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Research Article

The Determinant of Agricultural Productivity and Profitability (Rate of Return) In Punjab

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Abstract: The present paper analyzes the farm size, productivity and profitability in districts of Punjab, Mansa and Jalandhar. Cotton though less popular, is cultivated in Mansa mainly due to non-suitability of soil for paddy cultivation and low water availability. It is found that productivity of wheat and paddy has a positive relationship with size of holding, whereas the relationship turns negative for cotton and potato. Further, the productivity of wheat is found high in Jalandhar and of paddy in Mansa.

Keywords: farm size, productivity, profitability, Punjab, Jalandhar and Mansa.

INTRODUCTION

The post globalization period in India is viewed with different perspectives. The high growth rate satisfies a large number of economists and sees the positive impact of openness and structural adjustment, but contrary to this an equal number are of the opinion that it has not ensured balanced sectoral growth and the regional and inter personal inequalities have grown. The growth has occurred from selected sectors and the basic sectors like agricultural and manufacturing are not only lagging behind but they have started stagnating. The agriculture in particular has been marginalized. The agriculture has been cause of concerned to the economists, politicians and researchers because of the dependency of larger segment of population on it. The agricultural development in the post green

revolution period has been very fast and has been contributing significantly to the economy also. This development of agriculture though came to selected areas but those areas alone contributed so much as the production increased over five times to the early sixties. Punjab as an agriculturally developed state has been the major contributor to the production. The overall stagnation of agriculture by the process of marginalization has reached to the stage that not only the contribution to GDP has declined but the growth rate has also reached to its minimum.

In the recent past the Punjab state has experienced the productivity stagnation. This is because the state has been utilizing the modern agricultural technology to the fullest possible level. Almost all farmers across the size of holdings and all districts have been using HYV seeds, chemical fertilizer, irrigation and other machinery. Despite of maximum use of technology the productivity is almost constant and rate of returns have become constant rather in many cases it has declined due to increasing prices of agricultural inputs.

The present paper intends to analyse and tried to answer the question of stagnating productivity and rate of returns in Punjab. The analysis is based on the selected crops which are prominently grown in the two sample districts of Mansa and Jalandhar. The sample farmers have been selected on a random basis and the data for per acre production and the expenditure on various inputs are collected. The rate of returns (profit) has also been analyzed with reference to the technological inputs.

Following are the Main Objective

- To compare cost of cultivation of major crops.
- To estimate profitability of major crops among various size class.

The differences in productivity largely depend on farm size, assets, inputs used. Increase in the operational holding, however, does not have a similar impact of all classes. In the some of the cases, where the possibility of use new technology in cultivation is high and it requires assets like, tractor, tube well etc., to insure proper care of the crop, large holdings are better of compare to small holdings. This leads to higher productivity of large farmers. To test this hypothesis the paper has attempted to use a linear multiple regression. The econometric exercise has been done separately for four major crops, namely, wheat, paddy, cotton, potato. The maize crop is not included due to less number of farmers in our sample who are cultivating this crop, which reduces the degree of freedom.

On the other hand crops that require more manual labour may have higher productivity in small holdings. Thus we may find different relationship between farm size and productivity depending on possibility of substitution between labour and capital. The productivity of crop gives us only one aspect of the process. And second aspect which is equally important is the sustainability of small holdings. The sustainability does not just mean the total income of a farmer but also is indicated through the profits per acre obtained by small holdings. If the small holdings have equal or higher profits per acre then the larger holdings they may still be a viable preposition. However they may not sustain in long if their profitability is low.

They may also in a situation where they have higher profitability in some of the crops and low profitability in others. This may lead to small holdings being specialized in some of crops where they have higher profitability and large holdings may specialize in other crops, where small holdings have lower profitability. To test this hypothesis the paper has used a linear regression model where per acre profit is used as dependent variable. The next subsection will discuss the details of independent variables used in two models.

Determinants of Productivity (per acre production): Productivity per acre has been analyzed with an objective to find out the determinants of productivity. The variables are defined as under:

Size of operational holding (SOH): The productivity debate shows that size of holding is negatively related to productivity (per acre production). However, the later studies found that the advantage of low size of holding disappeared with chose of modern technology and infect large holding have higher productivity. Hence, we expect operational holding to be positively related to farm productivity.

Per acre expenditure on seed (SE): Expenditure on seed shows use of high yield varieties and in higher expenditure is expected to have positive impact on productivity.

Per acre expenditure on pesticides (PE): The use of pesticides reduce the risk of disease and may increase the productivity however it may also be true that pesticide expenditure is high due to high possibility of disease. Therefore, we do not have any a priori expectation about the sign of its coefficient.

Per acre expenditure on fertilizer (FE): The use of fertilizer increase the potential of soil hence expected to add to the productivity of the crop.

Per acre expenditure on manual labour (ML): Since manual labour is associated with low use of machinery which often increases the productivity, a negative co-efficient is expected for manual labour.

Per acre expenditure on machinery (ME): The machinery increases the efficiency of the farmers and they can complete the work much easily. We expect the coefficient of machinery to take positive sign.

Per acre expenditure on irrigation (IR): The high expenditure on irrigation may point out towards better irrigation facilities or higher cost of irrigation. In first case we expect it to have negative relationship with per acre production and positive in second case.

Per acre transportation and interest (TE): Transport and interest adds to the cost therefore any addition in the transport cost may have impact on productivity.

District dummy (DD): The soil condition, water availability also has an impact on productivity. Hence the two districts may have difference in per acre production of any crop. The dummy takes value 0 for Jalandhar and 1 for Mansa.

Tractor (TE) and electric pump (EP): Machinery and timely availability of water is essential for any modern cultivation and their ownership affects the productivity positively through their timely availability. The tractor dummy take value 0 for no tractor and 1 represent ownership of tractor. Similarly electric pump dummy takes value 1 for an electric pump and 0 for no electric pump.

$$\text{Per acre production} = b + b_1\text{SOH} + b_2\text{SE} + b_3\text{PE} + b_4\text{FE} + b_5\text{ML} + b_6\text{ME} + b_7\text{IR} + b_8\text{TE} + b_9\text{DD} + b_{10}\text{TE} + b_{11}\text{EP} + e$$

The associated statistical coefficient of 't' and R^2 are also calculated to test the significance level and variance explained.

Determinants of Profitability (per acre profits): Profitability is measured on the basis of total output minus the total inputs. The net returns are taken as profitability per acre and are explained with help of following explanatory variable defined as under:

Size of operational holding (FRS): The literature has suggested that profit per acre increases with farm size. The reason for this relationship is lower cost of cultivation of large farmers. There are many inputs which are different to divide to fit for small holdings. Hence the small farmer may be underutilizing them. This leads to hypothesis that farm size and per acre profits are positively related.

District dummy (DD): Both the districts have different level of development and differ in their soil type. This may influence the per acre profit of farmers. Here we do not have any a prior expectation about the sign of co-efficient. The dummy takes value 0 for Jalandhar and 1 for Mansa.

Tractor (TE) and electric pump (EP): The both variable are expected to have positive impact on per acre profit threw their effect on cost of cultivation as well as output. The tractor dummy take value 0 for no tractor and 1 represent ownership of tractor. Similarly electric pump dummy takes value 1 for an electric pump and 0 for no electric pump.

Paddy (PD), Potato (PT), Maize (MZ), and Cotton (CT): The profit per acre highly depends on type of crop. Therefore a dummy is taken for crop paddy, cotton, maize and potato. The value 1 for each crop represents the cultivation of that crop and 0 shows non cultivation of that crop. Here wheat is taken as the basic crop to compare other crops.

$$\text{Per acre Profit} = b_0 + b_1 \text{FRS} + b_2 \text{DD} + b_3 \text{TE} + b_4 \text{EP} + b_5 \text{PD} + b_6 \text{PT} + b_7 \text{MZ} + b_8 \text{CT} + e$$

The related tests and statistical is also calculated.

Determinant of Crop Productivity:

Productivity of Wheat: Productivity of wheat is a dependent variable of the two districts explained with help of expenditure on various inputs. The effect of various inputs on productivity is measured with reference to per acre seed expenditure, per acre fertilizer expenditure and per acre pesticides expenditure and per acre irrigation expenditure which is positively related and is significant, which means increase of one unit of any one of these inputs productivity increase. Per acre expenditure on manual labour is negative and is also significant, this means per unit increase in manual labour give no returns on productivity of wheat in both district. The result of multiple regression exercise for the determinant of wheat productivity is given in **Table 1**. The result shows, operational holding has positive impact on wheat productivity, showing about 7.8 kg increase in wheat production for one acre increase in size of holding. The coefficient of operational holding is in-significant at 5 percent level.

Table-1: Dependable Variable: Per Acre Production (Wheat)

Sr. No.	Independent Variable	Co-efficient	t – Value
1	Farm Size	0.07765	2.13
2	Per acre expenditure on Seed	0.00364***	2.80
3	Per acre expenditure on Pesticides	0.00235***	2.94
4	Per acre expenditure on Fertilizer	0.00053	0.91
5	Per acre expenditure on Manual Labour	-0.00035**	-2.31
6	Per acre expenditure on Machinery	0.00082***	3.18
7	Per acre expenditure on Irrigation	0.00150**	2.58
8	Per acre expenditure on Transport and interest	-0.00342***	-3.52
9	District dummy	-2.3258***	-6.98
10	Tractor dummy	0.0276	0.13
11	Electric pump	0.27000	1.22
12	Constant	16.4035***	8.46
	Adjusted R squared	.40	
	No of observation	370	

Note: *** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent

Seed expenditure, pesticides expenditure, machinery expenditure, irrigation expenditure, transportation and interest expenditure also show significant positive impact on wheat productivity. However the coefficients are small that they represent the change in output rupee change in input expenditure on these inputs. Given that this is a small sample, so a very small value of these coefficients may in fact be indicating smaller zero value of the coefficient. The cost of manual labour has a negative coefficient which is significant at 5 percent level; nonetheless it also is too small to be considering different from zero.

The district dummy which is significant at 1 percent level and has negative value, points out towards lower productivity of wheat in Mansa. Mansa on average has 2.3 Qt less per acre production of wheat. The coefficient of fertilizer expenditure, tractor and electric pump are not significant at even 10 percent level. R^2 value shows that about 40 percent of variations are explained by independent variables.

Productivity of Paddy: In case of paddy multiple regressions shows again per acre production increases about 10.5 kg for one acre increase in size of holding (**Table 2**). Seed expenditure, fertilizer expenditure and manual labour expenditure also have positive coefficient which is again too small.

Table-2: Dependable Variable: Per Acre Production (Paddy)

Sr. No.	Independent Variable	Co-efficient	t - Value
1	Farm Size	0.1045***	4.19
2	Per acre expenditure on seed	0.003283***	3.19
3	Per acre expenditure on pesticides	-0.0007817**	-2.35
4	Per acre expenditure on Fertilizer	0.000633**	1.99
5	Per acre expenditure on Manual Labour	0.0002571***	4.21
6	Per acre expenditure on Machinery	-0.000815***	-4.89
7	Per acre expenditure on Irrigation	-0.000954***	-10.94
8	Per acre expenditure on Transport and interest	-0.0008466	-1.55
9	District dummy	1.8472***	10.75
10	Tractor dummy	0.03918	0.26
11	Electric pump	0.1810	1.24
12	Constant	36.09374***	34.52
Adjusted R squared		.63	
No of observation		335	

Note: *** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent

Pesticides expenditure, machinery expenditure and irrigation expenditure has negative significant coefficient however it is also very small. The district dummy this time has a positive and significant co-efficient which shows that productivity of paddy is on average 1.85 Qt higher in Mansa. The adjusted R^2 shows that about 63 percent of variations are explained our model. It is found that the expenditure on inputs have been increasing with the increasing price. But the productivity remains almost the same hence the expenditure on inputs fails to increase the productivity of paddy and wheat.

COTTON

(Cotton Productivity in Mansa district): Cotton crop is sown only in Mansa district. In the multiple regressions for cotton crop district dummy is omitted since only sample of Mansa district has farmers who are cultivating cotton (**Table 3**).

Table-3: Dependable Variable: Per Acre Production (Cotton)

Sr. No.	Independent Variable	Co-efficient	t - Value
1	Farm Size	-.1548**	-2.17
2	Per acre expenditure on seed	.00379***	2.76
3	Per acre expenditure on pesticides	.00092	0.62
4	Per acre expenditure on Fertilizer	.00111	1.29
5	Per acre expenditure on Manual Labour	-.000182*	-1.89
6	Per acre expenditure on Machinery	-.000206	-0.22
7	Per acre expenditure on Irrigation	.000583	1.33
8	Per acre expenditure on Transport and interest	-.00044	-0.25
9	District dummy	Omitted	
10	Tractor dummy	.5237	1.74
11	Electric pump	.5457	.76
12	Constant	3.6907	1.38
Adjusted R squared		.44	
No of observation		65	

Note: *** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent

In case of cotton the operational holding has negative and significant (at 5 percent) coefficient. The value of coefficient shows that with each one acre increase in farm holding approximately there is decline of 15.5 kg of cotton per acre production. Only two other significant variables in case of cotton are seed expenditure and manual labour expenditure which have coefficient almost equal to zero for any practical purpose.

POTATO

(Potato productivity in Jalandhar district): Potato is grown only in Jalandhar district. In the model of potato three independent variables, district dummy, tractors, electric pumps are omitted due to their same value for all the observations (Table 4).

Table-4: Dependable Variable: Per Acre Production (Potato)

Sr. No.	Independent Variable	Co-efficient	t – Value
1	Farm Size	-7.1595*	-1.87
2	Per acre expenditure on seed	.00102	1.01
3	Per acre expenditure on pesticides	-.01881**	-2.52
4	Per acre expenditure on Fertilizer	.0057816	0.83
5	Per acre expenditure on Manual Labour	-.002287	-1.14
6	Per acre expenditure on Machinery	.0101162	1.62
7	Per acre expenditure on Irrigation	-.024151	-1.19
8	Per acre expenditure on Transport and interest	.01365**	2.32
9	District dummy	Omitted	
10	Tractor dummy	Omitted	
11	Electric pump	Omitted	
12	Constant	126.3006***	3.62
Adjusted R squared		.77	
No of observation		30	

Note: *** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent

The model for potato shows there are results similar to that of cotton crop. The coefficient of size holding has a negative coefficient which is significant at 10 percent level. The value of coefficient shows that for one acre increase in land holding there is about 7.2 Qt decline in production of potato. The coefficients of pesticides expenditure and transportation expenditure are also significant at 5 percent level. The pesticides have negative relationship with productivity, where as transportation expenditure is positively associated with productivity of cotton. R^2 value shows that the model explains almost 77 percent of variation independent variable.

Determinant of Profitability (Rate of Return): The responsiveness of price and technology has long been established that farmers assign their resources taking returns on different crops. The rate of return on different crops varies because of the variation in inputs used and the price they receive from each crop. It is long been observed that the rate of return in Punjab has been either constant or has been declining over time. This has lead to the farmers of Punjab to diversify their cropping pattern. Present section of the paper deals with the rate of return i.e. the profitability of different crops in the two districts. The expenditure on different inputs actually determines the level of profitability from the crops.

Table 5 shows the result of regression model for per acre total profits for all the crops together. The results point out that size of holding is positively related to profitability. With each one acre increase in holding size there is about rupees 394 increase in profits per acre. The district dummy has negative sign which is significant at 1 percent level. It shows that on average, farmers from Mansa earn rupees 2931 less than their counterparts in Jalandhar. Tractor, however, does not come to be a significant variable. Ownership of electric pump also has a positive relation with profitability and is the reason for about Rs 470 addition in per acre profit. Paddy, cotton and potato also earns significantly higher income for farmers compare to wheat, whereas maize has lower per acre profits.

Over all the results shows that as holding size increases the productivity wherever machination is possible and lower is where more manual labour is required or possibilities of use of mechanical device is limited. The profitability (per acre profit) is also high for large holdings. Nonetheless higher income from potato crop, which is more labour intensive and mostly preferred by small and large farmers, may still keep small holding economically viable. Despite these findings in favour of small holdings, overall trend is against them and they may not sustain in long run unless they diversify to crops which are more labour intensive or they adopt some alternative arrangement of production.

Table-5: Dependable Variable Total Profitability

Sr. No.	Independent Variable	Co-efficient	t - Value
1	Operational holding	393.78***	11.36
2	District dummy	-2930.94***	-13.16
3	Tractor dummy	71.25	-0.25
4	Electric pump	470.306*	1.66
5	Paddy dummy	901.62***	4.44
6	Cotton dummy	7045.74***	18.88
7	Maize dummy	-2373.99***	-2.73
8	Potato dummy	8888.853***	16.66
9	Constant	19382.8***	74.48
Adjusted R squared		.56	
No of observation		810	

Note: *** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent

SUMMARY AND CONCLUSION

In this paper the productivity and rate of returns are discussed and are analyzed to identify the factors that determine the productivity and profitability in agriculture. The literature has found that productivity and farm size are negatively related in the initial years¹⁻⁹. However over the time with increased use of new technology this relationship has either disappeared or has turned positive, in the light of their finding the present paper has tried to look into the relationship between farm size and productivity from a new prospective⁹⁻¹⁸.

The hypothesis that likelihood of productivity being positively associated with farm size increases with increase in possibility of easy substitution between labour and machinery. The hypothesis is derived from previous studies which find that the reason for previous negative relationship turning positive is largely due to mechanization of agriculture. These results also mean that the relationship between size of holding and productivity may still be negative if cultivation of a crop is highly labour intensive with less possibility of use of machinery without lowering the productivity.

Based on our hypothesis the paper has analyzed change in productivity with increase in farm size. It is found that productivity of wheat and paddy has a positive relationship with size of holding, whereas the relationship turns negative for cotton and potato. Further, the productivity of wheat is found high in Jalandhar and of paddy in Mansa. In addition paper has also looked into the factors that determine profitability in agriculture. The result shows that farm size ownership of electric pumps are positively related to farm income and district dummy shows that Mansa on average has lower per acre profits. Also paddy, cotton and potato have significantly higher profits per acre compare to wheat.

The profits per acre are especially high for cotton and potato. Given the negative relation between farm size and productivity for cotton and potato, the small holding, may remain viable. The possibility of viability of small holdings is especially high for potato which shows relatively larger decline in productivity with increase in farm size. However these are preliminary finding and are based on limited sample size. For better understanding of phenomena there should be more studies with relatively large sample sizes.

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