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The Relationship between Farm Size and Productivity: District Level Analysis of Himachal Pradesh

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Abstract

This paper is an attempt to study the relationship between farm size and productivity. The relationship between farm size and productivity has been intensely debated in India. The present study is based on the National Sample Survey Organization unit level data on situation assessment survey of farmers in India. Descriptive statistics and ordinary least square technique have been used to find out the relationship between farm size and output. The study concluded that there is a negative relationship between farm size and productivity in hilly State of Himachal Pradesh. The study also analyzed the factors responsible for the negative relationship between farm size and output. The overall result shows that the expenses on seeds, fertilizers, pesticides and irrigation are the major factors responsible for a negative relationship between farm size and productivity because small farmers spend more than large farmers.

Keywords: Land Size, Productivity, Output, Agriculture.

Introduction

Farm size and productivity is an old debate started in the 1960s after the publication of Farm Management Studies (FMS) reports, which shows the negative relationship between farm size and productivity. It means when the size of the farm increases its productivity declines. A number of studies have undertaken, some are in favor of this argument and those who are critics of this argument most of the time they neglected this inverse relationship argument on the basis of techniques used in proving this negative relationship. In India, the relationship between farm size and productivity has been intensely debated since the 1960s. The studies during the 1960s and 1970s show that with an increase in the size of the farm, crop productivity per unit of land declined in Indian agriculture system. These studies provide strong support for reforms related to land in India. The government should support small farmers in order to increase productivity in the country. The studies which analyzed the impact of government programmes also concluded an inverse relationship between farm size and productivity. The reason for this inverse relationship is that small farms are more efficient because small farmers make intense use of their land as compared to large farms. It is therefore, needed to study the relationship between farm size and productivity in hilly States like Himachal Pradesh.

Review of Literature

A large number of studies provided convincing evidence that crop productivity per unit of land declined with an increase in farm size. (Khusro, 1964) found that the gross output per acre was declined with the expansion of farm size in six out of the seven States of India. The farm business income per acre also declined consistently with an expansion of farm size. Net profits per acre increase with farm-size in all the seven states". (Sen, 1964) concluded that by and large, productivity per acre decreases with the size of the holding. He also analyzed the relationship between capital investment and agriculture productivity and found that smaller farms are more productive because they have more capital investment per acre. (Sanyal, 1969) examined factors which are responsible for a negative relationship. The first factor is non–availability of labor during the peak seasons is often referred to as the main factor affecting productivity in large holdings. Another factor is insufficient management on the part of large holders having numerously scattered parcels of land. (Fan, Chan-Kang 2005 & Dogra, 2002) found small farming more efficient and therefore he

suggested restricting the big industries from purchasing agricultural land. He argued that large farmers tend to plant monocultures because they are the simplest to manage with heavy machinery. On the other hand, small farmers are more likely to plant crop mixtures intercropping, where the empty niche space that would otherwise produce weeds is occupied by other crops. They also tend to combine or rotate crops and livestock, with manure serving to replenish soil fertility. Such integrated farming systems produce far more per unit area than monocultures. (Chand, R., Prasanna, P. L., & Singh, A. 2011) analyzed that as landholding increased the percentage of area under irrigation decreased. The use of fertilizer per hectare of the area remained the highest in the bottom category of farm size and it declined with an increase in farm size. Thus, the results show that as the farm size declined, the use of fertiliser per hectare of land increased even under unfavourable conditions. Lower the size of holding, higher was the use of inputs, crop intensity and coverage under a high yielding variety of seeds, reflecting technology. They concluded that farm size and land productivity are inversely related to each other. On the other hand, there are some studies which are against the negative relationship between farm size and productivity in India. These studies are: (Rudra, A. 1968) concluded that "there is no scope for propounding a general law regarding farm size and productivity relationship". (Chattopadhyay, M., & Sengupta, A. 1997) in the context of West Bengal, reported that the inverse relationship between farm size and productivity was stronger in agriculturally developed regions. On the other hand, (Subbarao, k. 1982) reported a positive relationship between farm size and productivity and attributed this to the higher application of fertilizer and other cash-intensive inputs on large farms. (Dyer, 1998) argued that the inverse relationship is neither a product of superior efficiency on the part of small farms nor is it due to better quality land on the small farms but arises from the desperate struggle for poor peasants for survival on below-subsistence plots of land. (Anupama, G. V., & Falk, T. 2018) found a positive relationship between the average plot size and the agriculture productivity from cultivation in India. The study observed that small farmers are more productive than large farmers. (Wassie, S. B., Abate, G. T., & Bernard, T. 2019) also found that small plots are more productive than large plots in Ethiopia.

Research Questions

1. What is the relationship between farm size and output?
2. What are the possible factors responsible for such a relationship?

Material and Methods

Data Source

Unit level data for the variables like expenses on seeds, expenses on pesticides, expenses on fertilizers, expenses on irrigation, output in value (Rs.) and area of land (all are per farmer household) is obtained from 59th Round of National Sample Survey Organization (NSSO), Situation Assessment Survey of Farmers of Himachal Pradesh. The information collected in the situation assessment survey of farmers by NSSO covered income, expenditure, assets, indebtedness and consumption of farmer households; access to resources; farming practices and behavior and access to modern agricultural technology.

Methodology

Descriptive statistics, as well as regression technique, have been used for the present study. For calculating the range of productivity and land size, descriptive statistics such as mean, median, variance and standard deviation have been used. In order to find out the relationship between farm size and output, Ordinary Least Square technique is applied. The dependent variable is productivity, which is the Value of Output (Rs.)/land in Bigha. Land in Bigha is calculated by land in Hectares/0.08440. Independent variable is the size of land, which has been divided into three categories 0-2 bigha, 1- 4 bigha and 4 and above. To analyze the relationship between farm size and productivity regression technique is applied for each district separately in Himachal Pradesh. To find the factors responsible for a possible relationship between productivity and land size, average expenses on seeds, fertilizer, pesticides and irrigation is shown district wise. These expenses are for per farmer per bigha of land. STATA software is used for all analyses.

Results and Discussion

Table1: Descriptive Statistics

	Productivity(value of output in Rs./land in bigha)			Land size in bigha		
	Land size 1(0-2)	Land size 2(2.1-4)	Land size 3(4.1 and above)	Land size 1(0-2)	Land size 2(2.1-4)	Land size 3(4.1 and above)
Mean	12267.7	1482.372	1172.378	1.040	2.974	9.387124
Median	1012.8	502.381	422	0.995	2.914	7.109
Variance	3.39E+10	4.58E+07	2.13E+07	0.343	0.334	5.05E+01
Standard deviation	184123.8	6769.171	4612.393	0.585	0.578	7.1086
Range	5635009	207121.5	118958	1.990	1.978	67.0616

Source: Authors calculations from NSSO unit level data

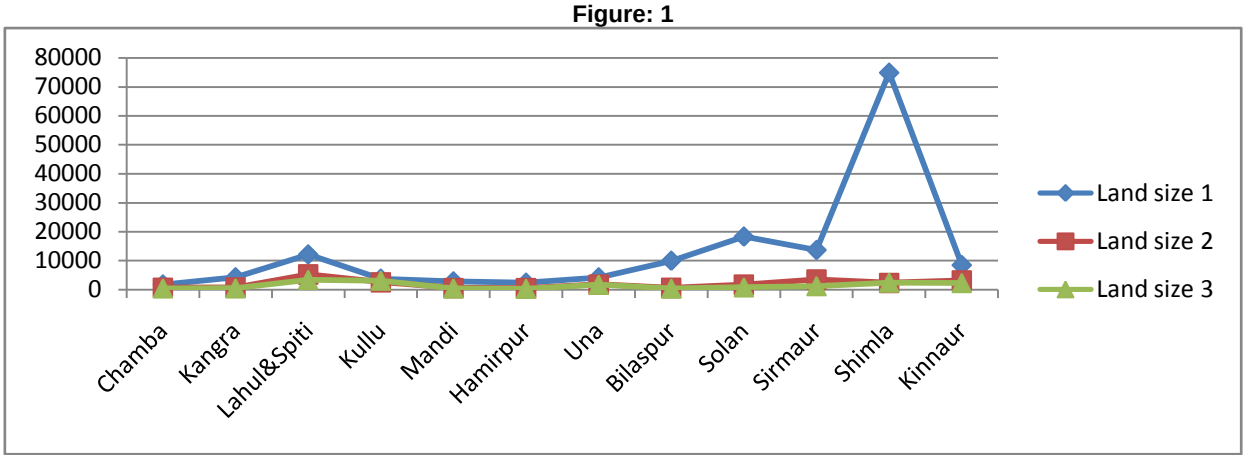
It is clear from table 1 that productivity in land size 1 is more than the other two categories on an average in Himachal Pradesh. It is also important to note that the standard deviation of productivity in land size 1 is also higher in comparison to the other two categories. Therefore, it shows that the magnitude of the productivity from there mean productivity is higher in land size 1 compared to the other categories. Variation in size of the land is more in land size 3 as compared to the other categories.

Table 2: Productivity by size of farm

	Mean of productivity (value of output/ land in bigha)		
Districts	**Land size 1(0-2bigha)**	**Land size 2(2.1-4bigha)**	**Land size 3(4 bigha and above)**
Chamba	1757.284	708.77	505.54
Kangra	4243.03	763.35	520.26
Lahul&Spiti	12134.38	5278.6	3444.13
Kullu	3751.17	2570.07	3164.58
Mandi	2831.67	601.84	476.77
Hamirpur	2380.04	500.85	350.7
Una	4221.99	1779.62	1752.56
Bilaspur	9966.18	636.91	440.62
Solan	18295.65	1736.74	858.16
Sirmaur	13658	3514.84	1286.93
Shimla	74815.48	2361.99	2491.37
Kinnaur	8458.95	3180.5	2355.79

Source: Authors calculation from NSSO unit level data

Figure: 1



It is clear from the table 2 and figure 1 that on an average productivity of farmers who are in land size 1 (0-2bigha) is more than, the farmers of other two categories of land size in almost all the districts of Himachal Pradesh. Therefore, the study shows that small farm size is more productive than large farm size. It shows the inverse relationship between farm size and productivity.

Regression Analysis

Our regression model is: Productivity=a +b(farm size)+ei . Where, productivity is calculated by the value of output in Rs./land in bigha. Farm size is used as dummy variable. Which take three values, 1 if the size of the farm is between 0-2 bigha, 2 if the size of the farm is between 2.1-4 and 3 if the size of the farm is above 4. ei is the residual term, which follows the assumptions of CLRM which are (a) zero, mean value of disturbance ei. (b) Homoscedasticity or equal variance of ei. (c) No autocorrelation between the disturbances. (d) Zero covariance between ei and Xi (which is farm size). Hypothesis is: b would be negative means with increase in size of farm productivity will decline.

Table 3: Relationship between Farm Size and Productivity

Districts	No. of observations	Productivity	Coefficient	std error	t	P>|t|	
Chamba	531	Land size 2	-1048.5	276.06	-3.8	0	R sqr=0.0431
		Land size 3	-1251.74	304.78	-4.11	0	F-statistic=11.90*
		Constant	1757.28	163.12	10.77	0	
Kangra	911	Land size 2	-3479.68	1275.26	-2.73	0.006	R sqr=0.0137
		Land size 3	-3722.77	1168.26	-3.19	0.001	F-statistic=6.32*
		Constant	4243.03	775.14	5.47	0	
Lahul&Spiti	118	Land size 2	-6855.77	3372.66	-2.03	0.044	R sqr=0.0812
		Land size 3	-8690.24	2729.1	-3.18	0.002	F-statistic=5.08*
		Constant	12134.38	2359.32	5.14	0	
Kullu	369	Land size 2	-1181.1	1441.02	-0.82	0.413	R sqr=0.0019
		Land size 3	-586.59	1323.83	-0.44	0.658	F-statistic=0.35
		Constant	3751.17	841.7	4.46	0	
Mandi	1016	Land size 2	-2229.84	420.8143	-5.3	0	R sqr=0.0405
		Land size 3	-2354.9	408.3759	-5.77	0	F-statistic=21.39*
		constant	2831.678	274.22	10.33	0	

Hamirpur	424	Land size 2	-1879.19	384.285	-4.89	0	R sqr=0.0882
		Land size 3	-2029.34	342.32	-5.93	0	F-statistic=20.37*
		Constant	2380.04	249.6	9.54	0	
Una	439	Land size 2	-2442.37	974.72	-2.51	0.013	R sqr=0.0232
		Land size 3	-2469.42	860.08	-2.87	0.004	F-statistic=5.19*
		Constant	4221.99	585.17	7.21	0	
Bilaspur	320	Land size 2	-9329.27	3099.63	-3.01	0.003	R sqr=0.0574
		Land size 3	-9525.55	2388.72	-3.99	0	F-statistic=9.66*
		Constant	9966.18	1527.51	6.52	0	
Solan	376	Land size 2	-16558.9	7023.731	-2.36	0.019	R sqr=0.0222
		Land size 3	-17437.5	6845.31	-2.55	0.011	F-statistic=4.24**
		Constant	18295.65	4514.5	4.05	0	
Sirmaur	492	Land size 2	-10143.7	8126.794	-1.25	0.213	R sqr=0.0061
		Land size 3	-12371.6	7721.858	-1.6	0.11	F-statistic=1.50
		Constant	13658.56	5013.191	2.72	0.007	
Shimla	527	Land size 2	-72453.5	41225.64	-1.76	0.079	R sqr=0.0087
		Land size 3	-72324.1	39250.04	-1.84	0.066	F-statistic=2.29
		Constant	74815.48	25927.72	2.89	0.004	
Kinnaur	155	Land size 2	-5278.45	3880.327	-1.36	0.176	R sqr=0.0211
		Land size 3	-6103.17	4073.062	-1.5	0.136	F-statistic=1.64
		Constant	8458.957	1985.821	4.26	0	

Source: Authors calculation from NSSO unit level data

Table 3 shows the relationship between the size of land and output in twelve districts of Himachal Pradesh. It shows that almost in all the districts there is a negative relationship between land size and productivity. If we move from land size 1 to land size 2 and land size 3, the average productivity is declining in all districts. Out of twelve districts, in 9 districts t values are significant at 1%, 5% and 10% level of significance. The significant result means that there is a relationship between farm size and productivity. Table 3 shows that in 9 districts of Himachal Pradesh, productivity declines with an increase in land size. However, in the other 3 districts, t values are insignificant (Kinnaur, Kullu and Sirmaur) at 1%, 5% and 10% level of significance. The standard error is almost high in all the districts. Moreover, the value of R-square is low in almost all the districts. Therefore the results are showing that land size and productivity are negativity related but there are other factors as well which are responsible for the negative relationship.

Factors responsible for the negative relationship between farm size and productivity

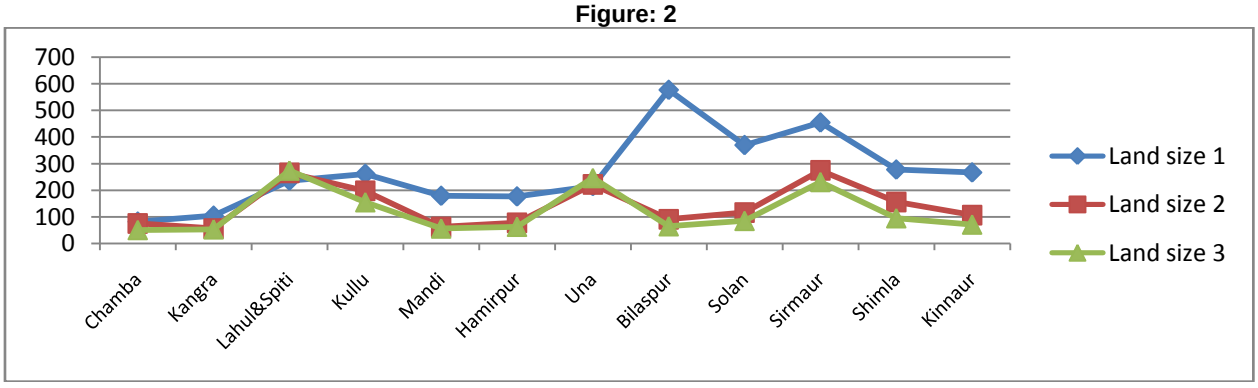
In order to analyze the factors responsible for the negative relationship between farm size and output some factors have been identified, which are expenses on seeds, fertilizers, pesticides and irrigation.

Table 4: Expenses on Seeds

	Average expenses on seeds(per bigha)		
Districts	**Land size 1**	**Land size 2**	**Land size 3**
Chamba	82.13	75.71	50.81
Kangra	104.43	56.14	53.36
Lahul&Spiti	236.25	264.85	273.94
Kullu	261.44	197.62	155.15
Mandi	179.15	62.32	56.45
Hamirpur	176.67	78.18	63.05
Una	215.73	221.43	245.76
Bilaspur	576.73	91.39	64.98
Solan	369.55	116.44	85.06
Sirmaur	454.13	274.64	230.91
Shimla	277.58	155.93	95.06
Kinnaur	266.76	107.02	71.38

Source: Authors calculation from NSSO data

Figure: 2



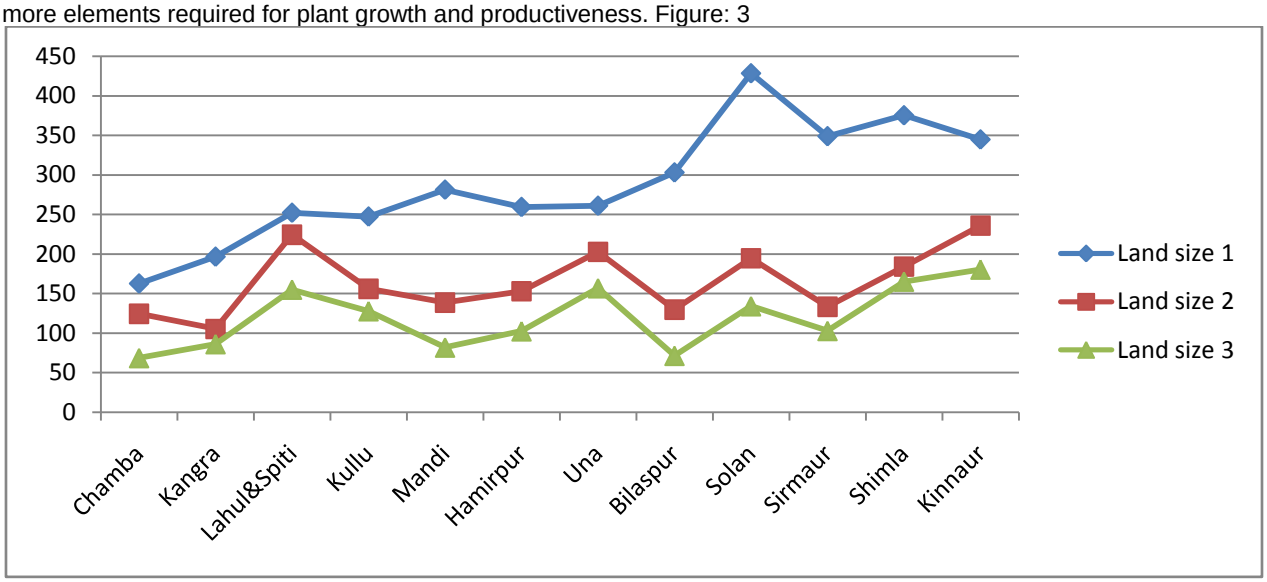
It is clear from table 4 that on an average per bigha expenditure on seeds are higher in land size 1 category in comparison to other categories. There are only two exceptions in Lahul & Spiti and Una districts, where expenses on seeds are increasing with an increase in land size. In all other districts, there is a negative relationship.

Table 5: Expenses on Fertilizers

	Average expenses on fertilizer (per bigha)		
Districts	**Land size 1**	**Land size 2**	**Land size 3**
Chamba	162.74	124.51	68.59
Kangra	196.63	105.4	86.19
Lahul&Spiti	252.15	224.36	154.97
Kullu	247.34	156.07	127.74
Mandi	281.29	138.7	81.92
Hamirpur	259.47	152.88	102.4
Una	260.99	202.63	156.7
Bilaspur	303.06	129.77	71.45
Solan	428.29	194.55	134.03
Sirmaur	348.81	133.45	102.81
Shimla	375.25	183.99	165.1
Kinnaur	344.72	235.72	180.31

Source: Authors calculation from NSSO unit level data

Table 5 shows that fertilizer use per hectare of the area remained the highest in the bottom category of farm size and it declined with an increase in farm size. The fertilizer is a material that is added to the soil to supply one or more elements required for plant growth and productiveness. Figure: 3



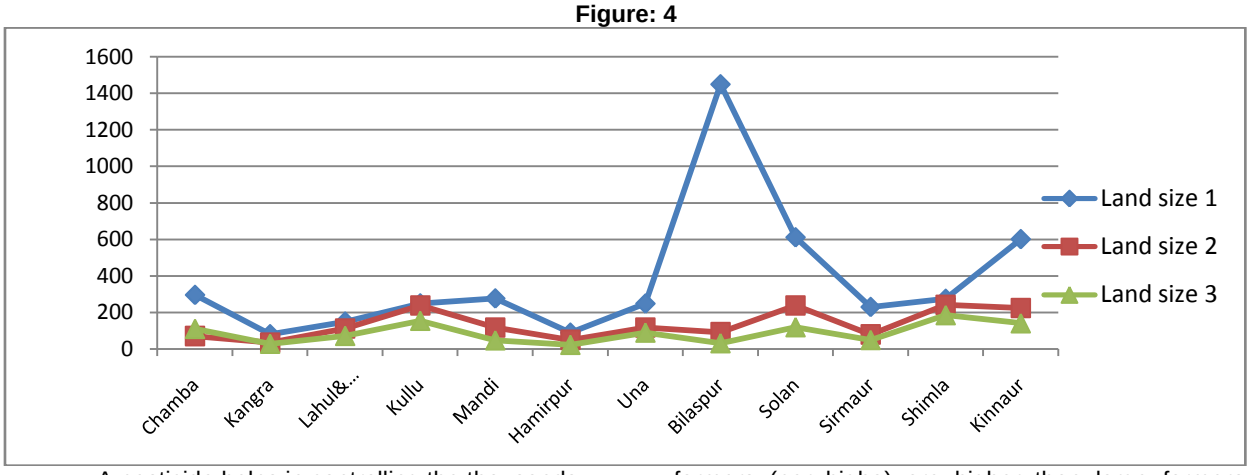
It is clear from the above graph that the average expenses on fertilizer (per bigha) are declining with an increase in land size in all the districts of the Himachal Pradesh. This is another reason for a negative relationship between farm size and productivity

.Table 6: Expenses on Pesticides

	Average expenses on pesticides (per bigha)		
Districts	**Land size 1**	**Land size 2**	**Land size 3**
Chamba	297.04	71.47	111.7
Kangra	82.06	36.11	30.35
Lahul&Spiti	150.69	112.82	73.47
Kullu	250.69	238.65	156.18
Mandi	277.76	117.83	48.91
Hamirpur	90.54	50.49	24.29
Una	249.67	117.53	91.43
Bilaspur	1449.58	92.63	33.18
Solan	612.3	238.25	120.97
Sirmaur	231.12	80.15	50.75
Shimla	275.7	241.92	187.05
Kinnaur	602.34	224.95	142.49

Source: Authors calculation from NSSO unit level data

Figure: 4



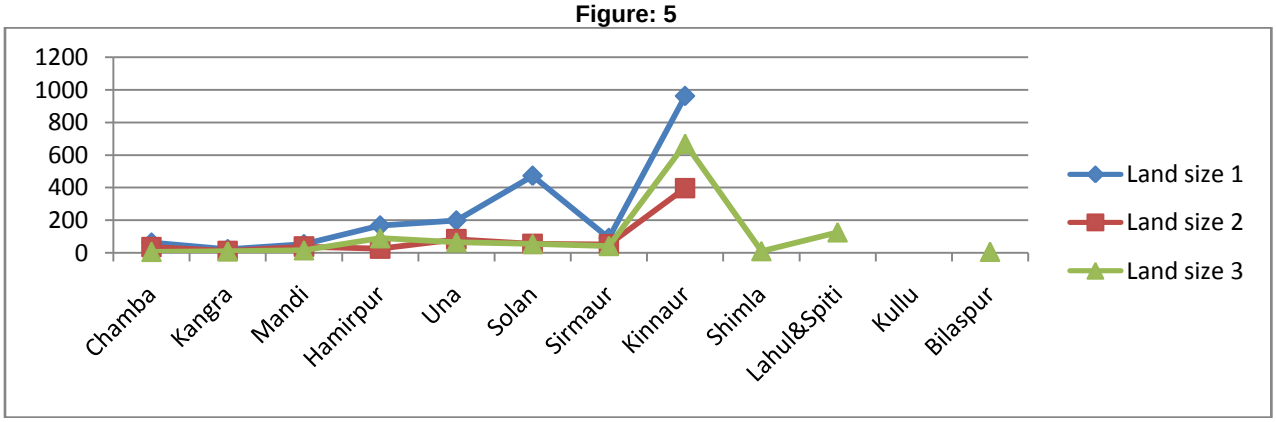
A pesticide helps in controlling the thousands of weed species, harmful insects and numerous plan diseases that affect crops. It is clear from table 6 and graph 4 that average expenses on pesticides of small farmers (per bigha) are higher than large farmers. This means with an increase in land size average expenses on pesticides/insecticides are declined in all districts of Himachal Pradesh.

Table 7: Expenses on irrigation

	Average expenses on irrigation(per bigha)		
Districts	**Land size 1**	**Land size 2**	**Land size 3**
Chamba	63.56	36.31	6.55
Kangra	23.19	12.71	9.69
Mandi	53.8	38.51	16.33
Hamirpur	168.39	25.68	90.08
Una	199.03	84.01	65.05
Solan	473.01	55.55	54.7
Sirmaur	92.32	52.76	42.79
Kinnaur	960.74	395.96	669.66
Shimla			11.16
Lahul&Spiti			126.56
Kullu			
Bilaspur			7.35

Source: Authors calculation from NSSO unit level data

Figure: 5



Above table 7 and figure 5 clearly shows that in some districts average expenses on irrigation are more in land size one as compare to the other districts. In districts like Lahul & Spiti, Kullu, Bilaspur and Shimla there are no expenses on irrigation by small farmers because in these districts irrigation is done by kulhs, which is a natural channel of the flow of water.

Conclusion

It is clear from the results that there exists a negative relationship between farm size and productivity in 9 districts out of 12 districts of Himachal Pradesh. The results clearly revealed that output per bigha declined with an increase in the size of hand holding. The major reason for this negative relationship is that the small farmers spend more on seeds, fertilizers, pesticides and irrigation as compared to the large farmers. The overall result

shows the negative relationship between farm size and productivity which is due to the more expenditure on inputs by small farms than large farms.

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