Journal of Rural Development, Vol. 36 No. (3) pp. 433-446
NIRD&PR, Hyderabad.

EFFECT OF RIVER MINING ON CROPPING SYSTEM IN KANGRA DISTRICT OF HIMACHAL PRADESH

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ABSTRACT

About 52 per cent of the population in India depends on agriculture for its livelihood. Proper utilisation of land resource halts the process of land degradation and increases productivity. The factors of land degradation may include improper agricultural practices, indiscriminate extraction of sand and stones from the rivers, etc. The indiscriminate sand and stone extraction from the rivers affects the water availability for irrigation and thereby affecting the productivity of the crops. The study was conducted in a hill State (Himachal Pradesh) of India. The Neugal is a small river among different rivers of the hill State and its water is used for irrigation and drinking by the people of the catchment area. The river has become a victim of sand and stone mining as the extraction has increased over the years due to urbanisation and economic development. Water level of the river has also gone down and during the summer the people of the region experience water crises. Therefore, the study was conducted in the catchment area irrigated by this river to analyse the effect of sand and stone extraction on the cropping pattern.

The study suggests that the farmers should be educated to go for high value and low water-requiring and demand-driven crops in their production programme. Prudent efforts should be made by government agencies for systematic / scientific extraction of mining materials and control the over-exploitation of river mining materials so that water table of rivers may not affect the cropping system adversely. The study concluded that river mining causes drying up of water sources, lowering of water table, soil erosion and shortage of water. Therefore, efforts should be made to address these issues by enforcing suitable laws and regulations.

Introduction

Land is one of the important scarce and basic natural resources for agriculture. About 52 per cent of the population in India depends on agriculture for its livelihood. Proper utilisation of land resource halts the process of land degradation and increases productivity. Land degradation may be due to natural as well as human factors. The factors of land degradation may include improper agricultural practices, indiscriminate extraction of sand and stones from the rivers, etc. The

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indiscriminate sand and stone extraction from the rivers affects the water availability for irrigation and thereby affecting the productivity of the crops. Increasing population, growing urbanisation and rapid industrialisation combined with the need for raising agricultural production generate competing claims for land and water. The sand and gravel are also crucial resources to economic development activities and their demand is increasing due to urbanisation, development and human population pressure, but their conservation is also important for water availability and land productivity. Water is available from rivers and these rivers play an important role in the lives of the people. The distribution of water resource in the country is highly uneven over space and time. Over 80 to 90 per cent of the run off in Indian rivers occurs in four months of the year and there are some regions experiencing abundance and others experiencing acute water scarcity. According to the Central Water Commission, the total water resource of the country has been estimated at about 206 m.ha, of which the surface water is of the order of 180 m. ha, representing 45.7 cm of runoff and the remaining 26 m.ha constituting the groundwater resource (Ganapathy, 2008). Although the quantity of available water resource is large, yet the economically utilisable water for irrigation purpose is as low as about 77 m. ha. Surface water provides irrigation to the extent of 39.5 m.ha accounting for 55 per cent of the total irrigation and groundwater irrigates 33.09 m.ha accounting for 45 per cent of total irrigation (Ibid.).

Himachal Pradesh is a hill State with great variation in the climatic conditions due to variation in elevation. The State has perennial rivers and these provide water to both the Indus and Ganges basins for irrigation, drinking, mining materials, etc., to the local people of the catchment area. They are protected by an extensive cover of natural vegetation. The amount of boulders, cobbles and sand deposited in riverbed depends on the amount delivered to the river from watershed and from bank erosion each year. The total number of parts of riverbeds presently identified for auction in the State is about 300 and out of this about 110 parts of riverbeds are under operation. In addition, about 156 leases in riverbeds have been granted for the establishment of stone crushers (Government of India, 2009). Based on a conservative estimate, approximately 35 lakh tonnes of sand, gravel and boulders are extracted annually from river/streams to meet the demand of road construction, bridges, building material and other developmental works. Apart from generating ₹ 2.8 crore of direct revenue, it has generated direct/indirect employment to about 20,000 persons of the State.

Kangra district occupies an important position in the State and there are a number of small rivers in the district originating from mountains and are major sources of sand and stones. A large number of people are engaged in extraction of sand and stone and transporting these materials from local streams and rivers to different towns. About 155 crushers in the district are established on the banks of the rivers which are extracting 4.28 lakh tonnes of sand, stone and bajri annually from the khuds/ rivers (Kumar et al., 2009). These rivers are the

major sources of irrigation providing irrigation through kuhls (it is an age-old method of directing water from various streams, rivulets and springs through small rills or channels) and nearly 89.0 per cent of the net irrigated area is watered by kuhls. The Neugal is a small river among different rivers of the hill State and its water is used for irrigation and drinking by the people of the catchment area. The river has become a victim of sand and stone mining as the extraction has increased over the years due to urbanisation and economic development. Water level of the river has also gone down and during the summer the people of the region experience water crises. Therefore, the study was conducted in the catchment area irrigated by this river to analyse the effect of sand and stone extraction on the cropping pattern.

Methodology

The study was conducted in a hill State (Himachal Pradesh) of India. The Neugal catchment area of Kangra district in Himachal Pradesh was selected because lot of mining extraction in the area and a large number of kuhls (irrigation channels) were emerging from this river. Nine villages were selected randomly for the study from three segments (upper, middle and lower). Twenty farmers were selected randomly from each segment of three villages by using proportional allocation method of sampling. The selected farmers were divided into two categories, i.e., marginal and small on the basis of their landholdings (marginal- less than 1 ha and small- greater than 1 ha). The ultimate sample for the present study consisted of 60 farmers. Both primary and secondary data were collected for the study during the agricultural year 2010-11.

Analytical Framework

In order to analyse the data various analytical tools were employed for the analysis and interpretation of the data.

Cropping Pattern : The cropping pattern was examined for the sample farms. This was computed as proportion of area under various crops to the total operational holding during the course of investigation. The formula used was as follows:

$$P_{ij} = \frac{A_{ij}}{A_j} X\ 100$$

Where, P_{ij} = Proportion of area under ithcrop in jth season.

A_{ij} = Actual area under ithcrop in jth season.

A_j = Total sown area during jth season

Per Cent Change: Per cent change has been calculated to see the change in the current season (2010-11) as compared with previous season (2001-02). The per cent change was calculated as:

$$\% \text{ change} = \frac{Cs - Ps}{Cs}$$

Where, Cs = Current season (2010-11)

Ps = Previous season (2001-02)

Respondents' Responses: The various responses of respondents were analysed on the basis of equal level scale (arbitrary method). The responses of the respondents were characterised into three groups, i.e.,

Very Severe	>66 per cent
Severe	33 – 66 per cent
Low	< 33 per cent

Problems and Constraints: The various problems faced by the marginal and small farmers were analysed by calculating the percentages. The problems faced by the sample households were divided into three categories, i.e., very severe, severe and low.

x^2 – test: To find out the differences in the severity of the problems across marginal and small farmers, Chi-square test was employed using the following algorithm:

$$x^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Where,

O_i = Observed frequency of problems

E_i = Expected frequency of problems

Results

Land Use Pattern: Land is the most important factor of production whose availability is decreasing due to increase in population pressure and sub-division of farm families. Ownership of land is one of the most important factors for socio-economic status of the household. It provides income and employment to families. The land utilisation pattern of sample households was presented in Table 1. The Table showed that the total owned land of small farms was higher (1.67 ha /farm) as compared to the marginal farms (0.55 ha/ farm). There was no leased-in and leased-out land in the sample households. In other categories of land, higher area was noticed under operational holding which was 0.64 ha/ farm in overall category, 0.46 ha/ farm under marginal category and 1.04 ha/ farm under small category followed by barren and uncultivable land which was 0.10 ha/ farm in overall situation, 0.03 ha/farm under marginal category and 0.26 ha/ farm under small category. The other categories of land use (orchards, pastures and grazing land, forests and current fallows) constituted very less area out of the total owned land.

Table 1: Land Utilisation Pattern of Sample Households (Ha/Farm)

Particulars	Marginal		Small		Overall	
	IR	UR	IR	UR	IR	UR
Total owned land	0.48 (100)	0.07 (100)	1.10 (100)	0.57	0.67 (100)	0.23 (100)
Operational holding	0.46 (95.83)	-	1.04 (94.55)	-	0.64 (95.52)	-
Orchards	0.02 (4.17)	-	0.06 (5.45)	-	0.03 (4.48)	-

(Contd.....)

Table 1 *(Contd.....)*

Pasture land	-	0.02 (28.57)	-	0.19 (33.33)	-	0.07 (30.44)
Forests	-		-	0.08 (14.04)	-	0.03 (13.04)
Current fallows	-	0.02 (28.57)	-	0.04 (7.02)	-	0.03 (13.04)
Barren and uncultivable land	-	0.03 (42.86)	-	0.26 (45.61)	-	0.10 (43.48)

Note: Figures in parentheses indicate the percentages of total; IR = Irrigated, UR = Unirrigated.

Cropping Pattern: Cropping pattern is one of the most important indicators which depicts the allocation of land resources among different crops. The allocation of land for different crops helps to determine the level of resource use and income generation. The cropping pattern for two periods and change were given in Table 2. It is evident from the Table that paddy, maize and wheat were the major crops grown by sample households. The Table showed that paddy in kharif season and wheat in rabi season occupied the highest area in marginal as well as small farms. It was observed that very less area was allocated to oilseeds and vegetables by sample farmers in both the periods. The Table revealed change in cropping pattern at overall level; the area under paddy (-7.80 per cent), vegetables (-75.41 per cent) and potato (-42.86 per cent) decreased in kharif and wheat (-1.31 per cent), potato (-14.71 per cent) and onion (-52.38 per cent) in rabi season. In marginal farms, there was very high decrease in area under vegetables (-43.70 per cent) followed by potato (-42.86 per cent) and paddy (-7.80 per cent), whereas in small farms, higher decrease was noticed in potato (-24.07 per cent) followed by paddy (-10.17 per cent) in kharif season. In rabi season, the highest negative change in area was under onion (-52.51 per cent) followed by potato (-15.07 per cent) and wheat (-10.80 per cent) in marginal farms, whereas in small farms, the highest percentage change in area was noticed under onion (-25.60 per cent) and wheat (-5.14 per cent). The analysis of Table revealed that the area in current season under different crops decreased as compared to previous period on marginal and small farms. The greater decrease was noticed in vegetables in kharif season and paddy, wheat, onion and potato in rabi season. The vegetables grown during May and June in the study area need more water due to high temperature. Similarly, other crops require water during their growing period. So, the area under crops shifted from more water-loving crops to less water-loving crops. This is due to decrease in the availability of water over time.

Table 2: Changes in Acreage on Sample Farms (Bigha)

Crops	Marginal			Small			Overall		
Kharif	P	C	% Change	P	C	% Change	P	C	% Change
Paddy	4.10	3.78	-7.80	9.34	8.39	-10.17	5.76	5.24	-7.80
Maize	0.77	1.00	30.02	2.00	2.76	38.00	1.16	1.56	29.87
Oilseeds	0.09	0.16	78.00	0.21	0.32	52.38	0.09	0.21	77.78
Vegetables	0.61	0.15	-43.70	0.37	0.63	70.27	0.53	0.30	-75.41
Potato*	0.28	0.16	-42.86	1.08	0.82	-24.07	0.53	0.37	-42.86
Rabi									
Wheat	4.57	4.51	-10.80	10.32	9.79	-5.14	6.39	6.18	-1.31
Oilseeds	0.03	0.10	67.00	0.24	0.42	75.00	0.10	0.20	66.67
Potato**	0.34	0.29	-15.07	1.23	1.13	-8.13	0.59	0.57	-14.71
Onion	0.21	0.10	-52.21	0.82	0.61	-25.60	0.40	0.26	-52.38
Vegetables	0.14	0.21	46.67	0.58	0.66	13.79	0.20	0.35	50.00
Gross cropped area	100 (11.14)	100 (10.46)		100 (26.19)	100 (25.53)		100 (15.75)	100 (15.24)	

Note: C= Current Period (2010-11), P= Previous Period (2001-02), One Bigha = 0.08 Ha.
Figures in parentheses indicate the gross cropped area.
*Sowing during September-October and ** Sowing during February-March

Irrigation Use Pattern of Sample Households in Kharif Season: The Irrigation use pattern exhibits the level of technology adoption on the farm and its balanced use. An appropriate use of irrigation is extremely important in increasing the farm productivity. Farm activities yield lower returns if critical inputs are not supplied at the right time and in optimum quantity. Keeping this in mind, the irrigation use pattern of the sample households is presented in Table 3. The Table gives the input use at two points of time and change made during the period. The change was studied in current period over past period (2001-02). It can be seen from the Table that percentage change in irrigation decreased in almost all the crops, i.e., paddy (-32.48 per cent), maize (-11.11 per cent), potato (-24.47 per cent) and in vegetables (-9.26 per cent) and increased only in case of oilseeds (2.63 per cent). Almost similar pattern was observed for marginal and small categories of sample households. This is due to the fact that the water availability for irrigation has decreased over the years and the level of water in the kuhls has declined. These views were responded by the sample households.

Table 3: Irrigation Use Pattern of Sample Households in Kharif Season (Number)

Particulars	Marginal			Small			Overall		
	P	C	% Change	P	C	% Change			% Change
Paddy	4.63	3.02	-34.77	4.79	3.51	-26.72	4.68	3.16	-32.48
Maize	1.78	1.69	-5.06	2.40	1.98	-17.50	2.07	1.84	-11.11
Oilseeds	1.29	1.05	-18.60	2.40	2.46	2.50	0.76	0.78	2.63
Potato (q)	5.51	26.30	-29.40	4.92	4.06	-17.48	5.23	3.95	-24.47
Vegetables	4.69	4.13	-11.94	5.56	5.32	-4.32	4.97	4.51	-9.26

Note: C= Current Period (2010-11), P= Previous Period (2001-02).

Irrigation Use Pattern of Sample Households in Rabi Season: The irrigation use and its changing pattern on sample households in rabi season is given in Table 4. It can be seen from the Table that the highest decrease in irrigation was noticed under vegetable crops (-27.41 per cent) followed by onion (-24.82 per cent), potato (-23.83 per cent), wheat (-22.47 per cent) which affected the production of crops. This may be due to decrease in water or decrease in flow of water in the kuhls. These views were also expressed by sample households during the survey. Similar changes for different inputs were noticed for different categories of sample households.

Table 4: Irrigation Use Pattern of Sample Households in Rabi Season (Number)

Particulars	Marginal			Small			Overall		
	P	C	% Change	P	C	% Change	P	C	% Change
Wheat	5.31	4.08	-23.16	5.41	4.13	-23.66	5.34	4.14	-22.47
Oilseeds	2.60	2.37	-8.85	2.57	2.23	-13.23	2.59	2.31	-10.81
Potato	5.67	4.46	-21.34	5.79	4.37	-24.52	5.75	4.38	-23.83
Onion	6.87	4.98	-27.51	6.93	5.45	-21.36	6.89	5.18	-24.82
Vegetables	5.70	4.44	-22.11	4.84	3.19	-34.09	5.29	3.84	-27.41

Note: C= Current Period (2010-11), P= Previous Period (2001-02).

Productivity of Different Crops on Sample Households: Productivity of crops shows the effective and efficient use of all resources. The output per unit of area is represented through yield, which generally speaks of the level of adoption of technology in that crop. Table 5 showed the productivity of different crops. The Table revealed that overall the productivity of crops of wheat, paddy and maize in current period was 22.70, 21.80 and 20.60 q/ha, respectively. The productivity of other crops was noticed comparatively lower. The percentage change for different crops in kharif season showed decrease in productivity of paddy, maize, oilseeds and potato. This change was -9.54 per cent in paddy, 6.19

per cent in maize, -19.46 per cent in oilseeds and -21.77 per cent in potato in the overall situation over the previous period. The productivity of vegetables decreased by -0.86 per cent. In rabi season, the productivity of wheat and oilseeds decreased, i.e., -5.42 per cent and -4.13 per cent, respectively. In case of marginal farms, the productivity of paddy (-10.00 per cent), oilseeds (-15.70 per cent), vegetables (-1.94 per cent) and potato (-28.37 per cent) decreased whereas in case of small farms, the productivity of paddy (-7.41 per cent), oilseeds (-14.59 per cent) and potato (-2.31 per cent) decreased in kharif season. In rabi season, under marginal farms the productivity of all crops decreased and in small farms, the productivity of wheat (-5.57 per cent), potato (-1.41 per cent) and onion (-1.03 per cent) decreased. This could be due to the fact that the production of different crops had decreased in current period which resulted in decrease in productivity.

Table 5: Productivity of Different Crops on Sample Households (q/ ha)

Crops	Marginal			Small			Overall		
Kharif	P	C	% Change	P	C	% Change	P	C	% Change
Paddy	24.00	21.60	-10.00	24.30	22.50	-7.41	24.10	21.80	-9.54
Maize	19.25	20.50	6.49	19.80	20.75	4.80	19.40	20.60	6.19
Oilseeds	8.60	7.25	-15.70	9.25	7.90	-14.59	8.80	7.45	-19.46
Vegetables	118.70	116.40	-1.94	120.50	122.25	1.45	119.27	118.25	-0.86
Potato	122.70	120.40	-1.87	125.40	122.50	-2.31	123.55	121.06	-21.77
Rabi									
Wheat	23.80	22.60	-5.04	24.25	22.90	-5.57	24.00	22.70	-5.42
Oilseeds	7.50	6.70	-10.67	7.50	8.25	10.00	7.50	7.19	-4.13
Potato	92.50	90.80	-1.84	92.50	91.20	-1.41	92.50	91.25	-1.35
Onion	144.25	142.75	-1.04	146.25	144.75	-1.03	144.88	143.38	-1.04
Vegetables	67.50	65.20	-3.41	65.30	66.50	1.84	66.80	65.61	-1.78

Note: C= Current Period (2010-11), P= Previous Period (2001-02).

Response of Sample Households about the Effect of River Mining: The effect of sand and stone extraction on different farming activities were analysed and given in Table 6. The responses of sample households were grouped into three categories as very severe, severe and low. This was estimated by examining the number of farmers who responded to different activities. A close perusal of the Table revealed that the response of sample households was high in case of lowering of water level of rivers (33.34 per cent) followed by less availability of irrigation water during cropping season (15.00 per cent) and drying up of irrigation sources (13.33 per cent) in overall situation. Similar pattern was noticed in marginal and small categories of households in these responses. In case of marginal farmers,

the response was lowest with increase in fallow land (82.93 per cent) followed by soil erosion (80.00 per cent) and degradation of land (58.05 per cent). This showed that there were no major problems faced by marginal farmers in these aspects. The high severity of problems faced by marginal farmers were lowering of water level of rivers (36.59 per cent), drying up of irrigation sources and non-availability of irrigation water during cropping season (14.63 per cent). In case of small farmers, lowering of water level of river (26.32 per cent) and non-availability of irrigation water during cropping season (15.79 per cent) were high ranking problems. This may be due to the fact that the water available for irrigation in kuhls decreased due to extraction of mining materials, i.e., sand, stone and bajri. The problems of mining as given by the respondents were decrease in productivity (73.33 per cent) followed by lowering of water level in the river (48.33 per cent), drying up of irrigation sources (46.67 per cent), less availability of water for irrigation during cropping season, etc. Almost same trend was observed for marginal and small categories of sample households. The chi square (?2) test revealed that value for different factors were not significant. It showed that effect of sand, stone and bajri extraction on different factors responded by respondents were same for marginal and small farmers as the values were tested at 1 per cent and 5 per cent level of significance (found non-significant). The effect of mining extraction on different factors was in conformity with Pathania et al. (2005) and Padamlal et al. (2008).

Table 6: Response of Sample Households about the Effect of Sand and Stones Extraction on Different Farming Activities

(Per cent)

	Marginal			Small			Overall			
Particulars	Very Severe	Severe	Low	Very Severe	Severe	Low	Very Severe	Severe	Low	x^2 value
Soil erosion		20.00	80.00		31.58	68.42		23.67	76.33	1.06
Effect on vegetation		24.40	75.60		15.79	84.21		21.67	78.33	0.57
Change in cropping pattern		42.27	57.73		41.58	58.42		41.90	58.10	0.03
Drying up of irrigation sources	24.39	46.34	29.27	15.79	49.11	35.10	20.04	47.67	32.79	1.09
Lowering of water level of river	36.59	48.78	14.63	26.32	47.37	26.31	33.34	48.33	18.33	1.39
Decrease in productivity of crops		73.17	26.83		73.68	26.32		73.33	26.67	0.002

(Contd.....)

Table 6 *(Contd.....)*

Degradation of land		41.95	58.05		38.32	61.68		40.15	59.85	0.14
Fallow land increased		17.07	82.93	5.26	10.53	84.21		15.00	83.34	2.50
Less availability of irrigation water during cropping season	17.07	48.78	34.15	10.53	47.37	36.84	15.00	48.02	35.53	2.14
Cultivated area under irrigation has decreased	7.32	41.46	51.22		47.37	52.63	5.00	43.33	51.67	1.50

Irrigation Related Problems Faced by Sample Households Due to River Mining: The farmers in the study area faced different irrigation problems due to sand and stone extraction from the river. The irrigation problems faced by sample farmers were analysed and presented in Table 7. These problems were characterised into 3 groups, i.e., very severe, severe and low. It was observed from the Table that in the overall situation, the high percentage of problems faced in very severe category was level of water decrease (33.34 per cent) followed by decreased water level in kuhls (23.34 per cent) and drying up of irrigation sources (20.04 per cent). In severe category, more than 40 per cent of the farmers reported decreased level of water in the river (48.33 per cent), drying up of irrigation sources (46.67 per cent) water shortage for irrigation and drinking during summer season (45.16 per cent) and reduction in water flow from irrigation sources (41.67 per cent). The important problem of low category reported by more than 40 per cent of the farmers in the overall situation was non-availability of water in adequate quantity (61.66 per cent) followed by water not available timely (46.67 per cent) and reduction in water flow from irrigation sources (45 per cent). Similar pattern for the irrigation problems was noticed for the marginal and small categories of households. It may be seen from the Table that chi square(χ^2) value was not significant at 1 and 5 per cent level of significance indicating that there was no difference in irrigation problems faced by marginal and small farmers. Shukla and Gurjar (1989) also reported similar irrigation problems due to river mining.

Table 7: Irrigation Related Problems Faced by Sample Households Due to Sand & Stone Extraction

(Per cent)

	Marginal			Small			Overall			
Particulars	Very Severe	Severe	Low	Very Severe	Severe	Low	Very Severe	Severe	Low	x^2 Value
Water is not available timely	24.39	36.59	39.02	5.26	31.58	63.16	18.33	35.00	46.67	4.30*
Water is not available in adequate quantity	12.20	24.39	63.41	10.53	31.58	57.89	11.67	26.67	61.66	0.35
Water shortage for irrigation and drinking during summer season	19.51	43.90	36.59	15.79	46.32	37.89	17.67	45.16	37.17	0.13
Level of water has decreased in the river	36.59	48.78	14.63	26.32	47.37	26.31	33.34	48.33	18.33	1.39
Drying up of irrigation sources	24.39	46.34	29.27	15.79	49.11	35.10	20.04	47.67	32.79	1.09
Water level in the kuhls has decreased	29.27	39.02	31.71	10.53	36.84	52.63	23.34	38.33	38.33	3.46
Less availability of irrigation water during rainy season	17.07	48.78	34.15	10.53	47.37	36.84	15.00	48.02	35.53	2.14
Reduction in water flow from irrigation sources	14.63	48.78	36.59	10.53	26.32	63.16	13.33	41.67	45.00	3.78

Problems in Management of Irrigation Sources: Management of irrigation source is important for good crop production. There were various problems faced by farmers in the management of irrigation sources. The problems faced by sample households in the management of irrigation sources are given in Table 8. The Table shows that frequent breaking of bandhs on river especially during rainy season which were reported by 86.14 per cent of the farmers followed by decreasing water flow of kuhls (44.72 per cent) and decreasing water table of the river with difficulty to channelise water in kuhls (44.92 per cent). The other problems are reported by less than 30 per cent of the farmers. The farm category analysis also showed the similar pattern. Chi square (χ^2) value calculated for different problems showed that there was only one problem which reported significant result whereas all other problems in management of irrigation sources were not statistically significant. The various maintenance and management problems of irrigation sources analysed were also in conformity with the earlier studies conducted by Singh (1982), Pathania et al. (2005) and Thakur (1996).

Table 8: Problems Faced by Sample Households in Management of Irrigation Sources

(Per cent)

Particulars	Marginal	Small	Overall	x^2 Value
Less irrigation facility available	30.00	25.50	28.58	0.18
Water flow in the kuhls has decreased	46.00	43.56	44.72	0.02
Water table of river decreased, so difficult to channelise water in kuhls	48.78	36.59	44.92	0.72
People of upper area throw garbage in the kuhls	7.32	0.00	5.00	3.00
Farmers not interested in management of kuhls because of their marginal holdings	26.83	7.32	20.65	4.56*
Lack of cooperation for maintenance	12.20	9.76	11.43	0.12
Frequent breaking of bandh on river/ kuhls especially during rainy season	85.37	87.80	86.14	0.02
Poor participation in management of kuhls	22.20	15.70	18.91	0.60

Note: * Indicates 5 per cent level of significance.

Summary and Conclusion

The operational holding was 0.64 ha/ farm in overall category followed by barren and uncultivable land. The higher proportion of area was observed under irrigation in both the categories of the sample households. Paddy and maize in kharif season and wheat in rabi season were the main crops. The area allocated to different crops in current season decreased as compared to past period on marginal and small farms. The greater decrease was noticed in vegetables and paddy in kharif season and wheat, onion and potato in rabi season. The area under different crops in current season shifted from more water-requiring crops to less water-requiring crops may be due to less water availability in the irrigation channels. The productivity of different crops was noticed changing from current period over past period. Number of irrigations in current over past period showed a change in their use for different crops. The responses of sample households were grouped into three categories as very severe, severe and low. The high severity response of sample households was in case of lowering of water level of rivers (33.34 per cent) followed by less availability of irrigation water during cropping season (15.00 per cent) and drying up of irrigation sources (13.33 per cent) in overall situation. Similar pattern was noticed in marginal and small categories of households for these responses. The severity level of response given by the respondents was decrease in the crop productivity (73.33 per cent) followed by lowering of water level in the river (48.33 per cent), drying up of irrigation sources (46.67 per cent), non-availability of water for irrigation during cropping season, etc. The chi square (χ^2) test showed that responses of marginal and small sample households related to different factors were same. The major problems faced by sample households in management of irrigation

sources were frequent breaking of bandhs on river/ kuhls especially during rainy season (86.14 per cent) followed by decrease in water table of the river (44.92 per cent) and decrease in water flow in the kuhls (44.72 per cent). The participation in the management of kuhls indicated no change. Villagers' participation (users) in the maintenance and management of irrigation sources was noticed very high (78 per cent) followed by government agencies (22 per cent).

The study suggests that the farmers should be educated to go for high value and low water-requiring and demand-driven crops in their production programme. Prudent efforts should be made by government agencies for systematic/ scientific extraction of mining materials and control the over-exploitation of river mining materials so that water table of rivers may not affect the cropping system adversely. The study concluded that river mining causes drying up of water sources, lowering of water table, soil erosion and shortage of water. Therefore, efforts should be made to address these issues by enforcing suitable laws and regulations.

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