area Sown. For infrastructure (*INFER*), length of roads (square km per 1000 ha of gross cropped area) was used as a proxy variable. Water was used as proxy for available resources. On the demand side (*DEMA*) variables, per capita income (Rupees per person) and population in millions were used in the model. The annual rainfall (mm) was used to define the climate (*RAIN*) related variable in the model.

RESULTS AND INTERPRETATION

The objectives of this study were to identify and quantify the major factors driving diversification towards high value crops and to ascertain the diversification towards high value crops could provide adequate income and employment to the farmers.

Determinants of High Value Crops (HVC)

For determining the effect of different factors on diversification a multiple regression model was used to prove that diversification towards high value crops could provide adequate income and employment to the farmers. The values for Index of High Value Commodities computed for measuring horizontal diversification were taken as dependent variable and different factors affecting diversification were taken as independent variables. The following econometric model was used to analyze the data.

IHVC = f (PCI, Population, Roads, Tube wells, Tractors, Water, Fertilizers, Rainfall, NAS, ϵ)

Results of the multivariate regression model have been presented in Table-2. The F-value is 8.22 and was found overall significant. R^2 value is 0.795 which was sufficient keeping in view the nature of the data used in the model. Tests of auto-correlation and heteroscedasticity showed that model is free from these problems.

Table.02 Determinants of Diversification towards HVC				
Explanatory Variables Method: Least Squares Sample: 1980 -2011	**Dependent Variable: Index of High value Commodities at 1980-81 prices**			
	Coefficient	***Std. error***	***t – value***	***P. Value***
PCI (Per Capita Income)	5.887895	2.900478	2.029974	0.0566**
Population	-3.986539	1.273192	-3.131138	0.0055*
Roads	22.12583	7.320620	3.022399	0.0070*
Tube wells	1.019403	0.40062	2.544565	0.0198*
Tractors	2.370335	2.737220	0.865964	0.3973
Water availability	2.633812	1.020670	2.580473	0.0183*
Fertilizer	0.995360	0.406110	2.450964	0.0241*
Rain fall	-0.065194	0.036101	-1.805874	0.0868**
Net Area Sown (NAS)	-13.97859	11.85483	-1.179147	0.2529
C	559.0316	156.8209	3.564776	0.0021*
* and ** Indicate statistical significance at 5 and 10 percent level of significance respectively				

R-squared	0.795594
Adjusted R-squared	0.698770
Durbin-Watson stat	2.354504
F-statistic	8.216926
Prob(F-statistic)	0.000065

To capture the effect of infrastructural development, one important variable, viz. length of roads was included in the model. This variable yielded positive and significant influence on diversification towards high value commodities in Pakistan. Understandably, better road network induced diversification in favor of horticultural commodities and offered low marketing cost and easy and quick disposal of these commodities. Such facilities also reduced the risk of post-harvesting losses in the case of perishable commodities and increase the income of Farmers. Due to poor infrastructural development, the post harvest losses in fruits are of about Rs. 30 billion and in vegetables about Rs. 20 billion. The high rate of post harvest losses in fruits and vegetables and rising consumer prices are resulting in low returns to the growers and traders, besides limiting the national exports. To minimize the post harvest losses in vegetables and fruits to safeguard the interest of growers, processors, traders and as well as consumers. In addition to this, the standardization of pre and post harvest management technologies aimed at minimizing post harvest losses and standardizing market practices are inevitable to promote high value commodities in Pakistan (Alam & Mujtaba 2002).

Similarly, the demand-side factors such as per-capita income showed a positive and significant impact on crop diversification towards high value commodities; it meant that crop diversification towards high value commodities enhanced with the increasing in per capita income, because purchasing power of the farmers augmented and they could purchase more vegetables, fruits, pulses and oilseed. The regression coefficient of population showed a negative and significant impact on crop diversification towards HVCs. It showed that the crop diversification towards HVCs decline with the increased in population, because when the population increased farmers concentrated towards the production of wheat, rice, sugarcane, and cotton to fulfill their basic needs.

The technology was defined by the use of fertilizer, Number of tube wells, Net Area Sown (NAS) and production of Tractors in numbers. But it was fertilizer and number of tube wells that turned-out to be significant. The regression coefficient of these variables showed a positive relationship with diversification. It meant that the crop diversification in favor of horticultural commodities enhanced through increasing the number of tube wells and usage of fertilizer. The coefficient for farm machinery (tractor) is positively related to diversification towards high value commodities but it was insignificant. It showed that farmers, which had tractors, were more likely to diversify, because they could properly perform different farming operations on time and could market their produce easily; therefore they were more likely to diversify towards high value commodities. The regression coefficient of Net Area Sown variable showed a negative relationship with diversification towards HVC. It meant that the crop diversification in favor of horticultural commodities declined by increasing Net Area Sown but it was insignificant.

The resource was defined by the availability of water for the irrigation purpose, which turned-out to be significant. The regression coefficient of this variable showed a positive relationship with diversification

towards HVC. It meant that the crop diversification in favor of horticultural commodities boost up with the availability of water.
Rainfall was another variable considered in the model to assess the impact of climate on crop diversification. The variable was highly significant with negative sign, indicating that crop diversification was limited in areas with higher rainfall. The farmers in these areas naturally preferred cultivating rice, and it was only in the medium and low rainfall areas that farmers wanted to diversify to increase their income and minimize risks.

Analysis of Autocorrelation

To determine whether the serial correlation up to lag order *p*, where *p* is equal to 1 in this case exist in the data. The Breusch–Godfrey serial correlation LM test is used for autocorrelation in the errors in a regression model. It makes use of the residuals from the model being considered in a regression analysis, and a test statistic is derived from these, are presented in Table 10.
The null hypothesis is that there is no serial correlation of any order up to *p*. To analyze whether the null hypothesis can be rejected in this case, the critical $\chi^2(1)$ value of 3.84 is obtained from the table D.4 of the χ^2 distribution (Gujarati 4th edition). Since the calculated Breusch-Godfrey LM test statistic of 0.20455 is less than χ2 (1) tabulated value, we can accept the null hypothesis of no serial correlation up to lag order 1 at the 95% confidence level.

Order of Integration and Testing for Stationarity

The main aim of this section is to test the Pakistan case and whether diversification towards high value commodities applies to this country. This section presents the empirical results and analyses of the study. The stationarity of the time series data is also investigated and seem to be non-stationary, since visually the mean, variance and the auto covariance of the series appear to be time-variant. In all of unit root tests, it is clear that the series are non-stationary at level except IHVC, Fertilizer and rainfall which are stationary at level. A regression that involves such m time series may, therefore, not reflect the true degree of association between them, but may simply highlight the common trend present in any time series data. Nevertheless, the first differences of these series are stationary, as is shown in Table 03.

Unit Root Tests

Table No.03 ADF tests of the series

S.No	Variables	Level/ First difference	Lag	Calculated tau	ADF critical 5%	Stationarity
1	IHVC	Level	3	-3.86	-3.56	Stationary
2	PCI	Level	3	-0.23	-3.56	Non- stationary
		First difference	3	-4.67	-3.56	Stationary
3	Population	Level	3	-1.55	-3.56	Non- stationary
		First difference	3	-5.58	-3.56	Stationary
4	Roads	Level	3	-0.34	-3.56	Non- stationary
		First difference	3	-6.11	-3.56	Stationary
5	Tube wells	Level	3	-2.86	-3.56	Non- stationary
		First difference	3	-7.04	-3.56	Stationary
6	Tractors	Level	3	-1.40	-3.56	Non- stationary
		First difference	3	-4.42	-3.56	Stationary
7	Water	Level	3	-1.97	-3.56	Non- stationary
		First difference	3	-8.38	-3.56	Stationary
8	Fertilizer	Level	3	-4.19	-3.56	Stationary
9	Rain fall	Level	3	-4.55	-3.56	Stationary
10	NAS	Level	3	-3.48	-3.56	Non- stationary
		First difference	3	-8.27	-3.56	Stationary

The augmented Dickey-Fuller unit root tests are applied to determine whether the series are stationary. Table above summarizes the results for all the variables. The results show that Index of High value crops, fertilizer and rainfall variables are stationary at levels since the calculated tau values are greater in absolute terms than the critical values. Whereas, per capita income, population, roads, tube wells, tractors, availability of water and net area sown variables are non-stationary at levels since the calculated tau values are less in absolute terms than the critical values. The variables are found to be stationary only when tested at first difference. Thus, they are mostly integrated of order one I(1). Each of these variables becomes stationary if it is differenced once.

Testing the Residuals for Unit Root

In finding that the time series are co integrated, one could obtain the residuals from the co-integrating regression. The residual of ΔU_t are given below in Table- 04 are tested for the existence of a unit root, therefore. If the residuals are found to be stationary I(0), then a co-integrating relationship will be established.

Table.04 ADF test on the residual at level

Dependent variable: ΔU_t

Independent Variable	*Coefficient*	*Standard error*	*t-Statistic*	*Critical value*
ΔU_t (-1)	-1.004231	0.197236	-5.092	-2.960

R-squared = 0.472 , Adjusted R-squared = 0.454, DW = 1.89

Level of significance is 5%

The decision rule is to reject the null hypothesis if the absolute value of the critical test is greater than the calculated tau. The ADF test statistics reported a result of -5.092, which is bigger negative than the calculated tau-statistic value of -2.960. This means that the series are stationary in level terms. Generally speaking, then, we can conclude that there is a co-integrating relationship amongst variables and interpret its parameters as long run parameters. Furthermore, this means that the original regression is not spurious.

CONCLUSIONS

Pakistani agriculture is diversifying towards High Value Commodities (HVCs) in response to rising per capita income, changing food consumption, increasing urbanization, unfolding globalization, improving infrastructure and reforming policies. HVCs yield higher, more regular and earlier returns compared to food grains. Employment generation and conservation of water resources are additional advantages of agricultural diversification. Smallholders and women are participating more in production of HVCs. But the speed of agricultural diversification towards HVCs has not met expectations mainly due to lack of appropriate markets, institutions and infrastructure as well as lukewarm policy response.

The present analysis has revealed that contribution of high-value commodities has been considerably higher in inducing diversification of agriculture in Pakistan, the production of these commodities being labor-intensive; generate the needed employment opportunities for farmers in the rural areas. However, the small marketable surpluses and high transaction costs are constraints being faced by the smallholders, limiting the speed of agricultural diversification towards high-value food commodities.

This study has corroborated the earlier findings that agricultural diversification towards high-value food commodities could augmented income, generated employment opportunities, empowered women farmers and conserved natural resources. Promoting agricultural diversification towards high-value commodities, doing value-addition through their processing and creating appropriate markets and the strong net work of roads can be used as effective measures to alleviate rural poverty, generate rural employment in the niche areas.

The GLS technique with fixed-effect model was applied to examine the impact of different forces on crop diversification in Pakistan. To capture the effect of infrastructural development, length of roads was included in the model it yielded positive and significant impact on diversification towards HVC in Pakistan. Due to poor infrastructural development, the post harvest losses in fruits are of about Rs. 30 billion and in vegetables about Rs. 20 billion. The high rate of post harvest losses in fruits and vegetables and rising consumer prices are resulting in low returns to the growers and traders, besides limiting the national exports. To minimize post harvest losses in vegetables and fruits to safeguard the interest of growers, processors, traders and as well as consumers. In addition to this, the standardization of pre and post harvest management technologies aimed at minimizing post harvest losses and standardizing market practices are inevitable to promote high value commodities in Pakistan (Alam & Mujtaba 2002).

Similarly, the demand-side factors such as per-capita income showed a positive and significant impact and the regression coefficient of population showed a negative and significant impact on crop diversification towards HVC. The use of fertilizer and number of tube wells that turned-out to be significant, the regression coefficient of both variables showed a positive relationship, it meant that the crop diversification in favor of horticultural commodities enhanced through increasing the number of tube wells and usage of fertilizer. Availability of water for the irrigation purpose, which turned-out to be significant and showed a positive relationship, It meant that the crop diversification in favor of horticultural commodities boost up with the availability of water. Rainfall was also significant with negative sign, indicating that crop diversification was limited in areas with higher rainfall. The farmers in these areas naturally preferred cultivating rice, and it was only in the medium and low rainfall areas that farmers wanted to diversify to increase their income and minimize risks.

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