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Adaptation of water conservation technique: Mulching to mitigate water crisis due to River Sand mining in state Bihar

Sunita Kushwah[1], Sripriya Das[1*], Madhu Sudan Kundu[2], Swapnil Bharti[1], Prem Prakash Gautam[1], Kumari Namrata[1], Kavita Verma1, Anup Kumar Singh[1] and Mukesh Kumar Singh[3]

[1]Krishi Vigyan Kendra, District-Vaishali, Dr Rajendra Prasad Central Agricultural University, Pusa (Bihar) India.
[2]Directorate of Extension Education, Dr Rajendra Prasad Central Agricultural University, Pusa (Bihar) India.
[3]Associate Dean cum Principal, Veer Kunwar Singh Agriculture Collage, Dumrao Buxer. (Bihar) India.

ABSTRACT

The present study was under-taken with a view to finding out the socio-economic profile of vegetable-growing farmers; and to finding out the relationship between the socio-economic characteristics of the respondents the vegetable adoption in river sand mining areas. It is observed that source of irrigation gets reduced per village after river sand mining. The availability of ground water and fresh water also decreased. Educated young farmers were found highly inclined towards water conservation technologies like mulching. Land holding size recorded positive significant correlation with the mulching technology, more land holding size easy to demonstrated technology and better results. It is revealed that own land holding respondents have more earnings and had good income to adopt vegetable cultivation. In this study, extent of adoption of twelve selected, scientific vegetable cultivation practices was measured. A total of 86 respondents were selected for the study. The practice of a higher percentage in the unknown category was knew about protected cultivation and diseases management and their control (95.34 %), followed by the selection of mulching sheets (93.02%) and other charactericts. In the case of after training i.e., trained farmers, the practices of a higher percentage grouped into complete knowledge category revealed that maximum knowledge gain was recorded for marketing of vegetables (95.34%), followed by storage of fresh vegetables (76.74%), while trained tribal women grouped into partial knowledge category were knowing the technology of vegetable cultivation and scientific method of nursery raising (76.60%), followed by use of organic fertilizers (74.47%). Overall knowledge gaps for the selected practices before and after training of tribal women farmers were obtained (78.92) and (27.12) percent respectively and the "t" test is reported significant for all vegetable cultivation practices with the use of mulching technologies. It means training was significant for the women farmers. Trained farmers adopt technology in a better way.

Keywords: *: Mulching, Water conservation, River Sand mining, Adaptation strategies, Vegetable cultivation, Bihar*

1. INTRODUCTION

Mulching has become an essential and decisive exercise in agricultural production. It lessens the application of herbicides and various chemical fertilizers, controls the weeds and maintains the soil moisture and soil temperature [1]. This article consists of the detail reviews of different research conducted on mulches, and sand mining and elaborates on the opportunities that they have to revolve the problem in agriculture especially sand mining affected areas.

Sand is an important mineral used for multipurpose work. Sand mining is the process of removal of sand and gravel. Now this practice is becoming an environmental issue as the demand for sand increases in industry and construction. In Bihar, there has been a significant increase in sand mining since the beginning of the 2005 following a boom in the construction industry, and the activity reached alarming proportions in several areas, particularly in the southern and western regions of the State, after court restrictions on sand mining came into effect in Bihar since 2016 but illegal mining is still continued. Similarly, River Chandan, Odhini, Ganga, Kosi, Mahananda, Gandak and seasonal mountainous rivers in Bihar has become a victim of indiscriminate sand mining [2]. Illegal and excessive sand mining in the riverbed of the Chandan & OIdhani catchment area in district Banka and Gandak river in district Begusarai, Vaishali has led to the depletion of groundwater levels and environmental degradation in the villages on the banks of the rivers Due to that agriculture directly affected said by the farmers.

The resources of water for agricultural operations have been inadequate over the years as a result of sand mining and uneven or uncertain rainfall in the low rainfall zones of India[3]. To alleviate the water scarcity in agriculture, mulching has a vital impact as a waster -conserving technique in rain-fed cropping. India being an agricultural country should have a better admiration towards water conservation tactics. By now we are fighting the great stress of water insufficiency and river sand mining is one of the major factors that created this situation. Each and every drop of water is important to us but inappropriately because of inattentiveness, we repeatedly waste gigantic volumes of water in which 70 to 80 % is passed down for irrigation purposes. Mulching and micro- irrigation techniques can play a vital role in controlling over and excessive

*Corresponding Author: **Sripriya Das**
Email Address: **sripriyadaspaul@gmail.com***

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irrigation and will also meet the water stress condition created due to river mining. This practice assists in preventing weed growth, incrementing soil moisture, reducing soil erosion, maintaining soil temperature, augumenting soil structure, improving soil fertility, and improving soil biological regime [4]. Scientific mining operations accompanied by ecological restoration and regeneration of mined wastelands and judicious use of geological resources, with a search for eco-friendly substitutes and alternatives must provide sensational revelation to the impact of mining on the human ecosystem [2]. Mulching is effective in reducing evaporation, and conserving soil moisture and has been known to modify the hydrothermal regime of soil [5]. reported that the bad effects of water deficit could be overcome by irrigation or adopting *in-situ* moisture conservation techniques, such as the use of mulches. Mulching has also been identified by many workers as a method to provide a favorable soil environment by minimizing crusting at the soil surface and keeping it stable. The influence of mulching on tomato production has been reported by many researchers [6]. If vegetable growers are trained in water conservation technology mulching the scenario will be changed.

The current objectives deals with the argument of every single feature of mulching and it's beneficiary effects.

1. The adoption of water conservation technique mulching in sand mining areas on different aspects of agricultural production, socioeconomic behavior of respondents, knowledge gained by the farmers, structural and extent of adverse effect to be need to examine. Hence the present study was under taken to find out the adoption of mulching and its extent in the changing scenario of agriculture in Bihar.
2. To solve the problem endogenous transformation model was used to analyze the impact of mulching techniques among farmers, the effect of soil and water conservation measures on agricultural output, and to evaluate the average treatment effect of the adoption of soil and water conservation techniques mulching.
3. The adoption behavior of soil and water conservation techniques in sand mining areas and agricultural output is included for analysis, revealing the influencing factors of farmers' adoption behavior of mulching and their output effects, enriching existing research.
4. To know the facts for change in the irrigation sources before and after sand mining and to find out the impact before and after the adoption of mulching by the farmers in crop production. The study was based on to developing a long-term strategic research plan to popularize new techniques and practices, which minimizes the cost of cultivation and retain soil health.

Based on the research objectives, the structure of this paper is as follows: the first part is the introduction; the second part is the methodology; the third part is the data source, and model construction and the fourth part is the analysis of the empirical results; the fifth part is the conclusion and based on the above analysis results, put forward policy recommendations.

2. MATERIAL AND METHODS

2.1 Study region

In this study three districts of Bihar were selected for the study where sand mining was done. The first one was the Banka district, which occupies an area of 3,020 square kilometers (1,170 sq mi) and the district is the part of Bhagalpur division. Another study area was Begusarai district which occupies an area of 1918 square kilometers (741 sq mi), third was district Vaishali which occupies an area of 2,036 square kilometers (786 sq mi). Bihar is the third-largest state by population and the twelfth-largest by territory, with an area of 94,163 km^2 (36,357 sq m). The region receives rainfall from June to September in a year Figure 1.

2.2 Study Design

The present research was a cross-sectional and aquestionnaire-based survey was used for the study. A descriptive and diagnostic research design was used. This research design was used to find facts with adequate explanations. It clearly states the attributes of given circumstances or groups or individuals [7]. In this study, the differential level of adoption of adaptation strategies was subjected by using a diagnostic research design [6].

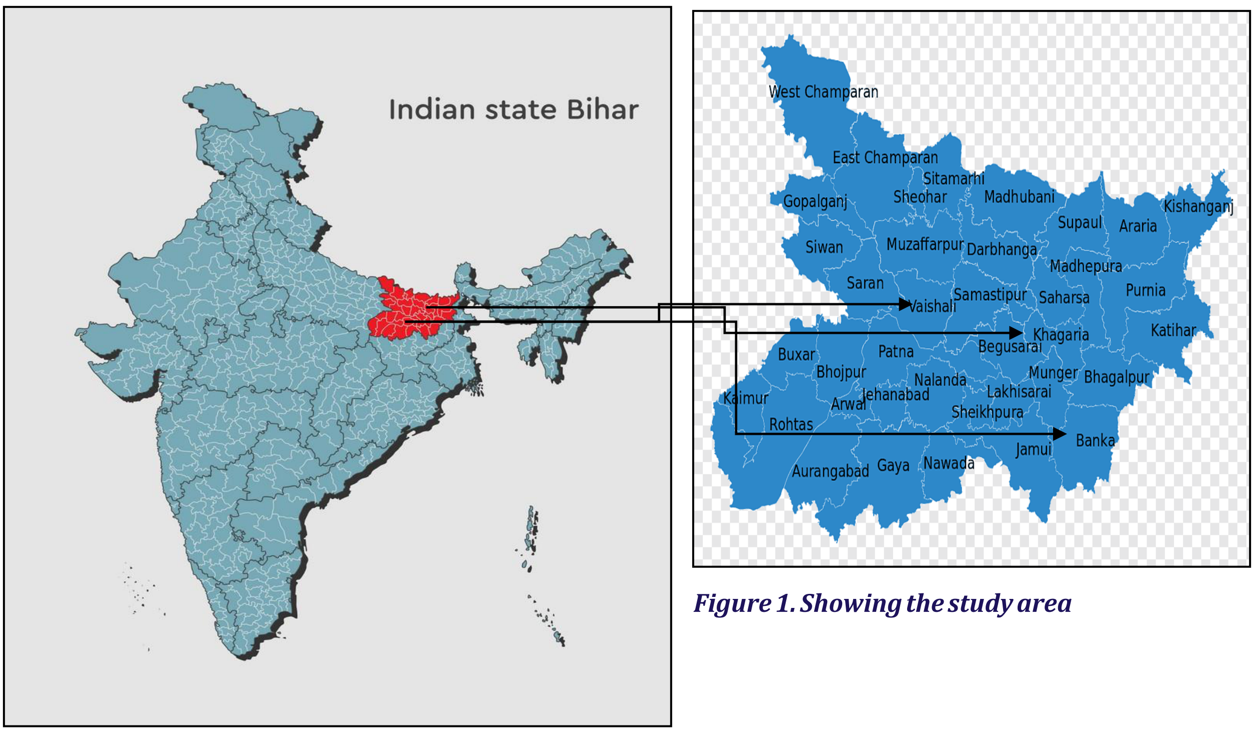

Figure 1. Showing the study area

2.3 Data collection methodology and sampling

Sand mining areas were selected for the study purpose and to identify the thrust areas of study. Under this study, 10 villages from district Banka i.e., Rajaun, Baunsi, Kakwara, Mandar, Jamdaha, Nonihari, Ballikita, Rajapokhar, Katoriya, and Madachak have been selected. All these villages are situated on the banks of different mountainous rivers. The river Belharni and Barua flows in the north-western area of the district. Chadan and Orhni flows from the middle of the district. The plains of Banka is formed from several streams of these rivers. In all rivers sand mining is continued for long. In Begusarai district 5 villages (Iniyar, Mohanpur, Balia, Tetri, and Bhelva) where the Ganga river catchment area, and 5 villages of Vaishali district i.e. Lalganj, Belsar, Goraul, Hajipur and Vidupur which is under Gandak- river and Ganga river catchment areas were selected for the study, the respondents randomly selected from each village in Banaka district 30 farmers per village and Begusarai and Vaishali distict 25 farmers per village for the study of the adoption of technology of mulching in river sand mining areas.

Training programs are organized for the skill development of vegetable farmers. Training programs (ON/OFF Campus) are conducted to strengthen their knowledge. About 350 farmers were trained for scientific vegetable cultivation, water conservation, crop production, and soil health management. The trainees were selected from the all-sand mining affected areas based on pre analysis of their livelihood needs. To measure the knowledge level of vegetable farmers, a knowledge index was prepared taking 12 dimensions, namely Knowing mulching technology for vegetable cultivation, Selection of mulching sheet , Scientific method of nursery raising, Use of organic and balanced doses of fertilizers, Diseases management, and their control, Insect pest management and their control, Maintenance of mulching, Seed treatment, Time of seed sowing, Knowing about protected cultivation, Marketing of vegetables, Storage of fresh vegetables and Knowing about sand mining drawbacks. These dimensions were identified after a thorough review of literature discussion with experts and with the vegetable farmers related to this field.

In this study 86 vegetable farmers of river sand mining areas were enrolled. The selection of farmers was randomly done. A major emphasis was given on skill and practical training. The training schedule was planned in such a way that forenoon session included theoretical orientation and the afternoon for skill or practical sessions, Oreintation about planning, marketing, and input management aspects was given to vegetable farmers towards successful cultivation of vegetables with water conservation technologies, its use & marketing.

2.4 Data analysis

All 86 farmers listed and arranged their names alphabetically. Finally, the total sample constitutes 43 before training and the same samplewas used for the data analysis after training from areas affected by sand mining. 86 samples were collected for data analysis for a questionnaire on technique mulching to mitigate water crisis due to river Sand mining and 43 samples was collected for investigation on the significance of the training provided.

The following device was developed to measures the knowledge level of respondents regarding selected technologies of scientific vegetables cultivation especially the mulching technique in river sand mining areas .Awareness/ familiarity percentage assay was answered by respondents as Yes or NO. Technology adoption was evaluated in a way that score of 1 was given to the respondent who answered YES to the awareness about the existence of the technology and 0 if the answer was NO. The maximum possible score for awareness percentage was 10 and the minimum possible score was 0. Knowledge test was evaluated in a way that each right answer was scored as one and each wrong answer was scored 0. The sum of the score was taken as the knowledge score. The maximum score possible was 50 and the minimum was 0.A knowledge test was developed using the procedure described by [9].

$$KI = X \; \frac{\text{Obtained Knowledge Score}}{100}$$

Obtainable Knowledge Score

Where,

KI= Knowledge Index of a respondent

t test- It was applied for comparison of two small samples for training (untrained) and training (trained) vegetable growers' tribal farmers. The t value was worked out by using the following statistics.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where,

$x1^{-}x1^{-}$ = Mean of the first set of values

$x2^{-}x2^{-}$ = Mean of the second set of values

S_1 = Standard deviation of the first set of values

S_2 = Standard deviation of the second set of values

n_1 = Total number of values in the first set

n_2 = Total number of values in the second set.

3. RESULT AND DISCUSSIONS

3.1 Comparison of average water availability & sources of irrigations in vegetable fields before and after river sand mining per village.

The water level of the river recorded a negative relative change of 58.15 percent after sand mining in 10 years. The depth of the river (ft) recorded a 109.56 percent relative change, indicating down fall in the water table and the depth of the river increased rapidly during the last 10 years after river sand mining. Sand lifting per day (t) was recorded (1350.90 %) positive relative change. It is too high, indicating that sand mining per day is above the recommended level by the Government.

Availability of water from the surface of the sand in a river (m) was observed high downfall of fresh water inside the sand layer in the river i.e. (578.13%). Sand lifting is directly associated with down fall of water level. It is evident from Table 1 that there is a negative relative change recorded for land irrigated by river (-78.51%). The irrigated area by river declined 78.51 percent due to mining in the last 10 years. It is resulted that sand mining creates adverse effects on available water resources. All resources directly or indirectly related to the sand mining in the river are stated [8].

It is observed from (Table 1), that the number of electric submersible pumps increased by 214.15 percent, the depth of the submersible recordedby 184.78 percent whereas the water level was lowered by 179.6 percent. This increased cost of operating tube wells. The average number of wells per village was declined by 72.54 percent from 2005 to 2017. Mostly old wells get dried or become non-functional 72.54 percent negative relative change was recorded during the study.

The number of available subsidiary channels which found 25 percent negative relative change. It is resulted in more number of irrigation channels destroyed and becoming non functional after sand mining because there is the increase in the depth and height of channels therefore it becomes non-functional for agricultural use. Most of the subsidiary channels not get repaired by the Govt. or concerned agencies last 10 years. Ponds were the good source of irrigation for the vegetable growing farmers but gradually numbers decreased in all the districts under the study area. Negative relative change of 41.81 percent was reported for ponds status. It is observed that water stagnation duration also decreased in ponds, canals and dams. It is recorded a negative relative change of 61.75 percent, 50.03 percent and 66.91 percent respectively. It indicates water availability in ponds as well as canals is very poor in the river mining districts. Similar findings reported in the prospective of average rainfall, negative relative change of 39.22 percent recorded. There is positive relative change reported for use of diesel engine pumps per village, it shown there is the increase in the number of pumps in the mining areas last 10-15 years.

Table-1 Comparison of average water availability & sources of irrigations before and after river sand mining per village. (n=86)

Sources of irrigation	Particulars	Status of resources		Absolute change	Relative change (%)
		Before sand mining	After sand mining		
River	Water level of river (ft)	2.39	1.00	-1.39	-58.15
	Depth of river (ft)	3.45	7.23	3.78	109.56
	Sand lifted quantity per day (t)	52.13	7093.75	7041.62	13507.80
	Availability of water from surface of the sand in river (m)	2.15	14.58	12.43	578.13
	Land irrigated by river %	79.73	17.13	-62.6	-78.51
Boring	No. of electric submersible pumps	13.45	41.59	28.14	214.15
	Depth of Submersible pumps (ft)	48.56	138.29	89.73	184.78
	Water level of boring (ft)	20.1	56.2	36.1	179.60
Wells	No of functional wells	16.1	4.42	-11.68	-72.54
	Water level of wells (ft)	17.67	44.87	27.2	153.93
Subsidiary channels (Daand)	No. of subsidiary channels	2.0	1.50	-0.5	-25
	No. of nonfunctional subsidiary channels	0	1.50	1.51	1.51
Ponds	No. of ponds	6.6	3.84	-2.76	-41.81
	Time of water stagnation (month)	11.06	4.23	-6.83	-61.75
Canals	No of canals	1.00	1.00	0	0
	Area irrigated by canals%	78.82	39.38	-39.44	-50.03
	water availability in a year (month)	8.13	2.79	-5.34	-65.68
	No of Dams (no change)	1.03	1.03	0	0
	Availability of water (months)	8.13	2.69	-5.44	-66.91
Status of rainfall	No of months rains	3.62	2.20	-1.42	-39.22
Pump house		1.2	0	-1.2	-100
Diesel engine		6.78	13.46	6.68	98.52

Source of data: Field survey (2017-18)

3.2 Socio-economic variable on adoption behavior vegetable growers.

It is revealed from Table 2 majority of the farmers 4.65 percent were illiterate they are making a thumb impression as a signature. It is recorded that 39.5 percent were primary pass, 12.79 percent were 8th pass, 25.58 percent were 10th pass, 12.79 percent were 12th pass and 4.65 percent were graduate. The majority of the farmers who were aged approx. >40 years were illiterate but women ratio was high. It is resulted in new youth is aware about education. All graduate respondents were aged about 23-28 years. Higher education i.e., PG and Ph.D. is not reported in the study area. Male farmers reported a 79.31 percent literacy rate, followed by women's literacy rate i.e., 20.68 percent. It indicates that still women's education is an issue, though so many programs are conducted by the government.

Table 2: Age and education of vegetable growers in the project area (N=86)

	No of respondent	(%)
Age		
20-30 years	7	8.13
30-40 years	42	48.83
40-50 years	33	38.37
50-60 years	4	4.65
Education		
Illiterate	4	4.65
5th	34	39.53
8th	11	12.79
10th	22	25.58
12th	11	12.79
Graduate	4	4.65
Gender education (M/F) literacy rate		
M	58	79.31
F	28	20.68

3.3. *Correlation of socio-economic variable on adoption behavior. (N=86)*

The adoption of improved vegetable cultivation practices also depends on the farmer's personal as well as social and economic conditions. The correlation coefficients of ten independent variables are presented in Table 3. These indicated the relationship between the variables of the respondents with adoption behavior. Age had a significant relationship with the adoption level of the mulching technique. It indicates young women might have adopt vegetable cultivation through mulching technology at their farms. The education of respondents found positive significant correlation with the adoption of mulching technology. It indicates that educated respondents had an interest in improved vegetable farming through mulching rather than without mulching. Family size and their occupation indicated a positive correlation with vegetable mulching; it meant for mulching techniques in vegetables their large family size is suited for the adoption of mulching techniques because vegetable cultivation is labor intensive. Social participation had shown positive significant correlation, it revealed that they are socially very strong. At the village level their coordination with each other is good. Ownership right to women indicated that women are decision-making. They decided the farming planning and they had family values. A positive correlation in this regard supported the view. Land-holding size recorded a positive significant correlation. It is revealed that own land holding respondents have more earnings and had good income to adopt the mulching in vegetable cultivation. Average annual income and credit status recorded positive correlation with vegetable cultivation through water conservation techniques i.e., mulching. It is resulted in their annual earnings from different other sources is also good and it was helpful to them to grow vegetables as a cash crop in river mining villages. Their credit status is satisfactory so that they got the credit from other sources easily rather than banks for vegetable cultivation. Education of respondent shown highest significant results with mulching techniques. If farmers are educated, they understand technology in easy way. Similar farmers already grown vegetables so transfer of technology was easier. Occupation and Social participation recorded positive significant results. Similar findings reported by [10].

Table 3 Correlation of socio-economic variable on adoption behavior. (N=86)

S. No.	Variables	Correlation coefficient (r)
1.	Age	0.223 **
2.	Education	0.359**
3.	Family size	0.289 **
6.	Occupation	0.332**
7.	Social participation	0.350**
8.	Holding Size	0.291**
9.	Average annual income	0.285**
10.	Credit Status	0.138*

**Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level*

3.4 *Distribution of respondents according to their overall extent of adoption of vegetable cultivation and its use among the vegetable growers (N=86)*

It is evident from table 4 majority (52.32%) of the respondents had high level of adoption, followed by low (27.38%) & medium (21.42%) level of adoption. The respondents from the trained category also showed higher overall extent of adoption of scientific vegetable cultivation technologies. From the above discussion, it can be concluded that the farmers of the trained category showed a higher extent of adoption of vegetable cultivation practices technology is pertaining to all 12 vegetable cultivation practices with mulching than those of the untrained category. Thus, the trained farmers showed an increasing trend in the use of mulching techniques in vegetables.

Table 4. Distribution of respondents according to their overall extent of adoption of vegetable cultivation and its use among vegetable farmers (N=86)

SI. No.	Categories	Frequency	
		Trained	Untrained
1.	Low	23 (27.38)	52 (60.46)
2.	Medium	18 (21.42)	10 (11.90)
3.	High	45 (52.32)	24 (28.57)
Total		86(100)	86(100)

3.5 *Distribution of vegetable growers before training of mulching techniques according to their extent of knowledge regarding selected vegetable cultivation practices.*

The extent of knowledge about mulching techniques before training and after training of vegetable growers in river sand mining areas regarding practices of production of vegetables was assessed and data are summarized in table 5 and 6, respectively.

Table 5 Distribution of vegetable growers before training of mulching techniques according to their extent of knowledge regarding selected vegetable cultivation practices with (N=43)

S. No.	Practices	Extent of knowledge					
		Unknown (0)		Partial known (1)		Completely known (2)	
		No.	%	No.	%	No.	%
1.	Knowing mulching technology for vegetable cultivation	26	60.46	17	39.53	0	0
2.	Selection of mulching sheet	40	93.02	3	6.97	0	0
3.	A scientific method of nursery raising	37	86.04	6	13.95	0	0
4.	Use of organic and balanced dose of fertilizers	3	6.9	41	95.34	0	0
5.	Diseases management and their control	41	95.34	2	4.65	0	0
6.	Insect pest management and their control	23	53.48	20	46.51	0	0
7.	Maintenance of mulching	11	23.40	36	76.60	0	0
8	Seed treatment	14	29.78	29	67.44	0	0

9.	Time of seed sowing	37	78.72	10	21.28	0	0
10.	Knowing about protected cultivation	41	95.34	2	4.65	0	0
11.	Marketing of vegetables	3	6.38	44	93.62	0	0
12.	Knowing about sand mining drawbacks	34	79.06	9	20.93	0	0

In a case before training of farmers, it is observed none of the practices having higher percentage it is almost zero in the complete known category though in unknown categories higher percentage is recorded for vegetable cultivation practices through mulching. Some of the farmers were partially known about the mulching techniques. The practice of higher percentage in the unknown category knew about protected cultivation and diseases management and their control (95.34 %), followed by the selection of mulching sheet (93.02%), scientific method of nursery raising (86.04%), knowing about sand mining drawbacks (79.06 %), time of seed sowing (78.72%), knowing about mulching technology in vegetable cultivation (60.46%), insect pest management and their control (53.48%). Similarly, Use of organic and balanced dose of fertilizers before training recorded higher percentages in the partial known category i.e. (95.34%) followed by the marketing of vegetables (93.62%), maintenance of mulching (76.60%). Similar findings, that trained farmers to grow mushroom in a better way was recorded by [11].

3.6 *Distribution of vegetable farmers after adoption of mulching techniques according to their extent of knowledge regarding selected vegetable cultivation practices.*

In case of training of the vegetable farmers about mulching techniques, the practices of higher percentage grouped into complete knowledge categories revealed in (table 6) were marketing of vegetables (95.34%), followed by knowing about sand mining drawbacks (76.74%), seed treatment (74.41%), time of seed sowing (58.13%), knowing about protected cultivation (58.13%), and maintenance of mulching (57.44). It is indicated that after training farmers were completely known about vegetable cultivation in sand mining areas.

Table 6 Distribution of vegetable farmers after adoption of mulching techniques according to their extent of knowledge regarding selected vegetable cultivation practices with (N=43)

S. No.	Practices	Extent of knowledge					
		Un known (0)		Partial known (1)		Completely known (2)	
		No.	%	No.	%	No.	%
1.	Knowing mulching technology for vegetable cultivation	0	0	36	76.60	5	11.62
2.	Selection of mulching sheet	0	0	29	61.70	14	32.55
3.	A scientific method of nursery raising	0	0	36	76.60	7	16.27
4.	Use of organic and balanced dose of fertilizers	0	0	35	74.47	8	18.60
5.	Diseases management and their control	0	0	32	68.08	11	25.58
6.	Insect pest management and their control	0	0	28	59.57	15	34.88
7.	Maintenance of mulching	0	0	27	57.44	16	37.20
8.	Seed treatment	0	0	11	25.58	32	74.41
9.	Time of seed sowing	0	0	32	68.08	11	25.58
10.	Knowing about protected cultivation	0	0	18	38.30	25	58.13
11.	Marketing of vegetables	0	0	2	4.26	41	95.34
12.	Knowing about sand mining drawbacks	0	0	10	21.28	33	76.74

The practices of a higher percentage concerning the trained farmers grouped into the partial knowledge category were knowing the technology of vegetable cultivation and scientific method of nursery raising (76.60%), followed by the use of organic and balanced doses of fertilizers (74.47%), time of sowing and diseases management and its control (68.08%), selection of mulching sheet (61.70%) and insect pest management and their control (59.57). But the mulching practices of the trained farmers grouped into unknown categories, knowledge gap for all the practices is recorded as zero. It showed all the trainees were aware about the practices they were not unaware for any practices [12]. The percentage of knowledge after training (vegetable growers) under complete and partial knowledge categories was higher as comparison to before training (untrained vegetable growers) table 5 & 6.

3.7 Difference in adoption level of mulching techniques in river sand mining areas before and after the training.

The test result reserved values for before and after training as well as t calculated which is higher than actual t value in Table 7. This indicates a significant ($p<0.05$) difference in the adoption level before and after the training. Highest significant values were obtained for seed treatment (32.71) followed by diseases management and their control (18.24), selection of mulching sheet (18.22). Lowest 't' value obtained for scientific method of nursery raising (3.24). The overall 't' values is obtained (12.59) which is highly significant at 0.05 level of probability. This shows, that respondents adopted mulching technology more after the training [13]. It is therefore important for vegetable farmers to be trained properly regarding the production of vegetables scientifically through mulching, as these efforts will definetly provide the self-employment and increase in income of vegetable growers in river mining affected areas.

Table 7 Extent of adoption of mulching techniques for vegetable cultivation practices by the farmers (N=86)

SI. No.	Particulars	t value
1.	Knowing mulching technology for vegetable cultivation	5.93*
2.	Selection of mulching sheet	18.22*
3.	A scientific_method of nursery raising	3.24*
4.	Use of organic and balanced dose of fertilizers	13.22*
5.	Diseases management and their control	18.24*
6.	Insect pest management and their control	6.86*
7.	Maintenance of mulching	12.64*
8.	Seed treatment	32.71*
9.	Time of seed sowing	3.41*
10.	Knowing about protected cultivation	5.49*
11.	Marketing of vegetables	13.62*
12.	Knowing about sand mining drawbacks	17.60*

**Significant at 0.05% level*

3.8 *Overall knowledge gaps for the selected mulching practices before and after training of the farmers*

The data presented in Table 8 reveals that overall knowledge gaps for the selected practices before and after the training of farmers were obtained (78.92) and (27.12) percent respectively.As reported by the farmers before training, the major contributing practices for this gap were diseases management and their control and selection of mulching sheets (97.82%) followed by marketing of vegetables (95.65%), use of organic and balanced dose of fertilizers and seed treatment (93.47%). Maximum knowledge gap recorded for selection of mulching sheets and minimum for time of seed sowing (52.17%). It is indicated that before training farmers were not aware about all aspect of mulching in vegetable cultivation. In case of trained farmers, the major contributing practices for this gap were the scientific method of nursery raising (41.43%), Knowing mulching technology of vegetable cultivation (39.13%), followed by use of organic and balanced dose of fertilizers (38.04%), time of seed sowing (35.86%), Diseases management and their control (34.78%). It is revealed in table 8 after training knowledge gap percentage decreased. It indicated that vegetable farmers trained well and they gained the knowledge about mulching and know how about its importance.[14] found similar findings as in the present investigation in relation to knowledge gap.

Table 8 Knowledge gap of the respondents (vegetable farmers) regarding mulching techniques in vegetable cultivation practices.

Scientific practices selected	Before training				After training			
	Maximum obtained score	Knowledge score obtained	Knowledge gap %	Rank	Maxim score	Score obtained	Knowledge gap %	Rank
Knowing mulching technology for vegetable cultivation	92	26	71.73	VI	92	56	39.13	II
Selection of mulching sheet	92	2	97.82	I	92	63	31.52	VI
Scientific method of nursery raising	92	42	54.34	IX	92	54	41.43	I
Use of organic and balance dose of fertilizers	92	6	93.47	III	92	57	38.04	III
Diseases management and their control	92	2	97.82	I	92	60	34.78	V
Insect pest management and their control	92	32	65.21	VII	92	64	30.43	VII
Maintenance of mulching	92	34	63.04	VIII	92	65	29.34	VIII
Seed treatment	92	6	93.47	III	92	83	9.78	XI
Time of seed sowing	92	44	52.17	X	92	59	35.86	IV
Knowing about protected cultivation	92	12	86.95	V	92	74	19.56	IX
Marketing of vegetables	92	4	95.65	II	92	90	2.17	XII
Knowing about sand mining drawbacks	92	8	91.30	IV	92	82	10.86	X

*Overall knowledge gap for all selected practices obtained 78.92 before training & 27.17 after training, t value 11.16**
**Significant at p=0.05 ** Significant at p= 0.01*

4. CONCLUSION

Based on the findings of the study, it may be concluded that, more than sixty per cent of the vegetable-growing farmers under the complete knowledge level of adoption category; whereas the extent of adoption for most of the recommended practices was found to be significantly higher for all the practices. The probable reason for high adoption was because all the above practices were felt to be more important for getting higher yield. Hence, in order to enhance the adoption of scientific vegetable cultivation practices by vegetable growers, they should be facilitated with latest technology know-how and motivated by imparting skill-based capacity-building programs. Besides, concentrated efforts should be made by line departments to offer technical support, guaranteed market linkage, value addition facilities and other input supply services to different stakeholders that may create entrepreneurial opportunities in the establishment of seedling nurseries by vegetable farmers. Nursery raising training and use of mulching in vegetable crops has been successful in producing a significant impact on the respondents. The study revealed that there had been a positive contribution of the training program in terms of knowledge, skill, and adoption of selected trainees. There is a gradually drastic change in the water availability for the irrigation of crops, so theuse of water conservation practices like use of mulching can be a better source of moisture conservation and water retention in soil for marginal farmers.

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