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Identification and resource productivities of predominant farming systems in Himachal Pradesh, India

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ABSTRACT

The paper has attempted to identify the predominant farming systems along the resource productivities in Chamba district of Himachal Pradesh.The proposed study was constructed on the primary data collected from 160 sample households. Three stage random sampling technique was employed for selecting the sample households.The farming system derived its name from the farming component that contributed maximum share to the farm family income. Farming systems components of the district were examined for cereals, pulses, millets, oilseeds, vegetables, livestock, poultry and horticulture. Further, four predominant farming systems were identified namely, Cereals based farming system (FS-I), Vegetables based farming system (FS-II), Livestock based farming system (FS-III) and Fruits based farming system (FS-IV) by the income approach. The present study also carried out to monitor and assess the present scenario of resource productivities of different farming systems for improving the economic conditions of the farmers and to measure the contribution of specific factor in combination with other factors which were responsible for the change in the level of output. Multiple regression analysis was used to assess the resource productivities and the elasticity coefficients were found highly significant in all the farming systems.

Keywords: Farming systems, identification and resource productivities

Himachal Pradesh, a potent example of hilly areas is located in Western Himalayas. The state has a deeply fissured topography, with mountain ranges and valleys of varying slopes and sizes, possessing myriads of diversified flora and fauna. Agriculture is the main occupation of the people of Himachal Pradesh. In the state, agriculture is beset with the disadvantage of small holdings and only ten per cent of the total geographical area is under plough of which 4/5th is rainfed. Agriculture in the state presents a varied picture wherein commercial agriculture is interspersed with mainstream rainfed agriculture.The farming system approach is seen as a potential way of raising and stabilizing productivity and profitability levels in the rainfed agriculture (Ramarao *et al.*, 2017). Thus in this challenging world, the present study seeks to identify the predominant farming systems and examine the resource productivities under different farming systems in Chamba district of Himachal Pradesh having about ninety six per cent of cropped area is rainfed (Anonymous , 2018a).

MATERIALS AND METHODS

Three stage random sampling technique was employed for selecting the sample households. Four blocks namely; Bhattiyat, Chamba, Tissa and Bharmaur were selected randomly for the study area. Further, five villages from each block were taken and a total sample of 160 farmers was drawn from the selected villages through proportional allocation technique. Income approach was used for the identification of farming systems. The farmers who derived more than 50 per cent income from cereals were categorized under FS-I (Cereals based FS), similarly, from vegetables were put under FS-II (Vegetables based FS), from livestock were grouped as FS-III (Livestock based FS) and from fruits were named as FS-IV (Fruits based FS). To analyse the resource productivities of different farming systems for improving the economic conditions of the farmers and to measure the contribution of specific factor in combination with other factors which were responsible for the change in the level of output, multiple regression analysis was used. Depending upon the value of R^2 (best fit) and the statistical significance of regression coefficients, suitable Cobb-Douglas production functionof the form given below was employed for detailed analysis and discussion.

$$Y = b_0 X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} X_8^{b8} X_9^{b9} X_{10}^{b10} X_{11}^{b11} X_{12}^{b12} u_i$$

where,

Y = Gross farm income (₹)

b_0 = Constant term

X_1 = Area under cereals (ha)

X_2 = Area under millets and pseudo cereals (ha)

X_3 = Area under oilseeds (ha)

X_4 = Area under pulses (ha)

X_5 = Area under vegetables (ha)

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X_6 = Area under fruits (ha)

X_7 = No. of livestock farm^{-1}

X_8 = No. of poultry birds farm^{-1}

X_9 = No. of mushroom bags farm^{-1}

X_{10} = No. of man days year^{-1}

X_{11} = Household expenditure on fertilisers and chemicals

X_{12} = Institutional credit availed in [1]

$b_{i's}$ = Regression coefficients (Production elasticities), i= 1,2,..,n

u = Random term

RESULTS AND DISCUSSION

In the present investigation, income approach was used for the identification of farming systems. The nomenclature of the farming system derived its name from the farming component that contributed maximum share to the farm family income. For this purpose gross income from different farm components was taken into account. Farming systems components in all blocks of the district were examined for cereals, pulses, millets, oilseeds, vegetables, livestock, poultry and horticulture (Table 1). During the pilot survey, it was found that in Bhattiyat block maximum (50.08 %) income was from cereals followed by livestock (24.53%), vegetables (17.09%), oilseeds (3.13%), pulses (2.09%), fruits (1.97%) and poultry (1.11%). In Chamba block, the contribution of various farm components to the total family farm income has been presented and found that vegetables were contributing maximum (53.49%) followed by fruits (21.55 %) whereas, the contribution of mushroom and poultry was 1.03 and 0.55 per cent, respectively. On an overview, Tissa block was dominated by livestock, fruits and cereals. In this block livestock contributed maximum (31.26 %) in gross farm income followed by fruits (28.73 %) and cereals (18.66%). The economy in Bharmaur block was mainly agriculture based with only single cropping season and also sheep and goats husbandry were the main occupation of the sample farmers along with agriculture. As such the sample households of Bharmaur block derived 54.66 per cent income from fruits followed by livestock (33.50 %) and pulses (6.12 %). On an overall basis, in Chamba district maximum (26.73 %) income was from fruits followed by livestock (25.12%), vegetables (23.06 %), cereals (19.36 %) and pulses (3.55 %).

The farmers were classified according to contribution of different farm components in gross income. A specialized farm is one on which 50 per cent or more receipts are derived from one enterprise (Dhondyal 1985). The farmers who derived more than 50 per cent

Table 1: Average gross income from various farm components in different blocks

Blocks	Cereals	Pulses	Millets & pseudo cereals	Oilseeds	Vegetables	Livestock	Poultry	Mushrooms	Fruits	Average gross income (₹ farm/annum) %
Bhattiyat	50.08	2.09	-	3.13	17.09	24.53	1.11	-	1.97	78871
Chamba	8.56	3.00	-	0.63	53.49	11.19	0.55	1.03	21.55	144407
Tissa	18.66	2.99	-	1.21	17.03	31.26	0.12	-	28.73	90454
Bharmaur	1.75	6.12	0.74	0.15	3.01	33.50	0.07	-	54.66	153929
Overall	19.36	3.55	0.18	1.28	23.06	25.12	0.46	0.26	26.73	116915

Table 2: Distribution of sample households across farming systems (number)

Blocks	Cereals based farming system (FS –I)	Vegetables based farming system (FS-II)	Livestock based farming system (FS-III)	Fruitsbased farming system (FS-IV)	Total
Bhattiyat	40(86.96)	-	-	-	40(25.00)
Chamba	-	40(100.00)	-	-	40(25.00)
Tissa	6(13.04)	-	16(88.89)	18(32.14)	40(25.00)
Bharmaur	-	-	2(11.11)	38(67.86)	40(25.00)
Total	**46(100.00)**	**40(100.00)**	**18(100.00)**	**56(100.00)**	**160(100.00)**

Note: Figures in parentheses show percentages to total households in each category of farms

Table 3: Land inventory of sample farms under different farming systems (Hectare)

Sl. No.	Particulars	FS-I	FS-II	FS-III	FS-IV
1	Owned land	0.77	0.73	0.64	0.70
	i) Leased-in	-	-	-	-
	ii) Leased-out	0.02	0.01	-	-
2	Average land holdings	0.83 (100.00)	0.76 (100.00)	0.58 (100.00)	0.74 (100.00)
3	Cultivated area under field crops (cereals, millets, vegetables, oilseeds, pulses and fodder crops)	0.70 (84.34)	0.57 (75.00)	0.43 (74.14)	0.43 (58.11)
4	Cultivated area under fruit crops (mango, litchi, aonla, citrus, apple and walnut)/ fruit orchards	0.02 (2.41)	0.06 (7.89)	0.03 (5.17)	0.16 (21.62)
5	Fallow land	0.03 (3.61)	0.02 (2.63)	0.02 (3.45)	0.01 (1.35)
6	Pastures and grassland	0.06 (7.23)	0.10 (13.16)	0.09 (15.52)	0.12 (16.22)
7	Wasteland and barren land(uncultivable)	0.02 (2.41)	0.01 (1.32)	0.01 (1.72)	0.02 (2.70)

Note: Figures in parentheses show percentages to total in each category

Table 4: Distribution of area under different crop groups

Sl. No.	Particulars	FS-I		FS-II		FS-III		FS-IV	
		Area(%)	SCII	Area(%)	SCII	Area(%)	SCII	Area(%)	SCII
1	Cereals	67.79	0.52	32.53	0.23	50.35	0.35	30.22	0.13
2	Millets and pseudo cereals	-		-		-	-	6.46	0.02
3	Pulses	3.10	0.02	7.10	0.04	8.13	0.05	35.87	0.15
4	Oilseeds	6.50	0.03	3.03	0.02	2.63	0.02	2.73	0.01
5	Vegetables	10.11	0.06	47.00	0.27	21.52	0.14	12.78	0.05
6	Fodder crops	12.50	0.05	10.34	0.04	17.37	0.08	11.94	0.03
	Total cropped area under field crops and vegetables (ha)	1.20	0.99	0.76	0.48				

Note: Percentages have been worked out over total cropped area under different crop groups. Specific Crop Intensity Index (SCII) has been calculated by using net sown area.

Table 5: Percentage of Distribution of area under fruits

Sr.No.	Particulars	FS-I	FS-II	FS-III	FS-IV
1	Mango	52.36	-	-	-
2	Litchi	20.80	-	-	-
3	Aonla	-	19.22	-	-
4	Citrus	20.00	40.78	-	-
5	Apple	-	24.52	60.64	65.58
6	Walnut	6.84	15.48	29.36	15.80
7	Pear	-	-	10.00	11.06
8	Apricot	-	-	-	7.56
	Total area under fruit crops (ha)	0.02	0.06	0.03	0.16

Note: Percentages have been worked out over total area under fruit crops.

income from cereals were categorized under FS-I (Cereals based FS), similarly, from vegetables were put under FS-II (Vegetables based FS), from livestock were grouped under FS-III (Livestock based FS) and from fruits were named as FS-IV (Fruits based FS). A sample of 40 households from each block was drawn during the field survey. By porting all the sample households it was revealed that in cereals based FS there were 46 households, out of which about 87 per cent were from Bhattiyat block and 13 per cent were from Tissa block. In case of vegetables based FS all the farmers (40) were from Chamba block. In livestock based FS, total farmers were 18, out of which maximum (89 %) households were from Tissa block and 11 per cent were from Bharmaur block. Similarly, in case of fruits based FS, out of total farmers (56), about 68 per cent farmers were from Bharmaur block and 32 per cent were from Tissa block. Thus, the overall sample size consisted of 160 households (Table 2).

Despite having made tremendous progress on several fronts, Indian agriculture continuing to face serious problems. Among other things, the gradual declining trend in size of land holding poses a serious challenge to the sustainability and profitability of the farming. The average size of the landholding has declined to 1.16 ha in 2010-11 from 2.28 ha in 1970- 71. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020 and would be further reduced to 0.32 ha in 2030 (Khan *et al*., 2015). Keeping this in view,land is the most prominent resource in the agricultural economy of rural society. The land holdings were distributed into cultivated, uncultivated, orchards, pastures and grassland, fallow land, *etc*. in the study area (Table 3). The average size of farm holding, among other things, provides the basis for judging whether a holding is sufficient for making livelihood or not. The size of holding that a farm household owns shows the basic strength of the farming family and its utilization reveals how efficiently this natural resource is used by the farmers. The average size of land holding was observed to be 0.83 hectare per farm in FS-I, 0.76 hectare in FS-II, 0.58 hectare in FS-III and 0.74 hectare in FS-IV. The area under cultivation of field crops and vegetables accounted for about 84.34 per cent of the total land holdings in FS-I, 75.00 per cent in FS-II, 74.14 per cent in FS-III and 58.11 per cent in FS-IV. The area under fruit crops accounted maximum for about 21.62 per cent under FS-IV, followed by 7.89 per cent in FS-II. In cereals and livestock based farming system fruit orchards contributed 2.41 and 5.17 per cent of total land holdings, respectively. Fruits based farming system had maximum area (0.12 ha) under pastures and grasslands. The area under uncultivated land was accounting for 2.41 per cent of the total land holdings in FS-I, 1.32 per cent in FS-II, 1.72 per cent in FS-III and 2.70 per cent in FS-IV.

Further, cereals dominated the area under cropping pattern in cereals based (67.79%) and livestock based (50.35%) farming systems whereas, in FS-II vegetables accounted for the maximum area (47.00%). In case of FS-IV, pulses had the highest area (35.87%). In FS-I, the fodder crops were next in importance accounting for 12.50 per cent of the total cropped area followed by oilseeds which accounted 6.50 per cent of total cropped area (Table 5). In FS-I, pulses ranked lowest accounting for only 3.10 per cent of the total cropped area. A cursory glance at the table reveals that after vegetables, the cropping pattern of FS-II was dominated by cereals (32.53%). In this system, the share of fodder crops stood at 10.34 per cent of total cropped area followed by pulses (7.10%). The share of oilseeds (3.03 %) was very low in vegetables based farming system. In FS-III, cereals accounted maximum area (50.35%) followed by vegetables (21.52) whereas, fodder crops covered 17.37 per cent of total cropped area. Pulses accounted for 8.13 per cent of total cropped area in FS-III. Buckwheat and finger millets were grown in high altitude areas of Bharmaur. These traditional crops being frost tolerant and requiring less care in raising, formed the staple diet

Table 6: Composition of livestock population on the sample farms under different farming systems (per farm)

Sr. No.	Particulars	FS-I		FS-II		FS-III		FS-IV	
		No.	Value (₹)	No./farm	Value (₹)	No.	Value (₹)	No.	Value (₹)
1	Local cow								
	i) In milk	0.08	724	0.08	400	0.46	4581	0.38	3501
		(53.33)	(65.94)	(100.00)	(100.00)	(58.23)	(70.21)	(70.37)	(85.23)
	ii) Dry	0.07	374	-	-	0.33	1944	0.16	607
		(46.67)	(34.06)			(41.77)	(29.79)	(29.63)	(14.77)
	iii) Sub-total	0.15	1098	0.08	400	0.79	6525	0.54	4108
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
	Dry to wet ratio	0.88		-		0.72		0.42	
2	Cross-breed cow								
	i) In milk	0.10	1183	0.18	1834	0.30	3205	0.28	1719
		(52.63)	(66.84)	(64.29)	(76.93)	(51.72)	(67.32)	(71.79)	(72.78)
	ii) Dry	0.09	587	0.10	550	0.28	1556	0.11	643
		(47.37)	(33.16)	(35.71)	(23.07)	(48.28)	(32.68)	(28.21)	(27.22)
	iii) Sub-total	0.19	1770	0.28	2384	0.58	4761	0.39	4362
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
	Dry to wet ratio	0.90		0.56		0.93		0.39	
3	Heifer								
	i) Local cow	0.11	565.22	0.05	150	0.39	1500	0.14	482
		(0.00)	(0.00)	(10.42)	(6.52)	(31.97)	(26.47)	(32.56)	(24.77)
	ii) Cross-breed cow	0.17	1478	0.43	2150	0.83	4167	0.29	1464
		(100.00)	(100.00)	(89.58)	(93.48)	(68.03)	(73.53)	(67.44)	(75.23)
	iii) Sub-total	0.17	1478	0.48	2300	1.22	5667	0.43	1946
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
4	Calves								
	i) Local cow	0.06	135	-	-	0.18	285	0.08	163
		(40.00)	(38.78)			(64.29)	(64.19)	(57.14)	(56.99)
	ii) Cross-breed cow	0.09	213	0.33	750	0.10	159	0.06	123
		(60.00)	(61.22)	(100.00)	(100.00)	(35.71)	(35.81)	(42.86)	(43.01)
	iii) Sub-total	0.15	348	0.33	750	0.28	444	0.14	286
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
5	Buffaloes								
	i) In milk	0.04	1022	-	-	0.28	5393	-	-
		(16.67)	(90.38)			(62.22)	(79.52)		
	ii) Dry	0.01	109	-	-	0.17	1389	-	-
		(4.17)	(9.62)			(37.78)	(20.48)		
	iii) Sub-total	0.05	1131	-	-	0.45	6782	-	-
		(100.00)	(100.00)			(100.00)	(100.00)		
	Dry to wet ratio	0.25		-		0.61		-	
6	Young stock (Buffalo)								
	i) Heifer	0.11	1413	-	-	0.39	3056	-	-
	ii) Calves	0.04	196	-	-	0.28	944	-	-
7	Bullocks	0.52	2717	0.25	1400	0.89	5222	0.95	4921
8	Sheep	0.05	71	0.03	125	0.73	3650	2.91	13062
9	Goats	0.06	132	0.05	250	0.84	4200	3.00	13566
10	Sheep/Goats (Nomadic)	-	-	-	-	6.11	30550	-	-
	- -	-	-	5.56	27800	-	-		
11	Total livestock	1.68	10354	1.50	7609	12.56	71801	8.36	42251
12	Total SAUs	1.59	1.23	6.09	3.49				
13	Poultry	1.96	980	1.58	790	0.37	185	0.78	390

Note: Figures in parentheses show percentages to total in each category

Table 7: Regression results for different farming systems

Farming systems	Sample size	Constant	Area under cereals	Area under millets and pseudo cereals	Area under oil seeds	Area under pulses	Area under vegetables	Area under fruits	Livestock	Poultry	Mushroom	Labour employed	Fertilisers and chemicals	Institutional credit	R^2-adj
FS-I	46	0.247	*0.413	-	*0.561	*0.230	*0.449	*0.211	*0.166	*0.100	-	*0.132	0.077	*0.243	0.65
		(29.01)	(0.033)		(0.033)	(0.012)	(0.016)	(0.066)	(0.041)	(0.004)		(0.007)	(0.032)	(0.072)	
FS-II	40	0.451	*0.206	-	*0.211	*0.190	*0.555	*0.400	*0.101	*0.099	0.170	**0.110	0.062	*0.122	0.90
		(23.12)	(0.017)		(0.011)	(0.006)	(0.031)	(0.013)	(0.008)	(0.018)	(0.006)	(0.031)	(0.010)	(0.004)	
FS-III	18	0.796	*0.259	-	*0.144	*0.336	*0.122	*0.411	*0.422	*0.066	-	-0.055	0.033	-0.455	0.69
		(07.03)	(0.017)		(0.029)	(0.014)	(0.026)	(0.019)	(0.066)	(0.012)		(0.067)	(0.028)	(0.011)	
FS-IV	56	0.122	*0.131	*0.153	*0.139	*0.662	*0.106	*0.668	*0.190	*0.029	-	*0.422	0.095	-0.533	0.87
		(60.88)	(0.032)	(0.013)	(0.009)	(0.022)	(0.011)	(0.023)	(0.010)	(0.005)		(0.061)	(0.063)	(0.025)	

Notes: Figures within the parentheses are standard errors of respective variables
***Significant at 1 per cent level and *Significant at 5 per cent level*

in this area (FS-IV). It can be seen from the table that in FS-IV, millets and pseudo cereals accounted 6.46 per cent of total cropped area. Oilseeds were given least importance (2.73%) in fruits based farming system.

Specific Crop Intensity Index (SCII) determined the amount of area-time devoted to each crop or group of crops compared to total area-time available to the farmer for crop production during the time period under study (Table 4). Cereals dominated the FS-I and FS-III cropping systems whereas, in FS-II, vegetables and in FS-IV pulses were the leading crops grown by the farmers. Further, it was indicated (Table 5) that fruits had 0.02, 0.06, 0.03 and 0.16 ha area in FS-I, FS-II, FS-III and FS-IV, respectively. In the study area eight major fruits (mango, litchi, aonla, citrus, apple, walnut, pear and apricot) were identified which were contributing to the economy of sample households. In FS-I, mango was dominating by contributing 52.36 per cent of total area under fruit crops whereas in FS-II, citrus contributed maximum area (40.78 %). In livestock and fruits based farming systems, apple was the main fruit crop contributing 60.64 and 65.58 per cent, respectively.

In the study area, livestock were being reared to produce milk, FYM, workforce, wool, meat, etc. Similarly, poultry was offering opportunities of income generation and supplementing nutritional security. The maximum livestock population was in FS-III (6.09 SAUs) followed by FS-IV (3.29 SAUs), FS-I (1.59 SAUs) and FS-II (1.23 SAUs) (Table 6).The milch animals were classified according to breed and stage of milking. The analysis showed that the local cows were found maximum in FS-III (0.79 farm^{-1}) followed by FS-IV (0.54 /farm). Among local cows, dry to wet ratio was found to be highest in FS-I (0.88) and in cross-bred cows maximum dry to wet ratio was in FS-III (0.93). The maximum population of buffaloes (0.45 farm^{-1}) was found in FS-III and their dry to wet ratio was 0.61 in this system. The heifers of the cows (1.22 farm^{-1}) and buffaloes (0.39 farm^{-1}) were found to be maximum in livestock based farming system. On an average, bullocks accounted maximum (0.95 farm^{-1}) for FS-IV as compared to other farming systems. The maximum average population of sheep and goat was in FS-IV (5.91/farm) followed by FS-III (1.57 farm^{-1}). In FS-III rearing sheep/goat by nomadic also contributed about 20.07 per cent in total Standard Animal Units (SAUs). Further, Table 4.10 reveals that livestock based farming system had the maximum investment (₹ 71801 farm^{-1}) in total livestock followed by FS-IV (₹ 42251 farm^{-1}) whereas, cereals based and vegetables based farming systems invested ₹ 10354 and ₹ 7609, respectively, in total livestock units. The average number of poultry birds was found to be more (1.96 farm^{-1}) in cereal based farming

system as compared to other farming systems in the study area.

The elasticity coefficients were found highly significant in all the farming systems (Table 7). The elasticity of production indicated that one per cent increase in area under cereal crops increased gross income ranging from 0.413 per cent, in the case of cereals based farming system (FS-I), 0.206 per cent in vegetables based farming system (FS-II), 0.259 per cent in livestock based farming system (FS-III) and 0.131 per cent in fruits based farming system (FS-IV). Further, one per cent increase in area under oilseeds and pulses increased gross income ranging from 0.14 (FS-III) to 0.56 (FS-I) per cent and 0.19 (FS-II) to 0.66 (FS-IV) per cent among various farming systems, respectively. In case of area under fruit crops, regression analysis indicated that one per cent increase in area lead to 0.21 (FS-I) to 0.67 (FS-IV) per cent gross income among the farming systems. Livestock included local cows, improved cows, buffaloes and sheep or goat rearing. The elasticity coefficients for the livestock were found significant, indicating that one per cent increase in the livestock increased gross income by 0.10 (FS-II) to 0.42 (FS-III) per cent among various farming systems. One per cent increase in poultry birds increased gross income 0.02 (FS-IV) to 0.10 (FS-I) per cent across all farming systems in the study area. One per cent increase in mushroom bags increased gross income by 0.17 (FS-II) per cent in vegetables based farming system. The negative and insignificant coefficient for human labour in the livestock based farming system indicated that it did not contribute significantly to the output of this farming system. The regression coefficient of fertilizer and chemicals was insignificant in all the farming systems. The regression coefficient of institutional credit in the cereals based and vegetables based farming systems was found significant. Singh *et al*., 2009 also reported the similar results for the livestock and sugarcane based farming systems in Uttar Pradesh.

There is a need to enhance the profitability of rainfed crops. Therefore, farming system assumes a greater importance for sound management of farm productivity, reducing environmental degradation, improve the quality of life of the resource poor farmers and sustainability in rainfed regions.The problem of land scarcity is more acute in mountainous regions due to uneven population pressure. There is need to increase the cropping intensity if the scarce land resource is to be augmented. There is also an imminent need to proper utilization of land area and productivity of the main cropping systems employing an appropriate mix of technology and policy framework.

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