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### Bangalore sewage treated water: Enhanced the livelihood security of Kolar district farmers

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#### Abstract

Kolar district of Karnataka is identified as an eternally drought prone area with no perennial rivers, faces severe water quantity and quality issues over the years. Government of Karnataka had taken an initiative to implement Koramangala-Challagatta Valley project for better utilization of treated water to fill the tanks in the district to improve the groundwater. The present study was purposively carried out in Kolar district of Karnataka State. Kolar and Srinivaspura taluks were purposively selected for the study as the number of tanks filled were more in these two taluks. The primary data were collected from 180 farm households, consisting of 90 farm households in Kolar taluk and 90 from Srinivaspura taluk. From each taluk 30 big, 30 small and 30 marginal farmers were categorised based on land holding and selected. The data were collected from the respondents through personal interview method using pre-tested and well-structured schedule during March 2022. The villages were selected randomly based on the area in which tanks were filled under the project in the district. It was evident from the study that majority of the farmers secured better livelihood in the K.C. Valley project area after the implementation of the project.

**Keywords:** Livelihood security, Koramangala-challagatta valley, Kolar, sewage water, farmers

#### Introduction

Kolar is the 'land of silk and milk' and livelihoods here are strongly linked with the natural environment. Agriculture and its allied sectors such as horticulture, livestock rearing and sericulture is the major livelihood activities in the district. Kolar typically receives 743 mm rainfall annually with 80 percent received from June to September (southwest monsoon) and 20 percent from October-November (northeast monsoon). Rainfall is characterized by uneven distribution, unpredictability and dry spells (Kolar District at a Glance, 2017-18).

Karnataka faces an extreme drought; Kolar District has been declared drought-hit (Karnataka Economic survey, 2021-22). Kolar district of Karnataka is identified as an eternally drought prone area with no perennial rivers, faces severe water quantity and quality issues over the years. Groundwater across the district is classified as overexploited and several areas have high fluoride content which leads to health issues. Overall, borewell success rates have decreased from 83.00 percent in 2009 to 66.00 percent in 2015. About 9 percent of borewells dug in 2015-16 have stopped functioning. In 2019, ground water level for Kolar District was 4.93 meters below ground level and during 2020 depth to water level ranged from 0.05 m below ground level.

Bangalore's wastewater also contains industrial effluents and its use for irrigation while potentially beneficial, is potentially hazardous if not used properly. At present, the health and environmental risks of using wastewater in irrigation are largely unregulated, however, if these risks are managed, irrigation can ensure reuse of both water and nutrients. An important part of the solution to Bangalore's water situation is wastewater reuse. If individual houses and smaller apartments treat their own sewage, there is great potential for us to achieve sustainable water for the city. Selecting appropriate technologies will help better maintain STPs and improve the quality of treated water released into the environment.

India generated 72,368 million litres per day whereas the installed capacity of STPs was 31,841 million litres per day (43.9%). Of this installed capacity, developed and operationalized capacity was 26,869 MLD (84.00%). Of the total operationalized capacity, 20,236 million litres per day (75.00%) was the actual utilised capacity. In other words, out of total 72,368 million litres per day sewage generated every day, only 20,236 million litres per day is treated. Five states viz., Maharashtra, Gujarat, Uttar Pradesh, Delhi and Karnataka account for 60 percent of the total installed treatment capacity of the country. However, states like

Arunachal Pradesh, Andaman & Nicobar Islands, Lakshadweep, Manipur, Meghalaya and Nagaland have not installed sewage treatment plants. (Anon., 2021) <sup>[2]</sup>.

Chandigarh ranks first in terms of total sewage generated to what is actually treated. It generates 188 MLD of sewage and has an operational capacity to treat 271 MLD. The actual waste treated is 235 MLD (125.00%) of total generated. The states and UTs that utilize just 0-1 percent of sewage include Arunachal Pradesh, Bihar, Assam, Chhattisgarh, Jharkhand, Kerala, Lakshadweep, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. States and UTs like West Bengal, Odisha and Jammu and Kashmir treat two to seven percent of sewage. The proportion of the reuse of treated sewage is maximum in Haryana (80.00%) followed by Puducherry (55.00%), Delhi (50.00%), Chandigarh (35.00%), Tamil Nadu (25.00%), Madhya Pradesh (20.00%) and Andhra Pradesh (5.00%). States like Gujarat and Haryana prescribe higher targets in subsequent years, to achieve 100 percent reuse by 2030 and 2033 respectively, while Karnataka prescribes 50.00 percent reuse by 2030. (Anon., 2021) <sup>[2]</sup>.

During the last four decades ground water table in Kolar district has drastically fallen resulting in drying up of bore wells and wells. So rejuvenation of bore wells and wells would be the only way to bring the parched lands back into agriculture operations. By considering this Government of Karnataka had taken an initiative for better utilization of treated water to fill the tanks in the district to improve the groundwater. Koramangala- Challagatta Valley initiative is regarded as unique project in India. The K.C. Valley Project was started in November 2016 and will gradually delivering treated sewage water to 126 irrigation tanks dispersed throughout Kolar and Chikkaballapur districts.

With this background the study was a modest attempt to assess the livelihood security of farmers of Kolar district after benefitted from Koramangala- Challagatta Valley irrigation project. It was useful in understanding the livelihood situation of farmers in Kolar district.

### Materials and Methods

The ex-post facto research design was used as the research design. It focused on assessing the existing status of the livelihood security of the farmers. Ex-post facto research design is a systematic empirical enquiry in which the researcher does not have direct control over independent variables, because their manifestation has already occurred or because they are inherently not manipulated and inferences about relationship among variables are made without direct intervention, from concomitant influence of independent variables on dependent variables" (Kerlinger, 2007) <sup>[5]</sup>.

The present study was purposively carried out in Kolar district of Karnataka State. Kolar and Srinivaspura taluks were purposively selected for the study as the number of tanks filled were more in these two taluks. Therefore, the

study primarily relies upon primary data collected from randomly selected sample farmers in the region. Random sampling design was employed for the selection of respondents. The primary data were collected from 180 farm households, consisting of 90 farm households in Kolar taluk and 90 from Srinivaspura taluk. From each taluk 30 big, 30 small and 30 marginal farmers were categorised based on land holding and selected. The data were collected from the respondents through personal interview method using pre-tested and well-structured schedule during March 2022. The villages were selected randomly based on the area in which tanks were filled under the project in the district.

Livelihood security is operationally defined as "ability of the farmers to earn by diversifying the livelihood assets and resources in K.C Valley Project area". Seven major dimensions related to livelihood security of farmers were identified based on review of literature and discussion with the experts of Agricultural Extension and allied sciences. The dimensions identified were food security, economic security, health security, social security, ecological security, psychological security and physical security. Both positive as well as negative statements pertaining to the psychological object were included.

Livelihood security of farmers were measured using a standard scale developed for the study. (Chaithrashree and Shivalingaiah, 2022) <sup>[10]</sup>.

### Results

#### Livelihood security of farmers in K.C. Valley project area

##### Component wise livelihood security level of farmers in K.C. Valley project area

To assess the livelihood security of the farmers in K.C. Valley project area, seven components were identified *viz.*, food security, economic security, health security, social security, ecological security, psychological security and physical security. Component wise analysis of livelihood security of farmers in K.C. Valley project area was done and depicted in Table 1 and discussed in the following paragraph.

In case of marginal farmers, food security (78.73%, rank I), economic security (76.13%, rank II) and social security (72.48%, rank III) were the major components of livelihood security followed by health security (67.11%, rank IV), physical security (66.71%, rank V), ecological security (65.67%, rank VI) and psychological security (64.47%, Rank VII).

In case of small farmers, economic security (77.38%, rank I), social security (71.38%, rank II), health security (69.89%, rank III) and physical security (65.76%, rank IV) followed by ecological security (65.42%, rank V), psychological security (65.00%, rank VI) and food security (63.27%, rank VII) were the prime components of livelihood security.

**Table 1:** Component wise of livelihood security level of farmers in K.C. Valley project area n =180

Dimensions	Total score	Obtained score	percent of scores	Rank
<b>Overall farmers (n=180)</b>				
Food security	4500	3019	67.09	VI
Economic security	14400	10844	75.31	I
Health security	2700	1853	68.63	III
Social security	6300	4482	71.14	II
Ecological security	3600	2363	65.64	VI
Psychological security	4500	2929	65.09	VII
Physical security	6300	4162	66.06	V
<b>Marginal farmers (n<sub>1</sub>=60)</b>				
Food security	1500	1181	78.73	I
Economic security	4800	3654	76.13	II
Health security	900	604	67.11	VI
Social security	2100	1522	72.48	III
Ecological security	1200	788	65.67	VI
Psychological security	1500	967	64.47	VII
Physical security	2100	1401	66.71	V
<b>Small farmers (n<sub>2</sub>=60)</b>				
Food security	1500	949	63.27	VII
Economic security	4800	3714	77.38	I
Health security	900	629	69.89	III
Social security	2100	1499	71.38	II
Ecological security	1200	785	65.42	V
Psychological security	1500	975	65.00	VI
Physical security	2100	1381	65.76	IV
<b>big farmers (n<sub>3</sub>=60)</b>				
Food security	1500	883	58.87	VII
Economic security	4800	3476	72.42	I
Health security	900	620	68.89	III
Social security	2100	1461	69.57	II
Ecological security	1200	790	65.83	IV
Psychological security	1500	987	65.80	V
Physical security	2100	1380	65.71	VI

In case of big farmers, economic security (72.42%, rank I), social security (69.57%, rank II) and health security (68.89%, rank III) were the main dimensions of livelihood security followed by ecological security (65.83%, rank IV), psychological security (65.80%, rank V), physical security and food security (58.87%, rank VII).

It is evident from the Table 1 that farmers in the K.C Valley region consider the following components in descending order as important components of livelihood security. Economic security (75.31%, rank I), social security (71.14%, rank II), health security (68.63%, rank III), food security (67.09%, rank IV), physical security (66.06%, rank V), ecological security (65.64%, rank VI) and psychological security (65.09%, rank VII).

The probable reason might be that cost of digging borewell has been reduced, area under cultivation has been increased and assured irrigation provides security against risk and uncertainties of farm yields which results in better economic security. Farmers are accessing to good and healthy intake due to increased economic status, started utilizing the benefits of various schemes due to diversification of crops by participating in various recognized extension activities. Further, due to increased income farmers purchased own vehicles, vehicles for transportation of produce, farm machineries which are required for carrying out the farm activities. The results are in conformity with findings of Shwetha (2019) [8].

#### **Statement wise distribution of farmers with respect to food security dimension in the K.C Valley area**

It was noticed from the Table 2 that under the food security component among marginal farmers the statement use of treated water for irrigation helps in growing the diversified nutrient crops ranked first with the mean score of 4.05 followed by diversification of crops due to K.C valley project helps to meet the nutrient requirement of the household ranked second with the mean score of 3.00. The statement I will produce the major portion of food items on my own in farm ranked third with mean score of 2.77, balance food is available to my family members ranked fourth with the mean score of 2.67 followed by clean water is available for cooking purpose ranked last with mean score of 2.33.

In case of small farmers, the statement use of treated water for irrigation helps in growing the diversified nutrient crops, diversification of crops due to K.C valley project helps to meet the nutrient requirement of the household and I will produce the major portion of food items on my own in farm with mean score of 5.00 ranked first followed by balanced food is available to my family members ranked fourth with the mean score of 2.48 and clean water is available for cooking purpose ranked last with lowest mean score of 2.20. In case of big farmers, the statement use of treated water for irrigation helps in growing the diversified nutrient crops ranked first with the mean score of 4.48 followed by

diversification of crops due to K.C valley project helps to meet the nutrient requirement of the household with the mean score of 3.30. The statement I will produce the major portion of food items on my own in farm ranked third with the mean score of 2.85, balance food is available to my family members ranked fourth with mean score of 2.72 followed by clean water is available for cooking purpose ranked last with mean score of 2.47.

It was evident from Table 2 that use of treated water for irrigation helps in growing the diversified nutrient crops

statement ranked first with the mean score of 4.51 followed by diversification of crops due to K.C valley project helps to meet the nutrient requirement of the household ranked second with mean score of 3.77. Producing the major portion of food items on my own in farm statement ranked third with mean score of 3.54, balance food is available to my family members ranked fourth with mean score of 2.62 followed by clean water is available for cooking purpose ranked last with mean score of 2.33.

**Table 2:** Statement wise distribution of farmers with respect to food security dimension in the K.C Valley area n = 180

Sl. No	Statements	Marginal farmers (n1=60)		Small farmers (n2=60)		Big farmers (n3=60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Use of treated water for irrigation helps in growing the diversified crops	4.05	I	5.00	I	4.48	I	4.51	I
2.	Diversification of crops due to K. C. Valley project helps to meet the nutrient requirement of the household	3.00	II	5.00	I	3.30	II	3.77	II
3.	Balanced food available to my family members	2.67	IV	2.48	IV	2.72	IV	2.62	IV
4.	Clean water is available for cooking purpose	2.33	V	2.20	V	2.47	V	2.33	V
5.	I will produce the major portion of food items on my own in farm	2.77	III	5.00	I	2.85	III	3.54	III

The probable reasons for the above results may be that majority of the farmers in study area were shifted from monocropping to multiple cropping as well as vegetable based cropping system. Due to diversification of crop cultivation farmers consuming much of the vegetable that might have added to the nutrient requirement of households. Water even though treated, contains traces of metals and other common contaminants which are on prolonged and regular consumption through cooking start to be deposited in the human body in the long run. The results are in line with Akudugu, *et al.* (2021) [9].

**Statement wise distribution of farmers with respect to economic security in K.C Valley project area**

Statement wise distribution of farmers with respect to economic security in K.C Valley project area was tabulated in the Table 3. It can be seen that among marginal farmers, cost of digging bore well has been reduced because of the project implementation area under cultivation has been increased after the implementation of project and failed bore wells have been recovered after the implementation of project strongly agreed with mean score of 5.00 ranked first followed by started savings of the earnings which act as a means of better livelihood ranked fourth with the mean score of 4.60. Availing credit from the banks after the implementation of project ranked fifth with mean score of 4.28, assured irrigation from K.C. valley project provides security against risk and uncertainties of farm yields ranked sixth with mean score of 4.17, availability of irrigation facilities helps in effective utilization of all the resources ranked seventh with mean score of 3.97, dependency on single crop has been reduced by practicing diversified cropping through assured irrigation from K.C Valley project ranked eighth with mean score of 3.88, diversification of crops through use of treated water resulted in higher cost benefit ratio ranked ninth with mean score of 3.87, project helped in generation of employment opportunity throughout the year ranked tenth with mean score of 3.78. The

statement all the family members are engaged in farming as well as earning after the implementation of project ranked eleventh with mean score of 3.28 followed by the statement livestock holding has been increased through generation of pasture added to total earnings of the family with mean score of 3.25 and I am repaying the loans regularly and not a defaulter statement with mean score of 3.12 ranked thirteen, I have insured all crops grown in the field against natural calamities ranked fourteenth with mean score of 2.95, I didn't sold any assets to meet the household expenditure after the project implementation ranked fifteenth with mean score of 2.88 and started practicing more than one enterprise by utilization of treated water ranked least with the mean score of 1.87.

In case of small farmers, dependency on single crop has been reduced by practicing diversified cropping through assured irrigation from K.C. Valley project, Cost of digging bore well has been reduced because of the project implementation and availability of irrigation facilities helps in effective utilization of all the resources strongly agreed with mean score of 5.00 ranked first. The area under cultivation has been increased after the implementation of project ranked fourth with mean score of 4.72, started availing credit from the banks after the implementation of project ranked fifth with mean score of 4.22, I started savings of the earnings which act as a means of better livelihood ranked sixth with mean score of 4.15, failed bore wells have been recovered after the implementation of project ranked seventh with mean score of 3.93. The statement project helped in generation of employment opportunity throughout the year ranked eight with the mean score of 3.73 followed by the statement assured irrigation from K.C. valley project provides security against risk and uncertainties of farm yields and diversification of crops through use of treated water resulted in higher cost benefit ratio ranked ninth with the mean score of 3.70. The statement livestock holding has been increased through generation of pasture added to total earnings of the family

ranked eleventh with mean score of 3.37, all the family members are engaged in farming as well as earning after the implementation of project ranked twelfth with mean score of 3.12, I have insured all crops grown in the field against natural calamities ranked thirteenth with mean score of 3.00, I am repaying the loans regularly and not a defaulter statement ranked fourteenth with mean score of 2.92. Didn't sold any assets to meet the household expenditure after the project implementation ranked fifteenth with mean score of 1.77 followed by the statement, I started practicing more than one enterprise by utilization of treated water ranked last with mean score of 1.62.

In case of big farmers the statement cost of digging bore well has been reduced because of the project implementation with mean score of 5.00 ranked first followed by area under cultivation has been increased after the implementation of project ranked second with mean score of 4.97, failed bore wells have been recovered after the implementation of project ranked third with mean score of 4.95, I started availing credit from the banks after the implementation of project ranked fourth with mean score of 4.55, I started savings of the earnings which act as a means of better livelihood with mean score of 4.27 ranked fifth. The statement availability of irrigation facilities helps in effective utilization of all the resources ranks sixth with mean score of 4.25, dependency on single crop has been reduced by practicing diversified cropping through assured irrigation from K.C Valley project ranked seventh with mean score of 4.08, assured irrigation from K.C. valley project provides security against risk and uncertainties of farm yields ranked eight with mean score of 3.95, project helped in generation of employment opportunity throughout the year ranked ninth with mean score of 3.90. The statement all the family members are engaged in farming as well as earning after the implementation of project ranked tenth with mean score of 3.45. The statement diversification of crops through use of treated water resulted in higher cost benefit ratio ranked eleventh with mean score of 3.43, I didn't sold any assets to meet the household expenditure after the project implementation ranked twelfth with mean score of 3.40 followed by I have insured all crops grown in the field against natural calamities ranked thirteenth with mean score of 3.08, livestock holding has been increased through generation of pasture added to total earnings of the family with mean score of 3.00 ranked fourteenth, I am repaying the loans regularly and I'm not a defaulter ranked fifteenth with mean score of 2.92 followed by I started practicing more than one enterprise by utilization of treated water ranked last with mean score of 1.70.

In case of total number of farmers the statement cost of digging bore well has been reduced because of the project implementation ranked first with the mean score of 5.00 followed by area under cultivation has been increased after the implementation of project ranked second with mean score of 4.89, failed bore wells have been recovered after the implementation of project ranked third with mean score of 4.62, availability of irrigation facilities helps in effective utilization of all the resources ranked fourth with mean score of 4.40. The statement I started availing credit from the banks after the implementation of project ranked fifth with mean score of 4.35, started savings of the earnings

which act as a means of better livelihood with mean score of 4.34 ranked sixth. Dependency on single crop has been reduced by practicing diversified cropping through assured irrigation from K.C. Valley project ranked seventh with mean score of 4.32, assured irrigation from K.C. valley project provides security against risk and uncertainties of farm yields ranked eight with mean score of 3.94, project helped in generation of employment opportunity throughout the year ranked ninth with mean score of 3.80, diversification of crops through use of treated water resulted in higher cost benefit ratio with mean score of 3.66 ranked tenth. The statement all the family members are engaged in farming as well as earning after the implementation of project ranked eleventh with mean score of 3.28, livestock holding has been increased through generation of pasture added to total earnings of the family ranked twelfth with mean score of 3.20, I have insured all crops grown in the field against natural calamities ranked thirteenth with mean score of 3.01, I am repaying the loans regularly and not a defaulter ranked fourteenth with mean score of 2.98, I didn't sold any assets to meet the household expenditure after the project implementation ranked fifteenth with mean score of 2.68 followed by I started practicing more than one enterprise by utilization of treated water ranked last with mean score of 1.73.

The probable reason might be that treated water availability has increased the groundwater table and farmers in the project area are getting water on an average by 400 feet as compared to 1200 feet to 1500 feet before the implementation of Project. In land which was left due to shortage of water because of borewell failure, due to recharge of borewells farmers are started cultivating the crops in those land. Further, assured irrigation has provided the confidence against risk and uncertainties, availability of irrigation facilities helps them in effective utilization of all the resources and extending the area under cultivation. Significant percent of the farmers started savings of the earnings which act as a better means of livelihood. Even before the implementation of project, farmers were having livestock, poultry along with the crop cultivation and sericulture as a means of livelihood that may be the reason for least score for the statement practicing more than one enterprise by utilization of treated water.

#### **Statement wise distribution of farmers with respect to health security in K.C Valley project area**

The data presented in the Table 4 depicts the Statement wise distribution of farmers with respect to health security in K.C. Valley area. It can be inferred that the statement more incidence of diseases at household, village and community level after implementation of project ranked first by marginal, small as well as big farmers with the mean score of 3.68, 3.62 and 3.75 respectively. The statement health insurance for my family members is done ranked second by marginal, small and big farmers with mean score of 3.20, 3.37 and 3.40 respectively. The statement health of all the family members are in good condition ranked third by all the categories of farmers with mean score of big farmers (3.15), small farmers (3.13) and marginal farmers (3.25) respectively.

**Table 3:** Statement wise distribution of farmers with respect to economic security in K.C Valley Project area n=180

Sl. No.	Statements	Marginal farmers (n <sub>1</sub> =60)		Small farmers (n <sub>2</sub> =60)		Big farmers (n <sub>3</sub> =60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Availability of irrigation facilities helps in effective utilization of all the resources	3.97	VII	5.00	I	4.25	VI	4.40	IV
2.	Diversification of crops through use of treated water resulted in higher cost benefit ratio	3.87	IX	3.70	IX	3.43	XI	3.66	X
3.	Dependency on single crop has been reduced by practicing diversified cropping through assured irrigation from K.C Valley project	3.88	VIII	5.00	I	4.08	VII	4.32	VII
4.	Cost of digging bore well has been reduced because of the project implementation	5.00	I	5.00	I	5.00	I	5.00	I
5.	All the family members are engaged in farming as well as earning after the implementation of project	3.28	XI	3.12	XII	3.45	X	3.28	XI
6.	I started practicing more than one enterprise by utilization of treated water	1.87	XVI	1.62	XVI	1.70	XVI	1.73	XVI
7.	Project helped in generation of employment opportunity throughout the year	3.78	X	3.73	VIII	3.90	IX	3.80	IX
8.	I didn't sold any assets to meet the household expenditure after the project implementation	2.88	XV	1.77	XV	3.40	XII	2.68	XV
9.	Area under cultivation has been increased after the implementation of project	5.00	I	4.72	IV	4.97	II	4.89	II
10.	Assured irrigation from K.C. valley project provides security against risk and uncertainties of farm yields	4.17	VI	3.70	IX	3.95	VIII	3.94	VIII
11.	Livestock holding has been increased through generation of pasture added to total earnings of the family	3.25	XII	3.37	XI	3.00	XIV	3.20	XII
12.	I started availing credit from the banks after the implementation of project	4.28	V	4.22	V	4.55	IV	4.35	V
13.	I started savings of the earnings which act as a means of better livelihood	4.60	IV	4.15	VI	4.27	V	4.34	VI
14.	Failed bore wells have been recovered after the implementation of project	5.00	I	3.93	VII	4.95	III	4.62	III
15.	I am repaying the loans regularly and I'm not a defaulter	3.12	XIII	2.92	XIV	2.92	XV	2.98	XIV
16.	I have insured all crops grown in the field against natural calamities	2.95	XIV	3.00	XIII	3.08	XIII	3.01	XIII

The possible reason may be that even though sewage water is treated, it may contain some chemicals and bacteria which invites illness and causes health hazards. Sometime causes

skin problems as a result of irrigating with partially treated sewage water. The results are in line with Rutkowski *et al.* (2006) <sup>[6]</sup>.

**Table 4:** Statement wise distribution of farmers with respect to health security in K.C Valley project area n = 180

Sl. No.	Statements	Marginal farmers (n <sub>1</sub> =60)		Small farmers (n <sub>2</sub> =60)		Big farmers (n <sub>3</sub> =60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	More incidence of diseases at household, village and community level after implementation of project	3.68	I	3.62	I	3.75	I	3.68	I
2.	Health of all the family members are in good condition	3.25	III	3.13	III	3.15	III	3.18	III
3.	Health insurance for my family members is done	3.20	II	3.37	II	3.40	II	3.32	II

**Statement wise distribution of farmers with respect to Social security in K.C Valley project area**

The data presented in Table 5 depicted the statement wise distribution of farmers with respect to social security in K.C Valley area. In case of marginal farmers, after implementation of K.C. valley project utilizing the benefits from the Govt. Schemes statement ranked first with the mean score of 4.50 followed by I started participating in trainings, krishimelas, exhibitions and campaigns etc., to acquire information about new technologies suitable for irrigated conditions ranked second with mean score of 4.25, interacting with progressive/ innovative farmers often after getting water from project ranked third with mean score of 3.67. Other social security statements were become a member of cooperative society after the implementation of project ranked fourth with mean score of 3.57, villagers are maintaining harmonious relationship after the implementation of project ranked fifth with mean score of 3.40, no conflicts among farmers over utilization of treated water in the fields ranked sixth with mean score of 2.82 and growing of diversified crops improves the cosmopolite characters of farmers ranked seventh with mean score of

2.78.

In case of small farmers after implementation of KC valley project I'm utilizing the benefits from the Govt. Schemes statement ranked first with the mean score of 4.60, followed by I started interacting with progressive/ innovative farmers often after getting water from project ranked second with mean score of 3.72, participating in training, krishimelas, exhibitions and campaigns etc., to acquire information about new technologies suitable for irrigated conditions ranked third with mean score of 3.67, he become a member of cooperative society after the implementation of project ranked fourth with mean score of 3.63 and villagers are maintaining harmonious relationship after the implementation of project with mean score of 3.62 ranked fifth. There are no conflicts among farmers over utilization of treated water in the fields statement rank sixth with mean score of 2.83 and growing of diversified crops improves the cosmopolite characters of farmers ranked least with mean score of 2.73.

Big farmers ranked the statement after implementation of K.C. valley project utilizing the benefits from the government Schemes ranked first with the mean score of

4.58, followed by interacting with progressive/ innovative farmers often after getting water from project ranked second with mean score of 4.07, participating in krishimelas, exhibitions and campaigns etc., to acquire information about new technologies suitable for irrigated conditions ranked third with mean score of 3.80. The statement villagers are maintaining harmonious relationship after the implementation of project with mean score of 3.62 ranked fourth followed by growing of diversified crops improves the cosmopolite characters of farmers ranked fifth with mean score of 3.60, become a member of cooperative society after the implementation of project ranked sixth with mean score of 2.73 and there are no conflicts among farmers over utilization of treated water in the fields ranked least with mean score of 2.52.

It can be clearly seen from the Table 5 that among total farmers ranked the statement after implementation of K.C. valley project I'm utilizing the benefits from the Govt. Schemes as first with the mean score of 4.56 followed by participating in training, krishimelas, exhibitions and campaigns etc., to acquire information about new technologies suitable for irrigated conditions ranked second

with mean score of 3.91, I started interacting with progressive/ innovative farmers often after getting water from project ranked third with mean score of 3.82. Become a member of cooperative society after the implementation of project with mean score of 3.60 ranked fourth, villagers are maintaining harmonious relationship after the implementation of project ranked fifth with mean score of 3.54. The statement there are no conflicts among farmers over utilization of treated water in the fields ranked sixth with mean score of 2.79 followed by growing of diversified crops improves the cosmopolite characters of farmers with mean score of 2.68 ranked least.

Because of the diversified farming, farmers started utilizing the benefits and subsidies available in various schemes of developmental departments. Further, due to improved socio-economic conditions, farmers practicing various activities and interacting with progressive/ innovative farmers to acquire information about new technologies suitable for irrigated conditions. Because of improved cosmopolite characteristics, they started becoming members in co-operative societies to get recognition in the society. Findings are in line with the Barela *et al.*, (2018) [7].

**Table 5:** Statement wise distribution of farmers with respect to social security in K.C Valley project area n =180

Sl. No.	Statements	Marginal farmers (n <sub>1</sub> =60)		Small farmers (n <sub>2</sub> =60)		Big Farmers (n <sub>3</sub> =60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	I have become a member of cooperative society after the implementation of project	3.57	IV	3.63	IV	2.73	VI	3.60	IV
2.	I started interacting with progressive/ innovative farmers often after getting water from project	3.67	III	3.72	II	4.07	II	3.82	III
3	I started participating in krishimelas, exhibitions and campaigns et., to acquire information about new technologies suitable for irrigated conditions	4.25	II	3.67	III	3.80	III	3.91	II
4	Growing of diversified crops improves the cosmopolite characters of farmers	2.78	VII	2.73	VIII	3.60	V	2.68	VII
5	Villagers are maintaining harmonious relationship after the implementation of project	3.40	V	3.62	V	3.62	IV	3.54	V
6	There are no conflicts among farmers over utilization of treated water in the fields	2.82	VI	2.83	VI	2.52	VII	2.79	VI
7	After implementation of K.C. valley project I'm utilizing the benefits from the Govt. Schemes	4.50	I	4.60	I	4.58	I	4.56	I

**Statement wise distribution of farmers with respect to ecological security in K.C Valley area**

The data presented in the Table 6 indicates the Statement wise distribution of farmers with respect to ecological security in K.C Valley area. In case of marginal farmers, treated water releasing the effluents / heavy metals which is causing soil pollution statement with mean score of 3.70 ranked first, Irrigation with treated water is providing favorable environment for crop growth ranked second with mean score of 3.12, application of treated water is compatible with the natural, physical, chemical and biological processes that occur on and in the soil ranked third with mean score of 2.87 followed by the treated water is destroying the soil structure in long run ranked fourth with mean score of 2.83.

Small farmers are of the opinion that the treated water releasing the effluents / heavy metals which is causing soil pollution statement ranked first with mean score of 4.87, Irrigation with treated water is providing favorable

environment for crop growth ranked second with mean score of 3.22 followed by the statement treated water is destroying the soil structure in long run ranked third with mean score of 2.82, application of treated water is compatible with the natural, physical, chemical and biological processes that occur on and in the soil ranked least with mean score of 2.00.

It was observed from Table 6 that, the among the big farmers statement treated water releasing the effluents / heavy metals which is causing soil pollution with ranked first mean score of 3.70, application of treated water is compatible with the natural, physical, chemical and biological processes that occur on and in the soil ranked second with mean score of 3.32, followed by statement I feel treated water is destroying the soil structure in long run ranked third with 3.20 mean score of and irrigation with treated water is providing favorable environment for crop growth ranked fourth with 2.90 mean score.

**Table 6:** Statement wise distribution of farmers with respect to ecological security in K.C Valley area n = 180

Sl. No	Statements	Marginal farmers (n <sub>1</sub> =60)		Small farmers (n <sub>2</sub> =60)		big farmers (n <sub>3</sub> =60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Treated water releasing the effluents / heavy metals which is causing soil pollution	3.70	I	4.87	I	3.70	I	4.09	I
2.	I feel treated water is destroying the soil structure in long run	2.83	IV	2.82	III	3.20	III	2.95	III
3.	Irrigation with treated water is providing favourable environment for crop growth	3.12	II	3.22	II	2.90	IV	3.08	II
4.	Application of treated water is compatible with the natural, physical, chemical and biological processes that occur on and in the soil	2.87	III	2.00	IV	3.32	II	2.73	IV

It was evident from Table 6 that, among the total farmers the statement treated water releasing the effluents / heavy metals which is causing soil pollution statement ranked first with mean score of 4.09, Irrigation with treated water is providing favorable environment for crop growth ranked second with mean score of 3.08 followed by the statement treated water is destroying the soil structure in long run ranked third with mean score of 2.95, application of treated water is compatible with the natural, physical, chemical and biological processes that occur on and in the soil ranked least with mean score of 2.73.

The probable reason for the above findings might be that use of industrial wastewater for agricultural purpose involves changes in physicochemical and microbiological properties of soil. It may affect the soil health and destroys the soil structure in the long run. General perception among the farmers is that treated water may destroy the soil structure in the long run due to heavy metal/effluents in the treated water. However, small and marginal farmers opined

that irrigation with treated water providing favourable environment for the crop growth.

**Statement wise distribution of farmers with respect to psychological security in K.C Valley area**

The results presented in the Table 7 depict the statement wise distribution of farmers with respect to psychological security in K.C. Valley area. It is evident from the Table that among marginal farmer, the statement project helped in reducing the mental stress with mean score of 5.00 ranked first followed by the statement after implementation of project my knowledge and skills of farming has been increased with mean score of 4.95 ranked second, assured irrigation has increased confidence of availing credit from the bank and repaying loans to the banks ranked third with mean score of 4.48. Assured irrigation provided confidence in trying out the innovative ideas in my farm ranked fourth with mean score of 4.10 and positive attitude to take risk has been increased ranked fifth with mean score of 3.38.

**Table 7:** Statement wise distribution of farmers with respect to psychological security in K.C Valley area n = 180

Sl. No	Statements	Marginal farmers (n <sub>1</sub> =60)		Small farmers (n <sub>2</sub> =60)		Big farmers (n <sub>3</sub> =60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	After implementation of project my knowledge and skills of farming has been increased	4.95	II	2.65	V	4.02	IV	3.89	IV
2.	Assured irrigation provided confidence in trying out the innovative ideas in my farm	4.10	IV	4.38	II	4.23	III	4.24	III
3.	Positive attitude to take risk has been increased	3.30	V	3.57	IV	3.47	V	3.47	V
4.	Project helped in reducing the mental stress	5.00	I	5.00	I	5.00	I	5.00	I
5.	Assured irrigation has increased confidence of availing credit from and repaying loans to the banks	4.48	III	4.27	III	4.48	II	4.41	II

In case of small farmers, the statement project helped in reducing the mental stress ranked first with mean score of 5.00, assured irrigation provided confidence in trying out the innovative ideas in my farm ranked second with mean score of 4.38, assured irrigation has increased confidence of availing credit from the bank and repaying loans to the banks ranked third with mean score of 4.27 followed by assured positive attitude to take risk has been increased with mean score of 3.57 ranked sixth and after implementation of project my knowledge and skills of farming has been increased statement ranked fifth with mean score of 2.65.

With respect to big farmers, project helped in reducing the mental stress statement ranked first with mean score of 5.00, assured irrigation has increased confidence of availing credit

from the banks and repaying loans to the banks ranked second with mean score of 4.48, assured irrigation provided confidence in trying out the innovative ideas in my farm with mean score of 4.23 ranked third followed by after implementation of project my knowledge and skills of farming has been increased statement ranked fourth with mean score of 4.02 and positive attitude to take risk has been increased least with mean score of 3.47.

It was observed that, among total farmers the statement project helped in reducing the mental stress ranked first with mean score of 5.00, assured irrigation has increased confidence of availing credit from the banks and repaying loans to the banks ranked second with mean score of 4.41, assured irrigation provided confidence in trying out the



innovative ideas in my farm ranked third with mean score of 4.24 followed by the statement after implementation of project my knowledge and skills of farming has been increased ranked fourth with mean score of 3.89 and positive attitude to take risk has been increased ranked least with mean score of 3.47.

The probable reason might be that, farmers had mental stress due to solitary nature of work and socio-economic conditions, due to aberrant weather conditions and droughts over the years which might have reduced after the implementation of the project which contributed in securing the better psychological livelihood among the farmers. Further, farmers have developed the confidence among themselves to try out new innovative ideas in their farm and availing credit from the bank and repaying loan in time due to assured irrigation.

**Statement wise distribution of farmers with respect to physical security in K.C Valley area**

The data presented in Table 8 depicts the statement wise distribution of farmers with respect to physical security in K.C Valley area. It can be inferred from the Table 8 that the I purchased new mobiles for telecommunications statement ranked first with mean score of 5.00 followed by have purchased machinery and implements for farming ranked second with mean score of 3.98, project implementation has helped us to possess a own house ranked third with mean score of 3.90, purchased vehicle for transporting the produce ranked fourth with mean score of 3.70. The statement farmer possessed a new bore well at low cost after

the implementation of project and purchased two wheeler/four wheelers after the project implementation ranked fifth with mean score of 3.25 followed by I expanded my livestock numbers in a desired way ranked seventh with mean score of 2.40.

In case of small farmers, purchased two wheeler/four wheeler after the project implementation statement ranked first with mean score of 4.22 followed by have purchased machinery and implements for farming ranked second with mean score of 4.15, purchased vehicle for transporting the produce ranked third with mean score of 3.73, purchased new mobiles for telecommunications ranked fourth with mean score of 3.70. The statement farmer possessed a new bore well at low cost after the implementation of project ranked fifth with mean score of 3.37, expanded my livestock numbers in a desired way ranked sixth with mean score of 2.22 and project implementation has helped us to possess a own house ranked last with mean score of 1.62.

Big farmers ranked the statement purchased machinery and implements for farming with mean score of 4.05 ranked as first followed by purchased vehicle for transporting the produce ranked second with mean score of 3.90, purchased new mobiles for telecommunications ranked third with mean score of 3.77, I have purchased two wheeler/four wheelers after the project ranked fourth with mean score of 3.68. The statement farmer possessed a new borewell at low cost with mean score of 3.00 ranked fifth., expanded my livestock numbers in a desired way ranked sixth with mean score of 2.42 followed by project implementation has helped to possess own house ranked last with mean score of 1.70.

**Table 8:** Statement wise distribution of farmers with respect to physical security in K.C Valley area n=180

Sl. No	Statements	Marginal farmers (n1=60)		Small farmers (n2=60)		Big farmers (n3=60)		Total (n=180)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Project implementation has helped to possess a own house	3.90	III	1.62	VII	1.70	VII	2.41	VI
2.	I have purchased vehicle for transporting the produce	3.70	IV	3.73	III	3.90	II	3.78	III
3.	I have purchased machinery and implements for farming	3.98	II	4.15	II	4.05	I	4.06	II
4.	I expanded my livestock numbers in a desired way	2.40	VII	2.22	VI	2.42	VI	2.34	VII
5.	I purchased new mobiles for telecommunications	5.00	I	3.70	IV	3.77	III	4.41	I
6.	Possess a new bore well at low cost after the implantation of Project	3.25	V	3.37	V	3.00	V	3.21	V
7.	I have purchased two wheeler/four wheeler after the project implementation	3.25	V	4.22	I	3.68	IV	3.72	IV

Overall it can be observed from total farmers that the statement I purchased new mobiles for telecommunications ranked first with mean score of 4.41 followed by purchased machinery and implements for farming ranked second with mean score of 4.06, purchased vehicle for transporting the produce ranked third with mean score of 3.78, I have purchased two wheeler/four wheelers after the project ranked fourth with mean score of 3.72. The statement farmer possessed a new bore well at low cost after the implementation of project ranked fifth with man score 3.21. The statement Project implementation has helped to possess own house ranked sixth with mean score of 2.41 followed by I expanded my livestock numbers in a desired way ranked least with mean score of 2.34.

The probable reason for purchasing new mobiles, machineries and implements, possessing a own house, vehicle for transporting the produce, possessed new

borewell at low cost after the implementation of project and purchasing two-wheeler and four wheeler might be that because of assured irrigation, farmer started cultivating vegetables and other commercial crops along with dairy which results in increased income and employment generation to the family may leads to food, nutritional and economic security which are the basic needs of human beings. Once the basic needs are fulfilled people wants recognition in the society in terms of possessing a new house, new mobiles, machineries and implements for carrying out the farm activities and two wheeler/ four wheelers vehicles. Hence, this trend was seen among the farmers.

**Conclusion**

Majority of the farmers secured better livelihood in the K.C. Valley project area after the implementation of the project.

Combination of enterprises including vegetables, mulberry, livestock and other activities in the farming system helped them to increase their farm income and employment opportunities. However, they expressed that degree of risk involved is more in combination of enterprise. Hence, the adoption of risk efficient plan should be suggested to farmers which would help farmers to generate sustained income through diversification.

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