



## Research Article

# ECONOMIC ANALYSIS OF PADDY PRODUCTION AND HOUSEHOLDS' LIVELIHOOD IN HILLY AREA OF ALMORA DISTRICT: POLICY FOR ENHANCING AND STABILIZING INCOME OF HOUSEHOLDS IN UTTARAKHAND, INDIA

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**Abstract:** Analysis revealed the characteristics of paddy producing households in randomly selected two villages: Adhuria and Balai from Almora district. Primary data of 60 randomly selected households were collected for detailed analysis. Descriptive statistics were applied and tabular analysis was used to ascertain the results in precise manner. The majority of farmers belong to marginal category that was 93 and 97% to total farmers in terrace and valleys environments, respectively. On the other hand, a meager share of farmers falls in small category, 7 and 3 % in the respective environments. Paddy was the major cereal crop in the surveyed area during *kharif* season and it accounts 48 and 58% area to total cropped area in terraces and valleys, respectively. Livestock considered as backbone of hill economy and formed a sustainable source of income for households. Use of machinery like tractor, harvester, threshers etc. was not common due to bio-physical condition of the cultivated land available on sample farms. Traditional implements/equipments were used in farming business to till now.

The average annual income of households in valleys was Rs.116547/- which was 69% higher as compared to terraces Rs.68934/-. Analysis also revealed that the paddy production scenarios in valleys are more attractive due to prevailing assured production environment which is served as profitable business for the farmers. However, farmers of terrace growing paddy in *kharif* season due to employment of available resources with them-land and family members. As the opportunity cost of family member employment in the hills during *kharif* season is zero. Regression analysis indicates the independent variables: age of household head, farming experiences, size of land holding, share of irrigated area and yield advantage of MV were found positive and significant effect on area planted under modern paddy varieties. Increase in productivity of paddy is a big challenge for the farmers in hills. Adoption of modern paddy varieties can improve the productivity to desirable level, if suitable variety made available to the farmers.

**Keywords:** Population, Literacy, Terrace, Valleys, Livestock, Farm assets, Income

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## Introduction

India is one of the world's largest producers of rice, accounting for 22% of all world rice production. Rice (paddy) is India's premier crop and is the staple food of the population belongs to the eastern and southern parts of the country. Production of rice has increased from 53.60 million tons in the year 1980 to 74.60 million tons in 1990, a 39 % increase over the decade. By the year 2013-14, rice production had reached 106.29 million tonnes, second in the world only to China with its 144 million tonnes. Since 1950, the increase has been more than 350 %. Most of this increase was the result of an increase in yields, the number of hectares increased only 40 % during this period. The per-hectare yield increased more than 262 % between 1950 and 1992. The India's rice production reached to a record high of 104.32 million tons in 2011-12. In 2013-14 crop year production of rice reached to 106.29 million tons due to better monsoon. But in crop year 2014-15 rice production decreased due to low rainfall and effect of cyclonic storm Hud-Hud at major paddy grown areas like Andhra Pradesh, Odisha, West Bengal and Chhattisgarh. Moreover, this country has the biggest area under rice cultivation. It is in fact the dominant crop of the country. India is one of the leading producers of this crop.

Eleven out of thirteen districts in Uttarakhand falls under hilly area of North Western Hill region. Paddy is the major cereal crop of *kharif* season accounting for more than 54% of the total area under cereals in the state. 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 hectares accounting for over 54% to the total area of cereal in *kharif*. Out of total 2.86 lakh ha rice, 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. Paddy apart from being a source of food is intimately related with all the religious, cultural and social functions of the life of hill people. It also provides feed for cattle, thereby reducing pressure on grazing land and forests. Thus, paddy helps to balance the delicate ecosystem of Himalayas, where fodder scarcity is more acute.

Paddy production practices followed in the hills of Uttarakhand state in two distinct environments namely; terraces and valleys by different categories of farmers with predominance of marginal and small farmers. The promising rice establishment methods in terraces were direct-seeded while valleys transplanted. Therefore, there is a lot of variation in costs and returns in different environments. Previous studies have shown that poor infrastructure, inaccessibility to modern technology, small and fragmented land holding, low investment capacity of farmers and problems like little use of modern inputs as both non-availability and non-suitability affected the hill agriculture significantly. Application of fertilizers and its per unit use in hilly areas of state is (8.0 kg/ha) very less, whereas for the region as a whole it is about 75 kg/ha.

Agriculture is practiced in hills 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 rice 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. In hill, high yielding rice 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. In view of above, this study undertaken to characterize rice production practices in complex, diverse and risk-prone paddy production environment of hills. Since local land races of paddy are continued in production in spite of several HYVs are available in the market but their adoption in the hills were limited. Therefore, determinants of adoption of modern paddy varieties were also analyzed in this study [1-8].

## Material and Methods

### Survey design and data collection

The requisite data was collected from primary as well as secondary sources. Two villages namely; Adhuria and Balai which were located in terrace and valley, respectively from Takula block of Almora district. The selection of district, block and villages were purposively based on the existence of largest paddy growing area in the hill district of the state. A separate list of farmers falling under both the villages was prepared and categorized into two groups viz., marginal and small farms based on land available for cultivation. The operational land 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. From this list, a sample of 30 paddy growers from each village were selected randomly and the total sample size was 60 paddy farmers. Data pertained to the agriculture year 2018-19 [9-16].

### 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.

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

Where,

W = Weight of  $X_i$ ,

$X_i$  = 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

### Determinants of modern varieties adoption

To determine the factors affecting adoption of modern paddy varieties, OLS regression model was used as given below.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + u$$

Where; Y = Area under modern paddy varieties (%)

$X_1$  = Age of household head (years)

$X_2$  = Experience in farming of household head (years)

$X_3$  = Years of schooling

$X_4$  = Household size (no.)

$X_5$  = Size of land holding (ha)

$X_6$  = Share of irrigated area (%)

$X_7$  = Contact with extension person (if yes=1, 0 otherwise)

$X_8$  = Yield advantage of modern variety (qtl/ha)

$\beta_i$  = Coefficients to be estimated ( $i = 0, 1, 2, 3, \dots, 8$ )

u = error term

The presence of multi co-linearity among independent variables was examined using zero order correlation matrixes.

## Results and discussion

### Characteristic of households in surveyed area

The major characteristics of the sample households 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. 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-1] 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.

Table-1 Characteristic of households in surveyed area (2018-19)

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 <i>kharif</i> 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

### Educational status and family size

The [Table-2] shows the family structure and their education level on sample farms in both the paddy growing environments. The average numbers of members were 5.20 and 5.80 per family in terraces and valleys, respectively in study villages. On an average, families in terraces constitute 2.20 male adults, 0.70 male children, 1.60 female adults and 0.70 female children. While the average family size in valleys was little bit more as compared to terraces with 2.90 male adults, 0.85 male children, 1.45 female adults and 0.96 female children. Data also showed that almost similar composition and distribution of family members in both the environments.

Table-2 Educational status and family size

Particulars	Terrace	%	Valleys	%	Overall	%
No. of male adult per family						
Illiterate	0.20	3.85	0.10	1.72	0.15	2.73
Up to secondary	1.20	23.08	1.00	17.24	1.10	20.00
Higher sec	0.50	9.62	1.20	20.69	0.85	15.45
Graduation and above	0.30	5.77	0.60	10.34	0.45	8.18
No. of male adult per family	2.20	42.31	2.90	50.00	2.55	46.36
No. of male children per family						
Infant	0.10	1.92	0.20	3.45	0.15	2.73
Up to secondary	0.50	9.62	0.35	6.03	0.43	7.73
Higher sec	0.10	1.92	0.30	5.17	0.20	3.64
No. of male children per family	0.70	13.46	0.85	14.66	0.78	14.09
No. of female adult per family						
Illiterate	0.80	15.38	0.60	10.34	0.70	12.73
Up to secondary	0.40	7.69	0.50	8.62	0.45	8.18
Higher sec	0.30	5.77	0.20	3.45	0.25	4.55
Graduation and above	0.10	1.92	0.15	2.59	0.13	2.27
No. of female adult per family	1.60	30.77	1.45	25.00	1.53	27.73
No. of female children per family						
Infant	0.20	3.85	0.15	2.59	0.18	3.18
Up to secondary	0.40	7.69	0.30	5.17	0.35	6.36
Higher sec	0.10	1.92	0.15	2.59	0.13	2.27
No of female children per family	0.70	13.46	0.60	10.34	0.65	11.82
Family size	5.20	100.00	5.80	100.00	5.50	100.00

Table-3 Land holding description of households

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	8.40	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	6.60	84.30
Overall	Marginal	57	95	14.53	89.53	6.29	43.29
	Small	3	5.00	1.70	10.47	0.49	28.82
	Total	60	100	16.23	100	6.78	41.77

The overall situation depicts an average picture of both environments viz., terraces and valleys and it reveals that an average family had 2.55 male adults, 0.78 male children, 1.53 female adults and 0.65 female children. This clearly shows that the percentage of males in average family size was higher in both environments.

[Table-2] also represents the educational status of sample households. A very small proportion of male adults were illiterate on sample farms. It revealed from the table that a higher proportion of male adult population educated up to secondary level which accounted 23.08 % in terraces followed by higher secondary and graduation levels. The proportion of male adults was educated up to graduation was more in valleys (10.34 %) than the terraces. Table also presents that majority of male children were studying up to secondary level which was 9.62 % in terraces and 6.03 % in valleys. In terraces the percentage of illiterate female adults was higher that is 15.38 %, where as in valleys it was about 10.34 %. A significant number of female adults per family were qualified up to secondary and very few were educated up to higher secondary. The situation becomes worse when move towards the higher education level i.e., graduation and above, only 2.59 % female adults per family educated in valleys, while it was 1.92 % for terraces.

A majority of female children falls under secondary level of education. It accounts for 7.69 % in terraces as compared to 5.17 % of valleys. On an average proportion of female children were 13.46 and 10.34 % to total population in terraces and valleys, respectively. The overall situation of female adults reveals that 12.73 % were illiterate and very few were graduate and above i.e., 2.27 %. Male adults form illiterate 2.73 % whereas educated up to graduation was 8.18 % to total population. The proportion of male adults educated up to secondary and higher secondary was at satisfactory level. The overall condition of children (male +female) showed that more than 17.31 % were educated up to secondary level.

### Land holding description of households

The concept of operational holding indicates that land is wholly or partially belongs to households for agricultural production purposes. It may be of different types land tenure arrangements like owned and self-operated or leased-in or partly leased-in. In this study land tenure system is entirely owned and operated by owner himself in the study area. [Table-3] indicates that majority of farmers belongs to marginal category that is 93.33 and 96.67 % to total farmers in terrace and valleys environment, respectively. Whereas a very poor proportion of farmers fall in small category i.e., 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 hectare, respectively. In terraces 6.67 % of the sample farmers' fall under small size and occupying 13.33 % cultivated area. Likewise, in valleys, 3.33 % of small 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 on aggregate level. The shares of irrigated area on marginal and small farms were 43.29 and 28.82 % to total cultivated area in surveyed villages.

### Distribution of livestock on sample farms

Livestock considered as backbone of hill economy and formed a sustainable source of income for households. [Table-4] represents the livestock population on the sample farm.

Table-4 Distribution of livestock on sample farms

Environments	Particulars	Number	%age to total animal	Number of animals per household
Terraces				
	Cows	35	47.30	1.17
	Buffaloes	27	36.49	0.90
	Bullocks	12	16.22	0.40
	Total large ruminants	74	100.00	2.47
	Small ruminants (Goat)	85	100.00	2.83
Valleys				
	Cows	38	48.72	1.27
	Buffaloes	25	32.05	0.83
	Bullocks	15	19.23	0.50
	Total large ruminants	78	100.00	2.60
	Small ruminants (Goat)	70	100.00	2.33
Overall				
	Cows	73	48.03	1.22
	Buffaloes	52	34.21	0.87
	Bullocks	27	17.76	0.45
	Total large ruminants	152	100.00	2.53
	Total small ruminants (Goat)	155	100.00	2.58

The total livestock population in the terraces was 159 constituting small and large ruminants. It was shared by 47.30 % cows, 36.49 % buffaloes and 16.22 % bullocks. Small ruminants' population was formed only by goats and they were 85 in number. In valleys large ruminant's population was 78 and small ruminant's population was only 70 in number. Contribution of cows, buffaloes and bullock in total population was 48.72, 34.21 and 17.76 %, respectively in the study sites.

[Table-4] also gives the information on number of animals per household on sample farm. Among large ruminants, cows found more in numbers in both the study environment followed by buffaloes and bullocks. While small ruminants (goats) was significantly more in numbers in terraces as compared to valleys. On an average total livestock population was 307. In valley's population of large ruminants was slightly more than the terraces environment. However, population of small ruminants was restricted only to goats.

#### Distribution of farm assets on the sample farms

[Table-5] reveals the assets situation on the sample farms which included cattle shed, major and minor farm implements and livestock. Fixed farm assets comprise of only cattle sheds, which was mainly build in the lower portion of the house. There were no separate cattle shed for the animals. Use of machinery like tractor, harvester, threshers etc. was not common due to bio-physical condition of the cultivated land available on sample farms.

Only traditional implements/equipment's were used in farming business. Average value of cattle shed in valleys was Rs. 48864/- slightly higher as compared to terraces Rs. 42240/-.

The value of desi plough and patela were also higher in the valleys as compared to terraces. If we compare the values of different livestock's in two diverse paddy growing environments, their values were higher in terrace. On an overall basis the value of cattle shed was highest among all the assets.

Table-5 Distribution of farm assets on sample farms (Rs./hhlds)

Particulars	Terraces	Valleys	Overall
<b>a. Fixed Farm assets</b>			
Cattle shed	42240.00	48864.00	45552.00
<b>b. Machinery and Equipment</b>			
Desi plough	1900.80	2323.20	2112.00
Patela	1056.00	1252.80	1154.40
Chaff cutter	384.00	432.00	408.00
Spade	283.20	316.80	300.00
Sickle	165.60	148.80	157.20
Sub total	3789.60	4473.60	4131.60
<b>c. Livestock</b>			
Cows	10173.33	12794.43	11483.88
Bullock	5343.57	7133.33	6238.45
Goats	17480.00	18763.00	18121.50
Buffalos	14491.65	13723.46	14107.55
Sub total	47488.55	52414.22	49951.39
Grand total	93518.15	105751.82	99635.00

#### Cropping pattern by season and environment

[Table-6] 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 seeming 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-6] 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.

#### Cost and returns analysis of paddy cultivation by environments

The average material and operational costs of paddy cultivation on per hectare basis are revealed from [Table-7]. The ratio of material and operational costs was 1: 1.7 in the terrace where as it was 1: 2.7 in the valley. This result indicates that the use of labour was more and about to one and half in the valley than the terrace because of bumper crop was harvested in valley as it provides favorable paddy producing environment. The cost of cultivation of paddy was Rs. 57250/ha in the valley which is one and half times higher than to the terrace Rs. 37350/ha. The material cost includes bullock power, seed, FYM, irrigation and fertilizer etc. Material cost was more in valleys due to use of chemical fertilizers.

In two environments viz., terraces and valleys, human labour included only family and exchange laborers because hired labor is not available in the hills. Labor cost in paddy cultivation included nursery management, establishment, application of manure and fertilizer, weeding, harvesting, threshing and winnowing. The expenses on labor cost were Rs. 23400/ha in terraces and Rs. 41700/ha in Valleys which constitute 62.65 and 72.84 % to total cost, respectively.



Table-6 Cropping pattern by season and environment

Crops	Terraces (ha)	Share (%)	Valleys (ha)	Share (%)	Grand total (ha)	Share (%)
<b>Kharif</b>						
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
<b>Rabi</b>						
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	

Weeding emerged out as a main component of labor cost in terraces. It was Rs.9000/ha for terraces and Rs. 7500/ha for valleys, followed by harvesting cost of Rs.6000 and Rs. 10500/ha in terraces and valleys, respectively. The yield of main product was higher in valleys i.e., 40.20 qtls/ha as compared to terraces, where it was only 14.60 quintal. It may be due to non-adoption of modern technologies such as HYVs seeds and fertilizers in terraces. Price of grain was also slightly higher in valleys i.e., Rs.1700/qlts which may be due to preferred quality of paddy by consumers as HYVs. The price of by-product (straw) is same (Rs.100/qlts.) across the paddy growing environments.

There are large differences observed in gross returns from paddy cultivation in two different growing environments. In valleys gross returns are near to tippie (Rs.72840/ha) than to terraces (Rs.25590/ha). This was happening due to extremely high yield of paddy grain in the valley where modern technologies of paddy production followed by the farmers. Valleys provide ideal paddy production situation in *kharif* season where all the newly developed technological interventions were adopted potentially. Surprising result were reported in this study from terrace where net returns of paddy cultivation are negative means gross return is less than the cost incurred in which is Rs.11760/ha.

Table-7 Costs and returns analysis of paddy production by environments (Rs./ha)

Environments Particulars	Terraces	%age	Valleys	%age
Material Cost	13950	37	15550	27
Operational cost	23400	63	41700	73
Total cost	37350	100	57250	100
Yield and return analysis				
MP (qtl./ha)	14.6	-	40.2	-
BP (qtl./ha)	15	-	45	-
Gross return (Rs.)	25590	-	72840	-
Net return (Rs.)	-11760	-	15590	-
B:C ratio	0.69	-	1.27	-

Source of NPK: Urea, DAP and SSP

### Annual average income of households

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.

[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.

### Determinants of modern paddy varieties adoption

Modern vs. traditional varieties: The paddy varieties were grown entirely 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 existing. Farmers of terraces were grown 03 paddy varieties, safedddhan, laldhan and kurmul which are local land races and adapted from ages. Most of the farmers growing safedddhan on their farms (25) followed by the laldhan (16) and least number of farmers growing kurmul (4). Acreage under safedddhan was highest which accounted 62.35 % of the total paddy area in terraces. These three traditional varieties having low yield, tall plant and lodging in nature with an average yield 14.60 qtls/ha. On the other hand, farmers of valleys, planted 02 improved varieties on their farms i.e., china-4 and thapachini.

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

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.

These varieties were developed in seventies and farmers of valley adopted it widely. China 4 is the early introduced from China, tall plant type, maturity duration is 130 days, semi-bold grain, droopy leaves and widely grown variety before HYVs developed for plains. The farm-level yield of these varieties was almost tripled than the traditional varieties being grown in terraces. The farmers were mostly preferred thapachini than the china-4 variety 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).

Results of regression analysis: The regression model was used to determine the factors affecting the adoption of modern paddy varieties in study area. Ordinary Least Square technique (OLS) was used for estimating the coefficient of regression model to ascertain the variables which affecting adoption of modern paddy varieties. The area under modern paddy varieties of an individual farmer was taken as dependent variable. However, age of household head, experience in farming, years of schooling, family size, size of land holding, share of irrigated area, contact with extension person and yield advantage of modern varieties were taken as the independent variables. The value of coefficient of multiple determination ( $R^2$ ) was 0.87, which indicates that 87 % variation in area under modern paddy varieties could be explained by the all independent variables included in the model and rest by the other variable which were not included in the model. The multiple regression analysis reveals that the independent variables viz., experience in farming, years of schooling, family size, size of land holding, share of irrigated area, contact with extension person and yield advantage of modern varieties had positive influence on the adoption of modern paddy varieties while age of household head had a negative impact.

Each slope coefficient in the result is a partial slope coefficient and measures the change in the estimated OLS model for a unit change in the value of the given variable (holding other variables constant). Thus, the coefficient of age of household head (-1.12) indicating that with other variables held constant, if age increased by a unit, on an average the share of area under modern paddy varieties decreased by 1.12 %, suggesting a negative relationship between the share of area under modern paddy varieties and age of household head. The coefficient of experience in farming (1.37) indicating that with other variables held constant, if experience in farming increased by a unit, on an average the share of area under modern paddy varieties increased by 1.37 %, suggesting a positive relationship between the area under modern paddy varieties and experience in farming of household head. The coefficient of years of schooling (0.43) indicating that with other variables held constant, if years of schooling increased by a unit, on an average the area under modern paddy varieties increased by 0.43 %, suggesting a positive relationship between the area under modern paddy varieties and years of schooling of household head.

The coefficient of family size (0.80) indicating that with other variables held constant, if family size increased by a unit, on an average the share of area under modern paddy varieties increased by 0.80 %, suggesting a positive relationship between the area under modern paddy varieties and family size of sample farm. The coefficient of size of land holding (4.72) indicating that with other variables held constant, if size of land holding increased by an unit, on an average the share of area under modern paddy varieties increased by 4.72 %, suggesting a positive

relationship between the share of area under modern paddy varieties and size of land holding. The coefficient of share of irrigated area (0.22) indicating that with other variables held constant, if share of irrigated area increased by a unit, on an average the share of area under modern paddy varieties increased by 0.22 %, suggesting a positive relationship between the share of area under modern paddy varieties and share of irrigated area. The coefficient of contact with extension person (3.54) indicating that with other variables held constant, if contact with extension person increased by a unit, on an average the share of area under modern paddy varieties increased by 3.54 %, suggesting a positive relationship between the share of area under modern paddy varieties and contact with extension person. The coefficient of yield advantage of modern varieties (1.15) indicating that with other variables held constant, if yield advantage of modern varieties increased by a unit, on an average the share of area under modern paddy varieties increased by 1.15 %, suggesting a positive relationship between the share of area under modern paddy varieties and yield advantage of this variety. The independent variable, yield advantage of modern variety was found statistically significant at 1 % level of significance however, size of land holding and share of irrigated area were found statistically significant at 5 % level of significance. Age of household head and experience in farming were found statistically significant at 10 % level of significance.

Table-9 Determinants of modern paddy varieties adoption

Variables	Estimated coefficient	Standard Error	T-value
Intercept	44.02	25.22	1.75
1. Age of household head (years)	-1.12***	0.63	-1.78
2. Experience in farming (years)	1.37***	0.78	1.76
3. Years of schooling (years)	0.43	0.76	0.57
4. Family size (numbers)	0.8	1.27	0.63
5. Size of land holding (ha)	4.72**	2.3	2.05
6. Share of irrigated area (%)	0.22**	0.1	2.31
7. Contact with extension person (if yes=1, 0 otherwise)	3.54	3.12	1.13
8. Yield advantage of MV (qtl/ha)	1.15*	0.21	5.43
$R^2$	0.87		

Note: \*, \*\* and \*\*\* indicates level of significance at 1, 5 and 10 % level of significance

[Table-9] also represents statistically the effect of variables viz., age of household head, experience in farming, size of land holding, share of irrigated area and yield advantage of MV were found positive and significant effect on area planted under modern paddy varieties. However, together all the variables had a significant impact on the share of area under modern paddy varieties, as the coefficient of multiple determination ( $R^2$ ) value was 0.87 which was found statistically significant.

## Conclusion

Farmers were getting less net return (negative) than the cost involved in paddy production in terrace environment. Beside this, farmers of the area continuously following paddy production, this may be due to the food security and surity, availability of fodder, family consumption requirements and cultural habits. Farmers have no other better alternative than the paddy production 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.

In spite of negative net return from paddy cultivation, farmers growing paddy on their farms since ages. Regression analysis indicates the independent variables: age of household head, farming experiences, size of land holding, share of irrigated area and yield advantage of MV were found positive and significant effect on area planted under modern paddy varieties. Availability of irrigation is pre-requisite for successful adoption of modern paddy varieties on farms.

Analysis revealed that the paddy production scenarios in valleys are more attractive due to prevailing assured production environment which is served as profitable business for the farmers. However, farmers of terrace growing paddy in *kharif* season due to employment of available resources with them-land and family members. As the opportunity cost of family member employment in the hills during *kharif* season is zero. Therefore, the options left to farmers for producing paddy in even in negative return which is minor too.

Increase in productivity of paddy is a big challenge for the farmers in hills. Adoption of modern paddy varieties can improve the productivity to desirable level, if suitable variety made available to the farmers.

**Application of research:** Increase in productivity of paddy is a big challenge for the everyone in the hills. Adoption of modern paddy varieties can be improving the productivity to desirable level, if suitable variety developed and made available to the farmers for commercial cultivation.

**Research category:** Agricultural Economics

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**Cultivar / Variety / Breed name:** Rice

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