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Research Article

ADOPTION PATTERN OF IMPROVED PADDY VARIETIES AND THEIR CONSTRAINTS ANALYSIS IN HILLY AREA OF ALMORA DISTRICT, UTTARAKHAND, INDIA

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Abstract: This paper describes the production practices of paddy in two distinct growing environments in hills of Uttarakhand where average productivity of paddy is not only lower but also stagnated from several decades. Analysis revealed the cropping pattern, characteristics of farming system and households, cost and returns, extent of adoption of improved paddy varieties and constraints in their diffusion in hilly district Almora. Data on different aspects of paddy cultivation were collected 60 randomly selected farmers from two villages namely: Adhuria and Balai from Almora district. Descriptive statistics were applied and tabular analysis was done to ascertain the mean, average, percentage values of collected data. Paddy was the major cereal in the surveyed area during kharif season and it accounts 89.53 and 10.47% area to total cropped area in marginal and small farm size, respectively. The majority of farmers belong to marginal category that was 93.33 and 96.67% to total farmers in terrace and valleys environment, respectively. On the other hand, very poor proportion of farmers falls in small category *i.e.* 6.67 and 3.33% in the respective environments. The total cost of cultivation of paddy was Rs.49806/- on marginal and Rs.46042/ha on small farm which is at par with gross returns. The average annual income of households in valleys was Rs.116547/- which was 69% higher as compared to terraces Rs.68934/-. Further research should be initiated to improve the productivity of paddy and its profitability; therefore, livelihood of farming community could be strengthened in the hills.

Keywords: *Diffusion, Fragile, Varieties, Bio-physical, Establishment*

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Introduction

Paddy is the staple food for about 50 % of the world's population that resides in Asia. Over 90 % of the world's paddy is produced and consumed in the Asian region comprising 80 % of the world's production and consumption. Growth in Asian population (1.8 % pa) in this region means an increase in demand for paddy continuously. Although the net availability of food grains has increased in 2013 at 229 million tonnes, but there may be shortage of paddy due to increased domestic needs coupled with export demand for paddy in future (IRJAES, 2015). In Asia, India has the largest area under paddy cultivation as 43.97 millions hectare accounting for 29.4 % of the global paddy area. Of the total harvested area, about 46 % is irrigated with 28 % rainfed lowland, 12 % rainfed upland and 14 % flood prone. Paddy is one of the largest traded commodities in the world with a total quantity trade touching 16.40 million tonnes. The Southeast countries account for about 40 % of the paddy traded in the world.

Paddy is the basic food crop and being a tropical plant, it flourishes comfortably in hot and humid climate. Paddy is also grown through irrigation in those areas that receives comparatively less rainfall. In 2014-15, total paddy production in India amounted to 97 million tonnes, which was much less than production of previous year, 106.29 million tonnes. These are happened due to low rainfall and effect of cyclonic storm at major paddy growing region Paddy commends recognition, as a supreme commodity to mankind, because paddy is truly life, culture, a tradition and a means of livelihood to millions [1].

Uttarakhand is one of the newly formed states of India, which falls under the North Western Himalayas (NWH) region. Eleven out of thirteen districts in Uttarakhand fall under hilly area of NWH region. Paddy is the major cereal crop of *kharif* season accounting for more than 54 % of the total area under cereals in the state.

The annual paddy production of the state is around 5.5 lakh tones from an area of about 2.80 lakh hectares. Half of this area is in the plains and half in the hills, but the total paddy production of the plains is twice the total production of the hills.

Paddy is cultivated in all the 13 districts of the state, but maximum area (33%) is in district Udham Singh Nagar that produces about 48% of the total paddy produced annually in the state. Districts Nainital, Haridwar and Dehradun occupy about 17.50 % area and contribute 22.20 % in the total production. From productivity point of view, these districts are classified in the medium category. Rests of the nine districts are classified in the low productivity category. These nine districts together occupy about 49.20 % area, but contribute only to 30 % of the total production [1,2].

Paddy is predominantly cultivated during the *kharif* season in the state. In hill, high yielding paddy varieties were popular in the valleys, whereas traditional varieties were grown on the terraces which show contrasting climatic conditions to valley situations. In terraces, farming activities begin immediately after rains occur as they are mainly rainfed. Valleys were irrigated by the hill canals. In both environments, land preparation was totally dependent on bullock power. Mechanization was not popular due to bio-physical conditions of land and small size of plots which have sloppy situations. However, paddy establishment methods differ in both the environments. Terraces was entirely direct seeded paddy (dry-seed and dry-soil), while in valleys, transplanting was the most popular paddy establishment method.

After the creation of the state, a substantial area declined due to urbanization, industrialization and for other development purposes in the plains. Total area under cereals in *Kharif* was about five lakh ha from which share of hills and plains was about 3.70 and 1.30 lakh hectare, respectively.

Paddy is grown in an area of about 2.86 lakh ha accounting for over 54% to the total area of cereal in *kharif*. Out of total 2.86 lakh ha paddy, 1.44 lakh ha, which was nearly 51 %, cultivated in hills and remaining 49 % in the plains. Production of paddy in the state was 532727 tones, out of which hills and plains constitute 196437 (36.80%) and 336290 (63.20%) tones, respectively. The average productivity of paddy in the state as a whole was 1.90 t/ha, whereas in hills it is 1.1t/ha only. The highest productivity of paddy is in the plains of districts Nainital and U.S.Nagar *i.e.* 3.0 and 2.6 t/ha, respectively. The highest productivity among hill districts is in Tehri Garhwal which is 1.60 t/ha. Hill agriculture is practice under harsh conditions; hill and mountain ecosystem which is unique because of topographical features, climatic variations along the slope *etc.* In general, hills receive 750 to 1250 mm precipitation, however, about 10 % of the area is under irrigation in hills that to confine to the lower valleys. The paddy productivity in the hill districts is stagnating for the past several years. Due to poor productivity in hills, the production is not adequate for the whole year of farming family. Even though state as a whole is surplus with food production but the hill districts depict a different picture. They face a net shortage of about 29000 tons of food grain annually. At the same time, state's population is growing at the rate of 2% per annum. Also, soil depths are shallow and limited land available for cultivation. In the backdrop of above, the present study was undertaken to analyze paddy production practices and livelihood of farming community in hills [3-16].

Material and Methods

Analysis carried out to compute costs incurred in various aspects of production practices and returns from different groups of sample farms. Tabular analysis was adapted to general characteristics of the paddy growers, resource structure, costs and returns structures *etc.*

Survey design of study

Three stage sampling technique was used for the selection of block, villages and farmers from Almora district purposively based on the existence of largest paddy growing area. A complete list of all twelve blocks located in Almora district was obtained from the district headquarters and Takula block that have highest area under paddy was selected purposively. For the selection of villages, a list of all villages falling under Takula block was prepared from the records of block headquarter and two villages namely; Adhuria and Balai which were located in terrace and valley, respectively and that have highest area under paddy were selected for the present study. A separate list of paddy growers of Adhuria and Balai villages was collected and arranged in ascending order based on land holding size and it was further categories into two groups *viz.*, marginal and small farms based on land available for cultivation. The operational holding size is usually very small in the hills, therefore, the farmers having 10-20 (0.50-1.0 acre) and 20-40 nali (1.00-2.00 acre) cultivated land were classified as marginal and small farmers, respectively. The above measurement was designed in view of smaller holding size available in the hills. From this list, a sample of 30 paddy growers from each village were selected randomly and the total sample size was 60 paddy farmers for the detail study pertaining data to the agriculture year 2018-19.

Analytical tools

Tabular analysis was adapted to general characteristics of the sample paddy growers, determination of resource structure, costs and returns analysis.

The weighted mean of the variable X was calculated by using following formula.

$$\text{Weighted mean} = \frac{\sum W Xi}{\sum W}$$

Where,

W = Weight of Xi,

Xi = Variables

The arithmetic mean of the variable X was calculated by using following formula.

$$\text{Arithmetic mean} = \frac{\sum X}{N}$$

Where,

X= value of observations,

N= number of observations

Measures of farm profit:

Gross income (Rs.) = Price of M.P. (Rs./qtl) × yield of M.P. (qtls/ha) + Price of B.P. (Rs./qtl) × Produce of B.P. (qtls./ha)

Net income (Rs.) = Gross income-Cost of cultivation

Results and discussion

Characteristic of selected villages

The major characteristics of the study villages are summarized in [Table-1]. The average operational holding of sample farmers in terrace was slightly higher 0.28 ha as compared to 0.26 ha in valleys in study villages. The overall average operational holding of sample farmers was about 0.27 ha. In valleys nearly 84.30 % of the fields have access to irrigation through hill canals. While terraces were mainly dependent on rainfall and very small portion was irrigated by hill springs. Average years of schooling of household head in valleys were slightly higher (8.40) as compared to terrace (7.60) and together they formed 8.00 years on overall basis.

Table-1 *Characteristic of selected villages*

Characteristics	Terrace	Valleys	Overall
No. of households	30.00	30.00	60.00
Average age of household's head (years)	52.30	50.80	51.55
Average years of schooling of household head	7.60	8.40	8.00
Average household size (no. of family members)	5.20	5.80	5.50
Average operational holdings (ha)	0.28	0.26	0.27
Irrigated area (%)	1.79	84.30	41.77
Sources of irrigation	Spring	Hill Canal	-
Share of paddy in total cropped area in kharif season (%)	47.66	58.13	52.71
Average paddy yield (q/ha)	14.60	40.20	27.40
Average number of parcels	5.30	1.50	3.40
Average number of plot/parcel	18.93	5.75	12.34
Average size of parcel (ha)	0.05	0.17	0.11

Average age of household's head was 52.30 year in terraces as compared to valleys where it was slightly lower *i.e.* 50.80 year. It is evident from the table that number of family members per family was 5.80 for valleys and 5.20 for terraces in target area. The overall average household size was 5.50 members per family. The difference in number of parcels and their size varies in two different paddy growing environments. Average numbers of parcels were more in the terraces than valleys, whereas number of plots per parcel almost equal. However, average size of parcel was smaller in terraces. It may due to hill slopes and undulating nature of land situation. Table also indicates that paddy accounted for 47.66 and 58.13 % share to total cropped area in *kharif* in terraces and valleys, respectively. The overall percentage area of paddy to total cropped area in *kharif* was 52.71 %. This clearly indicates that paddy is most important crop in the *kharif* season which supports livelihood of farming community in study area. Average yield of paddy was 14.60 and 40.20 qtls per hectare in terraces and valleys, respectively. Low yield level of terrace was associated with the undulating land type, poor quality soil and non-use of modern inputs such as HYV seeds, fertilizers, irrigation *etc.* Shallow depths of soil available for cultivation on rocks in terraces restrict farmers to apply fertilizers in the crop due to poor moisture resume.

Distribution of operational land holding

The concept of operational holding indicates that land is wholly or partially belongs to the households for agricultural production purposes. It may be of different land tenure system exist such as owned and self-operated, leased-in or partly leased-in *etc.* In this study land tenure system is entirely owned and operated by owner himself in the study area. [Table-2] indicates that majority of farmers belongs to marginal category accounted 93.33 and 96.67 % to total farmers in terrace and valleys environment, respectively. A minor proportion of farmers fall in small category which were 6.67 and 3.33 % from respective environments. This clearly indicates that a significant proportion of land holding was dominated by marginal category of farmers in target area. The average land holding size in terraces and valley was 0.28 and 0.26 ha, respectively. In terraces 6.67 % of the sample farmers' fall under small size and occupying 13.33 % cultivated area.

Table-2 *Land holding description*

Environments	Size of holding	Number	% to total	total area (ha)	% to total area	Irrigated area(ha)	% irrigated area
Terraces	Marginal	28	93.33	7.28	86.67	0.08	1.10
	Small	2	6.67	1.12	13.33	0.07	6.25
	Total	30	100	8.4	100	0.15	1.79
Valley							
	Marginal	29	96.67	7.25	92.59	6.21	85.66
	Small	1	3.33	0.58	7.41	0.39	67.24
	Total	30	100	7.83	100	6.6	84.30
Overall							
	Marginal	57	95	14.53	89.53	6.29	43.29
	Small	3	5	1.7	10.47	0.49	28.82
	Total	60	100	16.23	100	6.78	41.77

Table-3 *Cropping pattern by seasons and environments*

Crops	Terraces (ha)	Share (%)	Valleys (ha)	Share (%)	Grand total (ha)	Share (%)
Kharif						
Paddy	4.00	47.66	4.55	58.13	8.56	52.71
Mandua	2.28	27.10	1.59	20.37	3.87	23.85
Madira	0.57	6.73	0.00	0.00	0.57	3.48
Cowpea	0.08	0.93	0.02	0.28	0.10	0.62
Gahat	0.50	5.98	0.13	1.70	0.64	3.91
Soybean	0.55	6.54	0.58	7.36	1.13	6.93
Urd	0.13	1.50	0.31	3.96	0.44	2.68
Bhat	0.06	0.75	0.04	0.57	0.11	0.66
Bhat + Soybean	0.08	0.93	0.21	2.69	0.29	1.78
Groundnut	0.05	0.56	0.00	0.00	0.05	0.29
Maize	0.03	0.37	0.13	1.70	0.16	1.01
Chilli	0.02	0.19	0.25	3.25	0.27	1.67
Ginger	0.06	0.75	0.00	0.00	0.06	0.39
Total	8.40	100.00	7.83	100.00	16.23	100.00
Rabi						
Fallow	1.46	17.35	0.81	10.30	2.26	13.95
Wheat	4.18	49.81	4.19	53.46	8.37	51.57
Barley	1.41	16.79	1.31	16.78	2.72	16.79
Pea	0.17	2.05	0.07	0.85	0.24	1.47
Lentil	0.74	8.77	0.41	5.22	1.15	7.06
Mustard	0.38	4.48	0.50	6.35	0.87	5.38
Gram	0.03	0.37	0.10	1.27	0.13	0.81
Potato	0.03	0.37	0.45	5.78	0.48	2.98
Total	8.40	100.00	7.83	100.00	16.23	100.00
Grand total	16.8		15.66		32.46	

Likewise, in valleys, 3.33 % of small size farmers holding 7.41 % of cultivated land to total area. There was very small area under irrigation which was 7.35 % to total cultivated area in terrace. While in valleys share of irrigated area were 85.66 and 67.24 % to total cultivated area on marginal and small farms, respectively. Table indicates that on an average share of irrigated area was 41.77 % to total cultivated area on sample farms. Area under irrigated land was differed on different farm size. Although, the sources of irrigation and extent of irrigation in both the environments are quite different and majority of irrigated area comes from valleys. Shares of irrigated area on marginal and small farms were 43.29 and 28.82 %, respectively to total cultivated area in surveyed villages.

Cropping pattern

[Table-3] reveals the cropping pattern adopted by the sample farms in two districts paddy growing environments *viz*, terraces and valleys in the study area. It is evident from the table that paddy was the major cereal in the terraces and valleys during *kharif* season. However, paddy accounts 23.81 and 29.06 % area to gross cropped area in terraces and valleys, respectively. Importance of paddy was also seems very obvious during *kharif* because it occupied 47.66 and 58.13 % to total cropped area in terrace and valleys, respectively. The other important crop of *kharif* was mandua, emerged as second major cereal and occupied 27.10 and 20.37 % area to total cropped area in the respective environments. The other cereals, pulses, oilseeds and spices crops were minor in importance in terms of its acreage. Table also presents that wheat was a major crop in *rabi* season in both the environments. Acreage of wheat was highest and it covered 49.81 and 53.46 % area to total cropped area in terraces and valleys, respectively. Barley emerged out as a second most important crop accounted 16.79 % area to total cropped area across the environments. In terraces lentil occupies considerable area (8.77%) followed by mustard (4.48%). Where as in valleys, Mustard, Potato and lentil were the other crops occupies 6.35, 5.78 and 5.22 % area to total cropped area in *rabi* season. A major portion of land was leftover fallow during *rabi* season in both the environments due to soil-deficient-moisture at sowing and planting time. Paddy is the major economic activity of households in *kharif* season as it seems from the table that coverage of this crop is 52.71 % to total cropped area on an overall basis. Wheat is the major crop in *rabi* and it covered 51.57 % area to total cropped area. It revealed that more than 85 % of the total cropped area was devoted to subsistence food crops. Paddy and wheat both crops dominated in the agricultural production system in both the environments in study area.

Input use in paddy cultivation by farm size

Input use in paddy production by farm size on per hectare basis is presented in the [Table-4]. The input use pattern was almost similar in both the categories of farms. Analysis revealed that use of bullock power was 10 days/ha across the farm categories. However, seed used in case of small farms was 136 kg./ha which is higher as compared to 111 kg./ha that of marginal farms. At the same time FYM consumption was exactly opposite of seeds and it was 125 qtls./ha applied by marginal farms, which was higher than the use by small farms *i.e.* 113 qtls./ha.

The numbers of irrigation were 8 and 5 in marginal and small farms, respectively. Consumption of nitrogen was little bit more in marginal farms 31 kg./ha than the small farms 20 kg. However, consumption of phosphorus was 12 and 13 kg./ha in marginal and small farms, respectively. The fertilizer consumption mainly used by farmers of valleys because they use modern varieties/high yielding varieties and had irrigation access when they required.

Total labor incurred in paddy production in marginal and small farms were 114 and 104 man days, respectively. The three major operational activities in which major labour days is required which were harvesting (27), threshing & winnowing (26) and weeding (25) accounted for 68.42 % altogether to total labor days. However, in small farms two major operations was labor intensive as weeding (31) and harvesting (29) which accounted for 57.69 % together to total labour days. Other major operations of labor use was transplanting/establishment in which 17 and 11 labour days required on marginal and small farms, respectively. Other activities of labor use constitutes in nursery establishment and their management, application of manure & fertilizers and irrigation which formed very less share to total labour days.

In both types of farms inorganic fertilizer was use but lower quantity. The total inorganic fertilizers use was 43 kg/ha across the farms in target villages. Out of 43 kg, 31 kg nitrogen and 12 kg. phosphorus was use in the marginal farms. Whereas on small farms the quantity of nitrogen and phosphorus consumption was 20 and 13 kg,/ha respectively [Table-4].

Table-4 *Input use in paddy cultivation by farm size (Per ha)*

Farm size Particulars	Marginal farms	Small farms
Material		
Bullock power (days)	10	10
Seed (Kg)	111	136
FYM (qtls)	125	113
Irrigation (no.)	8	5
Fertilizer (kg)		
Nitrogen	31	20
Phosphorus	12	13
Labour days		
Nursery management*	2	1
Paddy establishment **	17	11
Manure application	12	13
Fertilizer application	2	1
Weeding	25	31
Irrigation	3	2
Total Pre-harvest labor	61	59
Harvesting	27	29
Threshing &Winnowing	26	16
Total labour days	114	104

*Preparation of nursery bed, FYM application, irrigation, seeding and care *etc.*
** 10 working hrs = one day

Cost and returns analysis of paddy cultivation by farm size

[Table-5] reveals that the average cost and returns from cultivation of paddy by different farm size on per hectare basis. The total cost of cultivation of paddy was Rs.49806/ha on marginal and Rs.46042/ha on small farms. Material inputs cost accounts for 31.33 and 32.24 % to total production cost on marginal and small farms, respectively. Among all items of material inputs cost, bullock power and FYM contributed considerable shares to total cost. However, cost of bullock power was Rs. 5000/ha across the farms in surveyed area. Cost of FYM was slightly higher of marginal farm Rs. 6250/ha as compared to Rs. 5650/ha of small farms due to variable quantity used.

Cost of bullock power and FYM were together accounted for 22.59 and 23.13 % in marginal and small farms, respectively. Other item of costs constituted relatively lower share to the total cost. The total material cost was Rs. 15606/- and Rs. 14842/ha in marginal and small farms, respectively.

Labor cost solely constitutes the cost of family labor in both types of farms. Labor cost includes various activities of paddy production which includes nursery management, establishment, manure application, fertilizer application, weeding, irrigation, harvesting and threshing & winnowing. Harvesting, threshing & winnowing and weeding formed together highest share (47%) of total cost and it contribute 16.26, 15.66 and 15.06 %, respectively, for marginal farms.

Whereas, on small farm the major component of labor cost activities were weeding and harvesting which accounts 20.20 and 18.90%, respectively. Activities like establishment/planting accounted for about 10.24 % in marginal farms and 7.17 % in small farms. Other items like nursery management, manure application, fertilizer application forms minor part of total cost of paddy cultivation.

Table-5 *Costs and returns of paddy cultivation by farm size, (Rs/ha)*

Farm size Particulars	Marginal farms	%age	Small farms	%age
Material Cost				
Bullock power	5000	10.04	5000	10.86
Seed	2220	4.46	2720	5.91
FYM	6250	12.55	5650	12.27
Irrigation	1600	3.21	1000	2.17
Fertilizer*				
Nitrogen	248	0.5	160	0.35
Phosphorus	288	0.58	312	0.68
Sub-Total	15606	31.33	14842	32.24
Labor Cost				
Nursery management	600	1.2	300	0.65
Paddy establishment	5100	10.24	3300	7.17
Manure application	3600	7.23	3900	8.47
Fertilizer application	600	1.2	300	0.65
Weeding	7500	15.06	9300	20.2
Irrigation	900	1.81	600	1.3
Total Pre-harvest labour	18300	36.74	17700	38.44
Harvesting	8100	16.26	8700	18.9
Threshing & Winnowing	7800	15.66	4800	10.43
Sub-Total	15900	31.92	13500	29.32
Total cost	49806	100	46042	100
Yield				
MP (q/ha)	28	-	26	-
BP (q/ha)	31	-	29	-
Paddy MP (Rs/q)	1675	-	1675	-
Paddy BP (Rs/q)	100	-	100	-
Value of MP (Rs)	46900	-	43550	-
Value of BP (Rs)	3100	-	2900	-
Gross return (Rs)	50000	-	46450	-
Net return (Rs)	194	-	408	-

** Source of NPK: Urea, DAP and SSP.*

Yield of main product of paddy was 28 qtls./ha on marginal farms, while it was relatively higher as 26 qtls./ha on small farms. There is an also minor variation in the quantity of by-product. It was 31 qtls./ha in case of marginal farms and 29 qtls on small farms which was slightly lower than former. The price of main-product of paddy was Rs. 1675/qtl. and the price of by-product was Rs. 100/qtl across the farms in study area. Gross returns from paddy cultivation was Rs. 50,000 and Rs. 46,450/ha on marginal and small farms, respectively. The net returns were Rs. 194 and Rs. 408/ha on marginal and small farms, respectively.

Since food security is the major issue in the hills, therefore, paddy producers are hardly concern for maximization of net return or profit. Producers are interested to use available land resources and to provide employment to their family members while opportunity cost of labor in the market is zero in *kharif* season.

Major paddy varieties, planted area and mean yield

The major paddy varieties planted and their characteristics are presented in [Table-6]. Paddy cultivated basically in two different growing environments *viz.*, terraces and valleys. The varieties grown were also different in terms of types: modern varieties (MV) and traditional varieties (TV). In terraces farmers were cultivating traditional varieties exclusively while in valleys, coverage of modern varieties was only exist. Farmers were cultivating three paddy varieties namely, safeddhan, laldhan and kurmuli in terraces which are local land races and adapted from ages.

Table-6 *Major paddy varieties, planted area and mean yield on sample farms.*

Varieties	No. of growers	Area (ha)	Extent of coverage (%)	Yield (qtls/ha)
TVs				
Safeddhan	25	2.49	62.35	15.17
Laldhan	16	1.24	30.98	14.74
Kurmuli	4	0.27	6.67	13.89
Sub-total	-	4.00	100.00	14.6
MVs				
China 4	28	2.00	44.04	41.73
Thapachini	32	2.55	55.96	38.67
Sub-total	-	4.55	100.00	40.2
Grand total	-	8.55	100.00	27.4

TVs = Traditional varieties, MVs = Modern varieties

Table-7 *Factors of adoption of improved paddy varieties and constraints analysis*

Components	Terraces	Standard deviation	Valleys	Standard deviation
No. of farmers	30	-	30	-
No. of plots	159	-	45	-
Extent of MVs' adoption (%)	0	-	100	-
Yield (q/ha)	14.6	2.92	40.2	5.7
a. Socio-economic variables				
Average age of households head (years)	52.3	11.74	50.8	10.9
Average years of schooling of households head	7.6	3.98	8.4	4.14
Average household size (no. of family members)	5.2	1.27	5.8	1.5
Average operational holdings (ha.)	0.28	5.83	0.26	6.54
b. Biophysical variables				
Land type	Upper and slopes	-	Lower and plain	-
Soil type	Brown soil and light texture	-	Red loam soil and heavy texture	-
Access to irrigation (%)	1.79	-	84.3	-

Table-8 *Average annual income of sample households, (Rs./households)*

Environments	Terraces		valleys		Overall	
Sources of Income	Income	Share (%)	Income	Share (%)	Income	Share (%)
Shops	17856	25.90	29376	25.21	23616	25.46
Teaching+++	9216	13.37	13824	11.86	11520	12.42
Government job	13824	20.05	33216	28.50	23520	25.36
Self Employed**	4320	6.27	6432	5.52	5376	5.80
Livestock	4838.4	7.02	5064	4.35	4951.2	5.34
Private services***	9552	13.86	12763.2	10.95	11157.6	12.03
Crop production	2107.2	3.06	8224.8	7.06	5166	5.57
Paddy+	-392	-0.57	520	0.45	64	0.07
Wheat++	1209.6	1.75	2457.6	2.11	1833.6	1.98
Others*	6403.2	9.29	4669.44	4.01	5536.32	5.97
Total	68934.4	100.00	116547	100.00	92740.72	100.00

**others include: Off-farm labour, Farm labour and Pension. ** Self employed includes: barber, blacksmith and tailor.*
**** includes: Hotels and restaurants, Shop, Industries, Servants, transport, corporate offices etc.*
+, ++ Value of these crops added in crop production. +++ includes: teacher from govt. school as well as private school.

Most of the farmers growing safeddhan on their farms (25) followed by the laldhan (16) and least number of farmers growing kurmuli (4). Acreage under safeddhan was highest which accounted 62.35 % of the total paddy area in terraces. These three traditional varieties having low yielding, tall plant and lodging in nature with an average yield of 14.60 qtls/ha. On the other hand, farmers in valleys, planted two improved varieties only on their farms *i.e.* china-4 and thapachini. Their yield level was almost tripled as compared to traditional varieties being grown in terraces.

The farmers are mostly preferred thapachini than the china-4 in the valleys in terms of acreage and number of farmer/growers. However, the yield of china-4 was also 8% higher (41.73 qtls./ha) than the thapachini (38.67 qtls). Factors influences adoption of improved paddy varieties and constraints analysis.

[Table-7] presents the information on various physical, bio-physical and socio-economic factors which affects the adoption of modern varieties (MVs) on the sample farms. Adoption of modern varieties (MV) in terrace was almost zero and whole area planted by TVs. While valleys were 100 % acquainted with modern varieties of paddy due to irrigation facility [Table-7].

Average year of schooling of household head in valleys was slightly higher (8.40 yrs.) as compared to terrace (7.60 yrs). Average age of household's head was 52.30 yrs. in terraces and it was slightly lower *i.e.* 50.80 yrs in valleys, more active population of hills. Although, there was no significant difference in the average year of schooling of household head and average age of heads for terraces and valleys. It is evident from the table that number of family members per family was 5.80 for valleys and 5.20 for terraces and didn't seen any significant difference. The average operational holding in terrace was slightly higher 0.28 ha as compared to 0.26 ha in valleys. [Table-7] also presents the standard deviation (SD) of different variables which is usually affecting the adoption pattern of MVs. There was no significant difference were found between the different socio-economic variables in two paddy growing environments. Also, the extent of variation was not significant among all socio-economic variables, except non-farm income. In general, one can state that socio-economic variables didn't play an important role in adoption of modern varieties of paddy. Another set of variables which affect the adoption of modern varieties was physical and bio-physical variables which were entirely different from each other in both the environments. Terraces mainly characterized by upper and sloppy lands, with very small size plots. However, plain and low laying land types was found in the valley. The soil type was also differed in both the environments; terraces covered with brown soil with light texture which poor moisture is holding capacity in contrast to it; valleys were inhibited by red loam soil and heavy texture with good irrigation facility (83.4%). Therefore, paddy production is more successful in valleys than the terrace which is characterized as fragile environment. So, this tabular analysis clearly indicates that bio-physical variables such as land and soil types, irrigation facility were basically responsible for the adoption of modern paddy varieties in the valleys. Whereas, bio-physical situations prevailing in the terrace especially constraints in the adoption of improved paddy variety.

Annual average income of household in surveyed villages

The average annual income of the household from all sources in two distinct paddy growing environment was presented in [Table-8]. Overall annual household's income from all the sources was Rs. 92740/-. Its major portion was constituted by shops and government jobs which contributed in equal share (25% each) in total income received by the households in a year. Whereas, teaching profession provides a substantial income as it was contributed 12.42 % to total income of households. The next important source of income was jobs in private sector, which derives considerable proportion of income (12.03 %). However, share of crop production in total households' income was 5.57 % which is quite lower than the other major sources. The other minor sources of income were selling of milk and self-employment *etc*. Terraces situation also reveals somewhat similar income trend like overall condition. In this environment, shops contributed highest share 25.90 % to the total household's income.

The second major source of income is the government jobs which accounted for 20.05 % of the total household's income. People involved in private services and teaching shared almost equal proportion of income accounted for 13.86 and 13.37 % to total income, respectively. Crop production formed only 3.06 % of household's income in which income from the paddy was in negative means gross income is less than the cost of cultivation. Beside this, farmers of the area constantly following the paddy production, this may be due to the food security, availability of fodder, consumption requirements and cultural habits. Farmers have no another better alternative than the paddy in *kharif* season and it also found prominent place in the daily food habit of the peoples, addition to use in social and religious occasions (worship of Gods and Goddess).

[Table-8] clearly depicts the livelihood strategies of farming community in study area. In spite of negative net return from paddy cultivation, farmers follow the practice of paddy cultivation constantly from ages due to family labour employment in their own farming situation. The opportunity cost of family labour in the hill during kharif season is zero.

The average annual income of households in irrigated valleys was Rs. 116547/- which was potentially higher about 69% as compared to rainfed terraces where it was only Rs. 68934/- annually. The major source of income was government jobs and it was accounted for 28.50 % followed by shops which contributed 25.21 % to total average annual income in the valleys. Teaching and crop production also considerably contributed to the average annual income in valleys that accounted for 11.86 and 7.06 %, respectively.

Conclusion and recommendations

Since food security is the major issue in the hills, therefore, paddy producers are hardly concern for maximization of net return or profit. Producers are interested to use available land resources and to provide employment to their family members while opportunity cost of labor in the market is zero in kharif season. Paddy being the most staple food grain in the hill but productivity is quite lower than the plains due to acreage of modern rice varieties in later paddy growing environment is very high. The productivity improvement in hills is a big challenge for the scientists, researchers, administrators, bureaucrats and policy makers. Adoption of modern paddy varieties can improve only by developing varieties which will be well suited to the given environment of hills: shorter duration, high yielding and to responsiveness of fertilizer application. Traditional varieties non-responsive to the fertilizer application due to their lodging character and lodging is the main source of yield losses in the field condition. This location/situation specific field studies are as an empirical evidence of paddy production which can facilitates to various stalk holders for technology design and policy formulation that could helpful in improving paddy yield in the hills.

Application of research: Development of suitable short-duration varieties and management practices of paddy production which could helpful to farming community in strengthening their food security by improving yield of paddy.

Research category: Agricultural Economics

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Study area/ Sample Collection: Almora district

Cultivar / Variety / Breed name: Rice

Conflict of Interest: None declared

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