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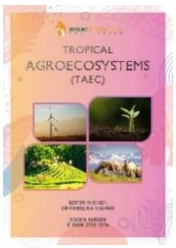

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RESEARCH ARTICLE

ASSESSMENT OF EFFECTIVENESS OF SHALLOW TUBEWELL IRRIGATION IN DHANUSHA DISTRICT, NEPAL

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ABSTRACT

A survey entitled "Assessment of effectiveness of Shallow tubewell irrigation in Dhanusha district" was carried to seek the status of Shallow tubewell irrigation and its effectiveness in agriculture. A total of 30 respondents were selected on the basis of simple random sampling method who uses shallow tubewell for irrigation. Major occupation of 77% of population of survey area was agriculture and about 73% of households were doing rainfed agriculture before installation of shallow tubewell. A total of 201.23 bigha of land was irrigated and 250 families were benefited from shallow tubewell irrigation. The area under cultivation and production of crops was also found to be increased after installation of shallow tubewell. The average annual production of cereals and vegetables after use of shallow tubewell was 6.01 ton and 1.08 ton respectively. The monoculture system of cropping was changed to multiple cropping system after installing shallow tubewell. Farmers now cultivated 1-5 types of crops before which 1-2 types before shallow tubewell irrigation. Rice, wheat and vegetables were cultivated in 1258 katha, 582 katha and 32 katha of land respectively before installing shallow tubewell but after installation cultivated in 1330 katha, 697 katha and 232 katha of land respectively. Similarly, productivity of rice. increased from 95.96 to 142.08 ton, wheat from 29.98 to 46.67 ton and vegetables from 7.52 to 27.9 ton after use of shallow tubewell irrigation. Poor supply of electricity was the major problem with the index value of 0.89 followed by canal problems.

KEYWORDS

Agriculture, Irrigation, Groundwater, Dhanusha, Shallow tubewells.

1. INTRODUCTION

1.1 Background information

Nepal is an agrarian country with 65% of total population involved in some sort of agricultural activities and contributing 27% GDP (MoAD, 2019). Nepal's poverty reduction strategy recognizes that agricultural growth is essential for growth and improving livelihood of people. Despite being the mainstream of national economy, agricultural growth hasn't been upto potential during recent time. The identified reasons for poor performance of agriculture are inadequate provision of irrigation, production inputs, credit, market and poor extension of advanced technology to support production growth (Agriculutre Prespective Plan, 1995). Among these factors, irrigation is key to accelerate, intensify and sustain agricultural growth (Sharma, 1994). Nepalese agriculture largely depends on monsoon rains from June to September, when 75% of annual rainfall occurs. Because of importance of agriculture to national economy, irrigation both small scale and large scale is essential. Therefore, regulated and controlled irrigation is critical for improving and sustaining agricultural productivity particularly during long dry seasons, also during dry spells in wet season which reduces crop yields.

Irrigation has traditionally consumed a large proportion of world's water. At the beginning of the century, 90% of water use in world was for irrigation. By 1960, it was about 60% (Biswas & A.K., 1993). Accounting to high water use (Wallingford & H.R, 1997) pointed that irrigated agriculture produced 40% food and agriculture commodities from 17% agriculture land. This makes food security critically dependent on irrigation. The dependence is more critical in Asia where 60% of agricultural commodities come from irrigated land. Furthermore, necessity of irrigation in Nepalese agriculture cannot be neglected as it plays pivotal role in sustaining food security in the country.

Irrigation has been major factor governing the increment in agricultural productivity. The possibility of expanding the agricultural areas being minimal due to increasing population growth, only way for improvement is introduction of modern farming systems with provision of adequate irrigation and their effective management. In Nepal, Farmer Managed Irrigation System occupy special status in national economy and food security system. Out of irrigated system, 70% fall under FMIS. Out of 2.7 million hectares of agricultural land in Nepal, only 1.3 Mha have irrigation facilities and majority of irrigation systems are small and medium scale (Pradhan, Prachanda, Parajuli, Khanal, & Chandra, 2017). About 1.7

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million ha of Nepal's cultivated land is irrigable, of which about 75% has been provided with some irrigation infrastructures and about two third of which, in turn, is actually irrigated during monsoon season (CERD, 2007).

Nepal is second most rich country in terms of water resources. There is huge potential of ground water utilization for irrigation. But only a fraction of ground water potential is being utilized for irrigation. Groundwater irrigation can be way of solving the problem of irrigation in Nepal. In recent time, GoN focuses on groundwater irrigation with mean of STWs and DTWs in terai region of country where longer period of drought occurs. As these tube wells are cheaper and easier in handling, they are widely used for irrigation in agricultural lands by famers of terai.

1.2 Problem Statement

Dhanusha is one of the leading district in agricultural production. Irrigation plays a major role in increasing productivity and sustaining food security. Despite the fact majority of farmers of the district are involved in agriculture, the productivity is below average due to lack of proper irrigation facilities. The farmers of this region has to depend on rainfall during period of drought and they are not acquainted with timely irrigation facilities. Farmers have limited access to irrigation sources and even if managed, irrigation water is not available at time of crops requirements ultimately reducing yield. With aim of providing irrigation facilities to farmers, government sector of this district focuses on ground water irrigation by granting STWs. Still the problem of irrigation in this region is deep rooted. The major problems associated with less adoption of STWs is due to lack of electricity facility. Farmers have to use generator instead of electric motor for withdrawal of water which operates on diesel increasing the cost of irrigation. The absence of reliable supplies of both diesel and electricity for STW irrigation has become a real problem that has substantially constrained investments and hurt crop performance, particularly when STW pumps cannot operate due to blackouts or fuel shortages at critical stages of crop production. Due to lack of technicians in remote areas of the district, the problem of repair and maintenance is matter of concern for farmers. Farmers are also unaware about the groundwater utilization for irrigation. Also, the lack of proper canal system hinders in proper water management from the tube wells. Hence, the agricultural production and productivity of the region has been explored to potential due to lack of irrigation.

1.3 Rationale of Statement

Dhanusha district is selected as rice zone under PMAMP site with a view to increase production and productivity and self-sustained the demand of rice in the district. So, irrigation plays vital role in increasing rice production in the district. Water scarcity and high cost of surface irrigation have encouraged the exploitation of groundwater for irrigation to enhance crop productivity, increasing cropping intensity and ultimately raise the income of farming households and enable them to attain high living standards. Still the farmers of this region are unaware about groundwater utilization for irrigation. Therefore, through this proposed study, attempt will be made to find out the effectiveness of STWs for irrigation. An assessment will be done to find out which tube well will be effective and cheaper for farmer by means of collection and interpretation of data. The success of this study will be helpful for farmers of this region as they can be acquainted with timely irrigation by means of tube wells. For the farmers of this region, due to good aquifers in many locations, STWs will be attractive option in absence of surface irrigation schemes and also due to high cost of DTWs. So, the study will help farmers in choosing effective tube wells for irrigation. Also, the findings will be significant for researchers, training personnel, extension workers in solving the problem related to groundwater irrigation and help to uplift production and productivity of this region.

1.4 Objectives

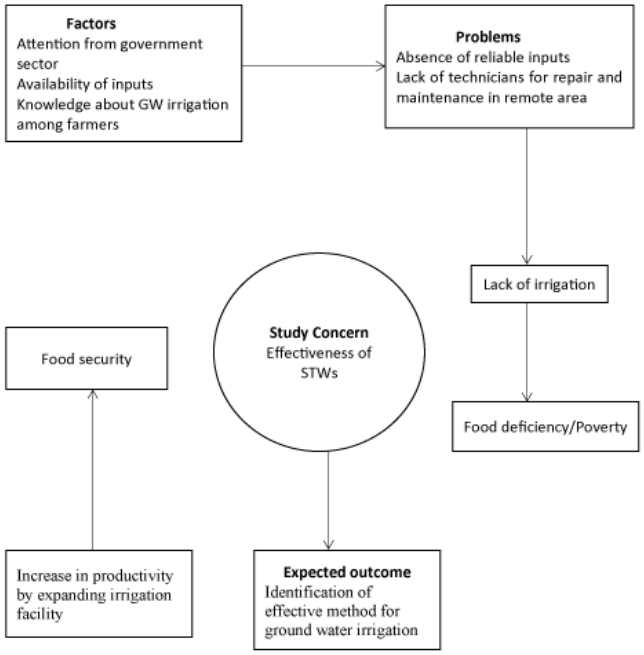
1.4.1 General Objectives

- To find out the effectiveness of STWs used for groundwater irrigation.

1.4.2 Specific Objectives

- To find out irrigation status and problems associated with STW irrigation of this region.
- To compare yield difference of crops before and after the use of STWs.
- To evaluate the economic and non-economic impacts on farmer's households from STWs.

2. CONCEPTUAL FRAMEWORK



3. METHODOLOGY

3.1 Lee site and sub-sector

Dhanusha district is located between latitude 25° 35'to 27°50' due North and longitude 85° 50' to 86° 20' due East with an elevation of 74 masl. Different area such as Shahidnagar, Hanspur, Mithila Bihari, Kanakpatti, Laxminiya, Aurahi, Bidhya, Bagchouda and Bateshwor were selected as research site. As this district is selected as rice zone under PMAMP site, most part of areas had irrigation facilities. The sources of irrigation in this district are are kamala irrigation ha project, first irrigation ha project, second irrigation ha project and many other sub irrigation projects. As farmers were well acquainted with irrigation, it was immense support for my research.

Figure 1: Map of Dhanusha depicting site of study and research area

3.2 Sample and sampling technique

Sample was selected from different households which had used STWs for groundwater irrigation. A total of 30 samples were taken on simple random sampling technique and data was collected from each sample.

3.3 Research Instruments

3.3.1 Household survey

Household survey was conducted by face to face technique using semi structured pre tested interview schedule. A set of question seeking status of STWs and their effectiveness was asked to the respondents. A total of 30 farmers using tube wells were interviewed for data collection.

3.3.1.1 Questionnaire Design

Co-ordination schema was used for purpose of designing questionnaire. Simple model of questionnaire was developed including the information on socio-economic condition of target group, status of irrigation, uses and effectiveness of STWs, problem related to tube wells and yield difference before and after the use of tube wells.

3.3.1.2 Preliminary study / pretesting

A preliminary study was done in order to gather information of the site and check the reliability and validity of interview schedule which helped in preparing final questionnaire taking the consideration of suggestion obtained during pretesting to make it more effective.

3.3.2 Key informant survey

To develop further idea of study site, informal discussion and an interview with key informants was carried out including local stakeholders, lead farmers and extension workers. These key informants were interviewed using an interview checklist. The information obtained from key informant interview was useful in verifying the information obtained through household survey.

3.3.3 Direct observation

Direct observation was carried out around the study site for additional information and field verification.

3.4 Data and data types

3.4.1 Primary data

Primary data was collected from framers and other concerned persons through household surveys and key informant interview.

3.4.2 Secondary data

Secondary data were collected from the detail review of literature on subject matter, various published and unpublished sources of data, journal article, reports of DADO, NARC, INGOs, NGOs, book related to subject matter will be consulted.

3.5 Data analysis technique

All the information collected from HHs survey, key informant survey and other sources was refined before analysis and then coded and entered in computer. Data entry was done using software packages namely SPSS and MS-excel. The data was analyzed by using descriptive statistics, mean comparison, frequency distribution, trend analysis, correlation analysis, regression analysis etc. whenever appropriate. The findings were represented and demonstrated by using tables, figures, bar-diagram, pie-charts etc.

4. Results and Discussion

The results obtained through the data analysis throughout the survey period are involved in this section.

4.1 Socio-demographic study

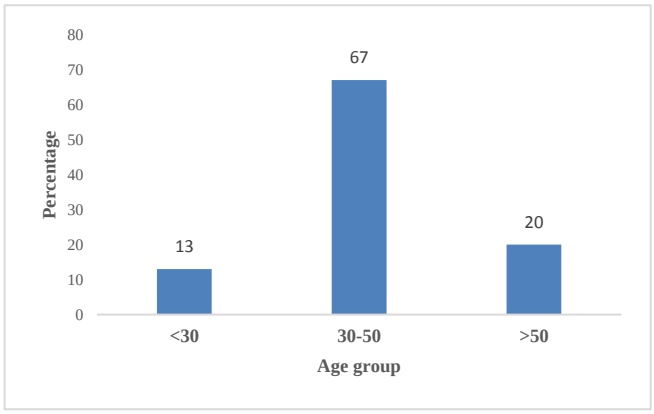
4.1.1 Age of respondents

In this study, out of 30 respondents, majority of people were between 30-50 years i.e 20(67%) followed by age groups below above 50 i.e 6(20%) and minority were below 30 years of age i.e 4(13%) as shown in table below:

Table 1: Distribution of respondents by age group

Age group	Frequency	Percent
below 30	4	13
30-50	20	67
above 50	6	20

The information is depicted in the bar diagram below:



Source: Field Survey, 2020

Figure 2: Respondents distribution by age

4.1.2 Gender of respondents

Most of respondents surveyed were male i.e. 24(80%) and only 6 (20%) were female. The details are shown below on table 2.

Table 2: Gender of respondents

Gender	Frequency	Percent
Male	24	80
female	6	20
Total	30	100

Source: Field Survey, 2020

4.1.3 Education of respondents

A total of 5 categories were made to determine the education level of the respondents. The detailed information is described in table and diagram below:

Table 3: Education level of respondents

Education	Frequency	Percent
Illiterate	2	7
Literate	3	10
primary level education	4	13
SLC	12	40
Higher secondary education	9	30
Total	30	100

Source: Field Survey, 2020

Among the 30 respondents, 2(7%) of them were illiterate, 3(10%) of them knew how to read and write, 4(13%) of them had education level upto primary level, 12(40%) had passed the SLC level and 9(30%) of them had pursued the higher education.

4.1.4 Population distribution of sampled household by gender

The survey was carried out on 30 respondents and population distribution of sampled household by gender is described in table below:

Table 4: Population distribution of sampled household by gender

Description	Mean	Minimum	Maximum	Sum
No. of male	3.73	2	11	112(55.72%)
No. of female	2.96	1	7	89(44.28%)
Family size	6.7	4	17	201

Source: Field Survey, 2020

The total population of entire household sampled was found to be 201 out of which 112(55.72%) were male and 89(44.28%) were female. The average family size was found to be 6.7 and the average number of male and female were found to be 3.73 and 2.96 respectively. The total number of family member ranged from 4 to 17 and that of male ranged from 2 to 11 and female ranged from 1 to 7.

4.1.5 Source of income

The sources of income were divided into 6 categories. Agriculture was the main source of income in most of the households i.e. 23 (77%). Besides agriculture, 2 (6.5%) household government job was main sources, 3(10%) household had income sources from foreign employment and 2(6.5%) households have their source of income undescribed. None of the households in survey area were found to have income sources from labour and non-governmental job. The detail information is shown in the table below:

Table 5: Source of income

Source of income	Frequency	Percent
Agriculture	23	77
Government job	2	7
Foreign employment	3	10
Labour	0	0
Non-governmental job	0	0
Others	2	7
Total	30	100

Source: Field Survey, 2020

4.1.6 Members involved in agriculture

As agriculture being main source of income, most of member from family were found to involved in agriculture. The detailed information is described in table below.

Table 6: Member involved in agriculture

Description	Mean	Minimum	Maximum	Sum
Member involved in agriculture	2.72	2	6	79

Source: Field Survey, 2020

The total number of member involved in agriculture was found to be 79. The average number of member involved in agriculture was found to be 2.72 and ranged from 2 to 6.

4.2 Land holding of respondents

Out of 30 respondents, all of them had their own land for cultivation. The detailed information of land holding of respondents are described in table below:

Table 7: Land holding of respondents(bigha)

Description	Mean	Minimum	Maximum	Sum
Total land	2.66	0.5	8	79.7
Land taken on lease	3.33	0.35	10	13.35
Land given on rent				
Cultivated land	2.43	0.85	8	70.6
Barren land	0.42	0	0.5	9.1
Irrigated land	2.12	0.5	7.5	66.65
Unirrigated land	0.6	0	2.25	13.05
Land registered on female's name	0.89	0	3	26.88

Source: Field Survey, 2020

The total land holding of respondents in survey area was found to be 79.7 bigha out of 70.6 bigha of land was used for cultivation and 9.1 bigha of land is remained as barren. Most of the farmers had good sources of irrigation. The irrigated land of entire household was found to be 66.65 bigha and 13.05 bigha of land are unirrigated as the land was swept away by flood.

Some of the household (4) had taken land on leased i.e.13.35 bigha for cultivation. The average total land of a single household was found to be 2.66 bigha, cultivated land was 2.43 bigha, barren land was 0.42 bigha, irrigated land was 2.12 bigha, unirrigated land was o.6 bigha and land taken on lease was 3.33 bigha. The total land of household ranged from 0.5 to 8 bigha, cultivated land ranged from o.85 to8 bigha, barren land ranged from 0 to 0.5, irrigated land from 0.5 to 7.5 bigha, un irrigated land from 0 to 2.25 bigha and land taken on leased from 0.35 to 10 bigha. In a patriarchal society like ours, some of the household have the land registered on female's name. The total land on female's name was 26.88 bigha and on average 0.89 bigha and ranged from 0 to 3 bigha.

4.3 Agricultural activities

4.3.1 Crops cultivated

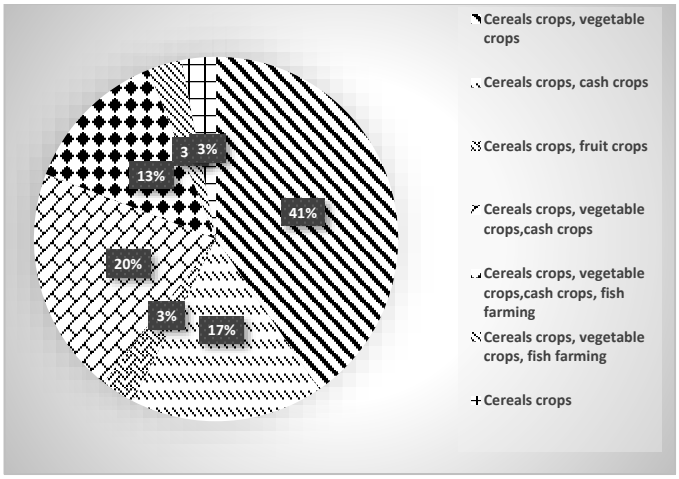
As terai is considered as grainary of a country, all of the household in survey area were involved in some sort of agricultural activities. Cereal crops along with some vegetables were grown in almost all of the households. Among the cereal crops, rice and wheat were given top priority by farmers. Due to lack of technical guidelines to farmers, they still follow the traditional way of crops cultivation in survey area. The detailed information of crops cultivation is shown in table below:

Table 8: Crops cultivated by households

Crops Cultivated	Frequency	Percent
Cereal crops, vegetable crops	12	41
Cereal crops, cash crops	5	17
Cereals crops, fruit crops	1	3
Cereals crops, vegetable crops, cash crops	6	20
Cereals crops, vegetable crops, cash crops, fish farming	4	13
Cereals crops, vegetable crops, fish farming	1	3
Cereals crops	1	3
Total	30	100

Source: Field Survey, 2020

Out of 30 households, 12(40%) of them cultivated cereals and vegetables crops, 5(17%) of them cultivated cereals and cash crops, 1(3%) of them cultivated cereals and fruits crops, 6 (20%) of them cultivated cereals, vegetable and cash crops, 4(13%) of them cultivated cereals, vegetables and fruits crops and fish farming, 1(3%) of them cultivated cereals and vegetable crops and engaged in fish farming. Only 1(3%) of the household cultivated cereals crops. As we can see, Cereal crops is inevitable in all of the households. The information is depicted in pie chart below:



Source: Field Survey, 2020

Figure 5: Crops cultivated by households

4.3.2 Annual production of crops

The total annual production of crops of 30 households was found to be 207.86 tonnes out of which 180.7 tonnes was cereals crops and 27.16 tonnes was vegetable crops. The production of vegetables is much lesser as compared to cereals crops as vegetables are cultivated in much lesser land and only few households are engaged in vegetable cultivation. The average annual production of cereals crops of a single household was 6.01 ton and that of vegetables crops was 1.08 ton. The annual production of cereals crops ranged from 1.8 to 11.2 ton and vegetables ranged from 0.2 to 6 ton. The information is shown in table below:

Table 9: Annual production of crops(ton)					
Annual Production	Mean	S.D	Minimum	Maximum	Sum
Cereals crops	6.01	2.55	1.8	11.2	180.7
Vegetables crops	1.08	1.19	0.2	6	27.16
Total					207.86

Source: Field Survey, 2020

4.3.3 Sales of crops

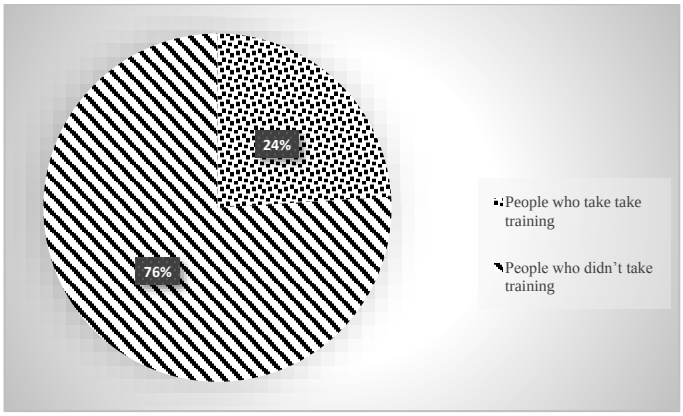
Out of 30 respondents, 25(83%) of them sold their surplus crops in local and urban market while 5(17%) of them did not sell their produced crops. The total amount from sale of crops was Rs18,35,000 and on an average single household sold crops of Rs73,400. The amount from sales of crops ranged from Rs15,000 to 1,70,000.

Table 10: Amount of sales of crops				
Description	Mean	Minimum	Maximum	Sum
Amount(Rs)	73,400	15,000	1,70,000	18,35,000

Source: Field Survey, 2020

4.3.4 Agriculture related training

Out of 30 respondents, 23(76%) of them didn't take any kind of the training. Only 7(24%) of the respondents had taken training related to agriculture. The information is depicted on diagram below:



Source: Field Survey, 2020

Figure 6: Pie chart showing respondents responses to agriculture relating training

The subjects of training were pesticides training, training on nursery raising of vegetables and mushroom, identification and management of insect and pest of rice, goat farming, training about shed management, parasite management and fish farming and fruit cultivation training. Mostly government organization and some agro vets and farms provided these training to the farmers.

4.3.5 Use of pesticides

Out of 30 respondents, 29(96.67%) of them use pesticides for insect and pest control in their farms while only 1(3.33%) of them did not use chemical pesticides rather uses organic pesticides for insect and pest management. The respondents used pesticide on both cereals and vegetables crops. Out of 29 respondents who used pesticides, 26 of them used pesticides on both cereals and vegetables, 2 of them used only on cereals crops and 1 of them on vegetable crops. The detailed information is shown in table below:

Table 11: Crops on which pesticides is used		
Crops	Household count	Percent
Cereals	2	7
Vegetables	1	3
Both	26	90
Total	29	100

Source: Field Survey, 2020

4.4 Information of shallow tubewells

From the household survey of respondents, it was found that shallow tubewells was main source of irrigation in survey areas. The detailed information is shown in the table below:

Table 12: Information of STW				
Description	Average	Minimum land	Maximum Land	Total
Number of families benefited	8.33	2	20	250
Total area irrigated(bigha)	6.7	1.9	12	201.23
Own area irrigated(bigha)	2.05	0.5	9	61.63

Source: Field Survey, 2020

A total of 250 families in survey area were benefited from shallow tubewells. The average number of family benefited from a single shallow tubewell was found to be 8.33 and ranged from 2 to 20. A total of 201.23 bigha of land is irrigated from tubewells in survey area. Out of that, 61.63 bigha of land irrigated belongs to respondents. The average area irrigated from a single tubewell was 6.7 bigha and ranged from 1.9 to 12 bigha of land. Cereals, vegetable and cash crops were mostly irrigated by these tubewells. Some respondents also used tubewells for fish farming.

Out of 30 respondents, 4(14%) of them take irrigation training and 26(86%) of them hadn't take any kind of training related to irrigation.

4.5 Impact of Shallow tubewell

4.5.1 Source of irrigation before STW

From the household survey and key informant interview, it was found that rainfall was the major source of irrigation before installing STW. Majority of the households had been doing rainfed agriculture. Out of 30 households, 22(73.33%) of them depend on rainfall for irrigation, 7(23.33%) of them irrigate their field from temporary canals while 1(3.34%) of them had other source of irrigation. The information is shown in table below:

Table 13: Source of irrigation before STW		
Source of irrigation	Household count	Percent
Rainfall	22	73.33
Temporary canals	7	23.33
Others	1	3.34
Total	30	100

Source: Field Survey, 2020

4.5.2 Differences in agriculture activities

Respondents in survey area were doing monoculture before installing STW. But now they were gradually shifting to multiple cropping system after installing STW as irrigation is available all year round. Before STW, 23(77%) of the respondents cultivated only 1 type of crops in their field while 7(23%) of them cultivated 2 types of crops. But after installing the tubewells, 6(20%) of the respondents cultivated 1 type of crops, 20(67%) of them cultivated 2 types of crops, 3(10%) of them cultivated 3 types of crops and 1 of them cultivated 5 types of crops. The information is shown in the table below:

Table 14: No of types of crop grown			
No of crops grown			
Before STW	Household number	After STW	Household number
1	23(77)	1	6(20)
2	7(23)	2	20(67)
		3	3(10)
		5	1(3)

Note: Figure in parenthesis represents percentage

Source: Field Survey, 2020

Before installing shallow tubewells, respondents mostly used to cultivate cereal and vegetable crops. Among the cereal and vegetable crops, rice, wheat and potato were mostly cultivated by them. But after the installing STW, cereals, vegetables, pulses and grasses were cultivated by farmers. It

was also found that respondents started cultivating the marginal land which used to be barren due to lack of irrigation. The detailed information of showing the differences before and after installing shallow tubewells are shown below:

Table 15: Crops cultivation with their area, production, household uses and sales before installing STW

Crops cultivated	Household count		Area(katha)	Production (ton)	Household uses(%)	Sales (%)
Rice	30	Average	41.93	3.19	85	25
		Minimum	11	0.6	25	0
		Maximum	100	6.4	100	75
		Total	1258	95.96		
Wheat	28	Average	20.78	1.06	76	24.21
		Minimum	5	0.15	35	0
		Maximum	60	3.2	100	65
		Total	582	29.83		
Vegetables	6	Average	5.33	1.05	48	52
		Minimum	1	0.1	10	0
		Maximum	10	4	100	90
		Total	32	7.52		

Source: Field Survey, 2020

Table 16: Crops cultivated with their area, production, household uses and sales after installing STW

Crops cultivated	Household count		Area(katha)	Production (ton)	Household uses(%)	Sales (%)
Rice	30	Average	44.33	4.7	70	30.3
		Minimum	12	1.36	30	0
		Maximum	100	8	100	70
		Total	1330	142.08		
Wheat	29	Average	24.03	1.6	66.48	34
		Minimum	5	0.2	35	0
		Maximum	60	4	100	65
		Total	697	46.67		
Vegetables	19	Average	10.63	1.24	51	55
		Minimum	1	0.3	10	30
		Maximum	30	6	100	90
		Total	202	24.9		
Grass	1	Average	1	0.42	100	0
		Minimum				
		Maximum				
		Total	1	0.42		
Pulses	5	Average	12.6	0.45	84	16
		Minimum	5	0.04	20	0
		Maximum	40	2	100	20
		Total	63	2.25		

Source: Field Survey, 2020

From the household survey, the major differences in the agricultural activities of respondents before and after installing the STW were identified. Before installing the STW, Rice was cultivated in 1258 katha, wheat in 582 katha and vegetables in 32 katha of the land in entire survey area. After the installation, area coverage of the crops was increased. Rice was cultivated in 1330 katha, wheat in 697 katha, vegetables in 202 katha of land, pulses in 63 katha and grass in 1 katha of land by respondents. The average land for cultivating rice, wheat and vegetables were 41.93 katha, 20.78 katha, 5.33 katha respectively before installing STW. After the installation, the land coverage of for cultivating crops also increased. The average land occupied by rice, wheat, vegetables, pulses and grass were 44.33 katha, 24.03 katha, 10.93 katha, 1 katha, 12.6 katha respectively. The minimum and maximum land cultivated before installing STW for rice, wheat and vegetables were 11-100 katha, 5-60 katha, 1-10 katha respectively. The minimum and maximum land cultivated after installation for rice, wheat, vegetables and pulses were 12-100 katha, 5-60 katha, 1-30 katha and 5-40 katha respectively. There were major differences in production before and after installing STW. The total production of rice, wheat and vegetables before installation was 95.96 ton, 29.83 ton and 7.52 ton respectively. The production of the crops was increased after installation as crops can get timely irrigation and increased in area under cultivation. The total production of rice, wheat, vegetables, pulses and grass was found to be 142.08 ton, 46.67 ton, 24.9 ton, 2.25 ton and 0.42 ton respectively. The average production of rice of single respondents was found to be 3.19 ton and ranged from 0.6 – 6.4 ton, 1.06 ton and ranged from 0.15-3.2 ton of wheat and average production of vegetable was 1.05 ton and ranged from 0.1-4 ton before installing STW. After the installation, the average production of rice, wheat, vegetables and pulses of respondents was found to be 4.7 ton, 1.6 ton, 1.24 ton and 0.45 ton respectively and production ranged from 1.36-8 ton, 0.2-4 ton, 0.3-6 ton, 0.04-2 ton respectively. On an average, 85% of produced rice, 76% of produced wheat and 48% of produced vegetable was used for household consumption and 25% of rice, 24.21% of wheat and 52% of vegetables was sold in local and urban market before installing STW. After the installation, on average 70% of produced rice, 66.48% of produced wheat, 51% of produced vegetables, 100% of grass and 84% of produced pulses were used for household consumption and 30.3% of produced rice, 33% of produced wheat, 55% of produced vegetables and 16% of produced pulses were sold in market.

4.6 Economic aspect of STW

4.6.1 Cost of installation

Most of the respondents installed STW which is given on subsidy by small irrigation department of Dhanusha district. About 60-70% of the cost of installation was provided by the department and also electric motor was given to the respondents by them. The detail of information is given in table below:

Table 17: Cost of installation of STW

Description	Average cost(Rs)	Minimum cost(Rs)	Maximum cost(Rs)
Cost of installation	22,334	8000	50000

Source: Field Survey, 2020

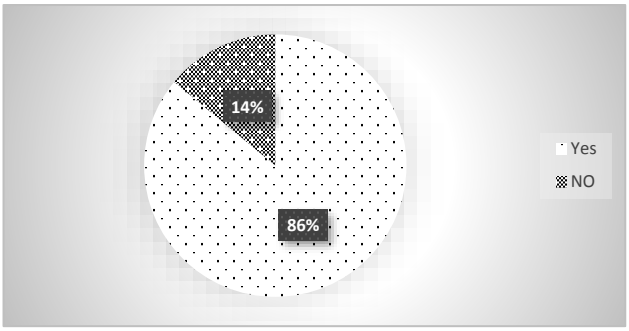
The average cost of installation shallow tubewell was Rs22,334 and minimum and maximum cost was Rs8,000 and Rs50,000 respectively.

4.6.2 Cost of maintenance

From the survey it was found that STW hadn't been damaged since it was installed a year ago so there was no cost incurred in maintenance.

4.6.2 Availability of local technicians

Out of 30 respondents, 26(86%) of them responded that local technicians are available for repair and maintenance of STW and 4(14%) of responded on not having the local technicians for repair and maintenance. The information is depicted in diagram below:



Source: Field Survey, 2020

Figure 7: Availability of local technicians

4.6.3 Places of parts availability

From the survey, it was found that for repair and maintenance respondents mainly bought the parts from local and urban market. Out of 30 respondents 12(40%) of them preferred local market while 18(60%) of them preferred urban market.

4.7 Problems while operating STW

From the household survey, KII five categories of problems were identified. They were problems of electricity, canals, installing and repairing problems, decrease in water level and destruction to cultivable land.

The problems while operating STW were ranked on the basis of rank provided by respondents and problem of electricity was found to be top most problems with the index value of 0.89 and destruction to cultivable land was bottom ranked problem with the index value of 0.34. The problems are ranked in table below:

Table 18: Problems while operating STW

	Intensity of scores								
Problems	1	0.8	0.6	0.4	0.2	Total	Weight	Index	Rank
Electricity	22	3	2	3	0	30	26.8	0.89	I
Canals	13	6	5	4	3	30	23	0.76	II
Installing and repairing	8	5	7	4	6	30	19	0.63	III
Decrease in water level	5	8	4	10	3	30	18.4	0.61	IV
Destruction to cultivable land	0	0	8	5	17	30	10.2	0.34	V

Source: Field Survey, 2020

The problems were ranked from I to V on the basis of ranking given by respondents. Each problem was given scores from 1 to 0.2 based on information provided by respondents. The scores were then multiplied with the total frequency and added to obtained the weight-age of each problem. The weight-age value of each problem is then multiplied with total number of respondents to obtain the index value. Then each problem is ranked on basis of this index value.

5. Conclusion

On the basis of finding and their logical interpretation, followings points can be concluded from research survey:

- Poor supply of electricity was the major problem faced by farmers while operating the STW.
- Rice, wheat, vegetables and pulses were major agricultural crops cultivated by farmers after installation of shallow tubewell.
- Shallow tubewell has been effective in increasing the production of crops and land under cultivation due to timely irrigation.
- Barren lands are being converted into cultivable are after installation of STW. The no of crops grown in single area had been increased form 1-2 to 1-5 after using STW.
- The yields of crops were found to be increased significantly and the sales of crops was increased and income of family was uplifted after using STW.

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