A Techno-Economic Assessment Solar Energy Application in Agriculture: (A Case study of Nashik District)

Submitted to

M.V.P. Samaj's KRT Arts, BH Commerce and AM Science (KTHM) College, Nashik.

Submitted by

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[MA Part II: Economics]

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Certificate

I certify that the work incorporated in the thesis of **A Techno-Economic Assessment of Solar Energy application in Agriculture (A Case study of Nashik District)** Submitted by **Mr.Patil Prathamesh Padmakar** was carried out by the candidate under my supervision/guidance. To the best of my knowledge: (i) the candidate has not submitted the same research work to any other institution for any degree/diploma, Associate ship, Fellowship or other similar titles (ii) the thesis submitted is a record of original research work done by the Research Scholar during the period of study under my supervision, and (iii) the thesis represents independent research work on the part of the Research Scholar.

Place: Nashik

Date: 30 /06 /2022

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Declaration

I declare that the thesis entitled **A Techno-Economic Assessment Solar Energy Application in Agriculture: A Case study of Nashik District** submitted by me for the degree of **Master of Arts in Economics** is the record of research work carried out by me under the supervision of **Assist. Prof. Dr. A.S.Kapadi** (Department Of Economics) and this has not formed the basis for the award of any degree, diploma, associate ship, and fellowship, titles in this or any other University or other institution of higher learning. I further declare that the material obtained from other sources has been duly acknowledged in the thesis.

Place: Nashik

Date: 30 /06 /2022

Research Student

Mr.Patil Prathamesh Padmakar

Acknowledgement

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Research Student

Mr. Patil Prathamesh Padmakar

INDEX

INDEX OF FIGURES

INDEX OF TABLES

CHAPTER 1

RESEARCH METHODOLOGY

1.1 INTRODUCTION

India has a large geographical landmass with the 7th largest country in the world. It has also led to the fastest-growing population country in the world keeping China behind. With the growing population, a large number of people are suffering a shortage of electrical energy in their day to day life as well as in industrial, agriculture sectors. Electricity is being a very important aspect of any sector of our country. Talking specifically about the agricultural sector, even today the electric supply is given at night or in the early morning between 2 to 4 AM. This is a very unfortunate thing that even being the leading country in the world and having a huge geographic dividend, we are lacking in energy resources. So in this research project, we are specifically going to talk about solar energy as the main source for individuals and as well as for industrial and agricultural use.

India has a surplus power generation capacity but lacks adequate transmission and distribution infrastructure. India's electricity sector is dominated by fossil fuels, in particular coal, which during the 2018-19 fiscal year produced about three-quarters of the country's electricity. The government is making efforts to increase investment in renewable energy. The government's National Electricity Plan of 2018 states that the country does not need more nonrenewable power plants in the utility sector until 2027, with the commissioning of 50,025 MW coal-based power plants under construction and the addition of 275,000 MW total renewable power capacity after the retirement of nearly 48,000 MW old coal-fired plants. It is expected that non-fossil fuels generation contribution is likely to be around 44.7% of the total gross electricity generation by the year 2029-30. (1)

The rural area of most of India suffers from heavy load shedding as electricity is supplied only for 7 to 8 hours. But sometimes in emergencies, it becomes hectic for

farmers. Agriculture is all about the time and climate-based sector. In this needy time, diesel pumps work as a substitute for the electric supply. But the cost of these diesel pumps vary from 5 to 20 thousand and this is not affordable to some farmers. (2) Diesel prices are also much hiked these days. So diesel pumps can be a substitute but not affordable.

1.2 SIGNIFICANCE OF RESEARCH

There is no denying the importance of solar energy. The return on investment of going solar is highly valuable, and not just financially, but for the sake of public health and environmental sustainability. The burning of fossil fuels leads to the release of harmful products into the environment. Carbon fuels such as wood, coal, petroleum release unburnt carbon particles in the environment. These particles are very dangerous pollutants and cause respiratory diseases for example asthma. When fuels are incompletely burnt, they release carbon monoxide gas into the atmosphere.

Solar is a safe alternative which can replace current fossil fuels like coal and gas for generation of electricity that produce air, water, and land pollution. World Wide Fund for Nature, also known as the World Wildlife Fund (WWF), notes that electricity generation from fossil fuels causes pollution of air leading to acid rain, damaged forest areas, and affected agricultural production leading to loss of billions of dollars worldwide.

The major Application of solar in rural, backward area helps to solve the problem of electricity which they are facing on regular basis. This research will helps to identify the integration of solar energy schemes, benefits, and awareness in rural areas.

1.3. RESEARCH QUESTION

1. does giving ample of government subsidies to installation of solar panels for agricultural use are really working and beneficial to beneficiaries?

1.4. OBJECTIVES OF RESEARCH

1. To do comparative study of diesel pump and solar water pump .

2. To study the government solar scheme benefit at grass root level in nashik district

1.5. HYPOTHESIS

1. Due to Government subsidies, the beneficiary count is rising day by day.
2. Because of the government subsidies ,private sector is not having that much scope In the solar panels field.

1.6. LIMITATIONS

1. Focus on agriculture use of solar panel instruments only
2. This research project is based on only particular tehsils named Chandwad ,Niphad, Baglan and Deola of Nashik district.

1.7. METHODOLOGY OF RESEARCH

Methodology of Research is like a framework of Research. In this part, Researcher covering all the aspects require for the field visit, Data collection, etc...Designing a Methodology of research guides the researcher to follow flow to study.

Does giving ample of government subsidies to installation of solar panels for agricultural use are really working and beneficial to beneficiaries?

Every year government launching number of Schemes for the welfare of society but the penetration of particular scheme at grass level is never evaluated. So through this study researcher going to work on grass root level implementation, difficulties of government Scheme

1.8. RESEARCH DESIGN

This study adopted the interview research design. Interviewing personally to the individual procedure used in obtaining the information from the target population with idea relevant to the objective of the study. The data for such study is not available so much online or offline mode. So the researcher want to collect data according to the research problem. The researcher needs to develop questions for the study according to the research problem. The interview design is one that studies targeted population by selecting and analyzing data collected from the individual through the use of questionnaire. The design is appropriate for this study as it tends to obtain data from individuals.

1.9. AREA AND POPULATION OF STUDY

According to the subject of study, the area or region selected for research should relevant to the subject. In this study, key point is solar energy. The researcher going to study area where the solar energy use concentrated. So the investigator, selected nashik district for the study. Therefore, in nashik district selected tehsil for study are Deola,Baglan,Chandwad and Niphad.

Solar panels totally work on sunlight. So while selecting the region for data collection researcher have to keep in mind this key point. Certainly draught prone area needs more solar panel working due to shortage of water. We can get clear sunlight in this kind of area. We are supposed to study in nashik district so we have four tehsils named, Niphad, Baglan ,Chandwad and Deola. These tehsils of nashik district experiences more water shortage and high temperature in summer comparing to other tehsils. Also these districts are highly dependent on monsoon for drinking as well as agriculture water use.

Geo Location of the interviewing individual are also get recorded at the time of data collection by using mobile application called “GPS MAP CAMERA”.

1.10. SAMPLE AND SAMPLING TECHNIQUE

- **SOURCES OF DATA**

1. Due to limited availability of online data and lack of desired information for study researcher decided to paid attention to primary data
2. The primary objective of the research is to analyze Techno-Economics Solar Energy Application for Agricultural with special reference to Nashik District. The primary data will be collected through a structured questionnaire. The method of collecting primary data from farmers is interview
3. This proposed research is based on primary as well as secondary data. The secondary data we obtain from internet sites

- **SAMPLING DESIGN**

1. Our population of study are the farmers who belongs to rural area in nashik district. In this researcher will studying on the farmers who has solar power.
2. According to need or location we will frame sampling method for taking samples of farmers who has solar power
3. Sample size
4. For collecting data sample size is 20 farmers of nashik district.

- **TOOLS FOR DATA ANALYSIS**

1. Tests and tools for data analysis we select on the basis of hypothesis i.e. it is qualitative or quantitative

1.11. DATA COLLECTION

Data Collection is the crucial part of any research project**.** Primary data collection is pivotal to the role of this case study as this offers insight into the characteristics of a region. The secondary data availability for this study is limited. The data used in this study has been collected by visiting individual farmer who have benefited with this scheme. Also those farmers who installed privately without government subsidy.

The primary objective of the PM KUSUM Scheme is to make cutting-edge technology available to our farmers and provide sources for de-dieselized irrigation to the agricultural sector. The main objectives of this scheme are:

1) The solar pumps assist our farmers in much more effective and eco-friendly irrigation as these are capable of generating safer energy.

2) In addition, the pump sets comprise an energy power grid that generates more energy than diesel driven pumps. Farmers will be able to sell the extra power to our Government directly to enhance their income.

.The following stages help us for data collection

FRAMING QUESTIONNAIRE FOR DATA COLLECTION. Framing Questionnaire is the first task of data collection. It should be done very carefully. Because the questions are helping to shape or cover all aspects require for case study. Researcher should followed the below aspects for framing questionnaire

1: Research aims and the goal of your questionnaire

2: Define Target Audience

3: Develop questions

4: Choose question type

5: Design question sequence and overall layout

6: Ready for Survey

1.12. REVIEW LITERATURE OF RESEARCH

Energy crisis in rural areas is frequent problem in rural area. A village is considered electrified if it possesses basic electrical infrastructure and 10% of its homes have access to power. However, nearly one-fifth of India's rural households (around 31 million) still remain in acute darkness (livemint May 2018 article).

As a nature of human, it tends to find solutions to problems, thus the scarcity in energy had been solved by the solution of having alternative energy resource coming from the sun to generate energy.

The application of solar energy is more beneficial to the rural areas where energy crisis faced by farmers on daily basis. The government schemes are playing key role to develop infrastructure in rural area. Such scheme government released in rural area for solar energy to the farmers known as ”PM KUSUM YOJANA". The earlier study on ground level of scheme is hardly available. With the reference of one project “SOLAR PHOTOVOLTAIC PUMPS FOR IRRIGATION IN MAHARASHTRA – APPROPRIATE SIZING"

Under the Centre for Technology Alternatives for Rural Areas (CTARA) researcher shows interest working on it. The purpose of this thesis was the comparative study of solar energy power generation with traditional fossil fuels energy generation.

The researcher shows interest working on it at ground level. So the researcher purpose to study the integration of solar energy in rural area along with implementation of government solar pump scheme.

CHAPTER 2

WHAT IS SOLAR?

2.1. WHAT IS SOLAR PUMP?

Solar pump definition is, as the name suggests the pump uses solar energy to function. Solar-pumps are robust, installation is simple, minimum maintenance is necessary and very expensive when we compare with normal water pumps. The life span of these pumps is a maximum of 20 years. But time to time the solar panels need to be cleaned for running. These kinds of pumps mainly used where there is an electricity problem otherwise consistent power supply is not accessible.

➢ SOLAR PUMP BLOCK DIAGRAM

The solar pump block diagram mainly includes a solar panel, water pump, electric motor, and controller. This pump is basically an electrical pump, and this pump uses the electricity which is received from the solar panels to work. These panels store the energy from the solar. The electric motor manages the alternating current or direct current. The controller used in this system adjusts the output power as well as speed.

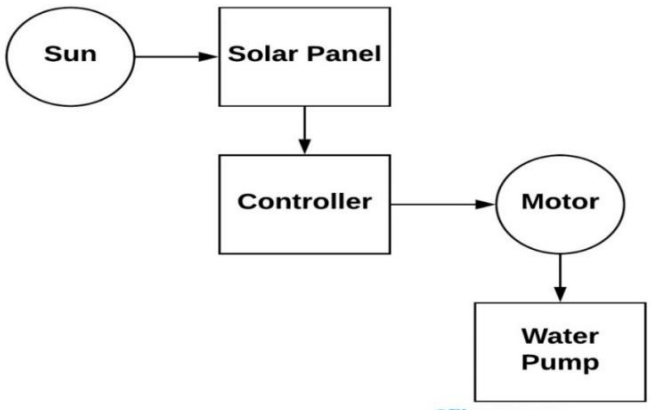


Figure 1 **SOLAR BLOCK DIAGRAM**

2.2. WORKING OF SOLAR PUMP

When the solar energy drops sun rays on the PV panels then the solar panel converts the rays into electrical energy with the help of Si wafers fixed within the PV panels. Then the solar energy supplies to the electrical motor to operate the pumping system using cables. By the revolution of the shaft which is fixed to the pump, then the pump begins to pick up the soil water and supplies to the fields.

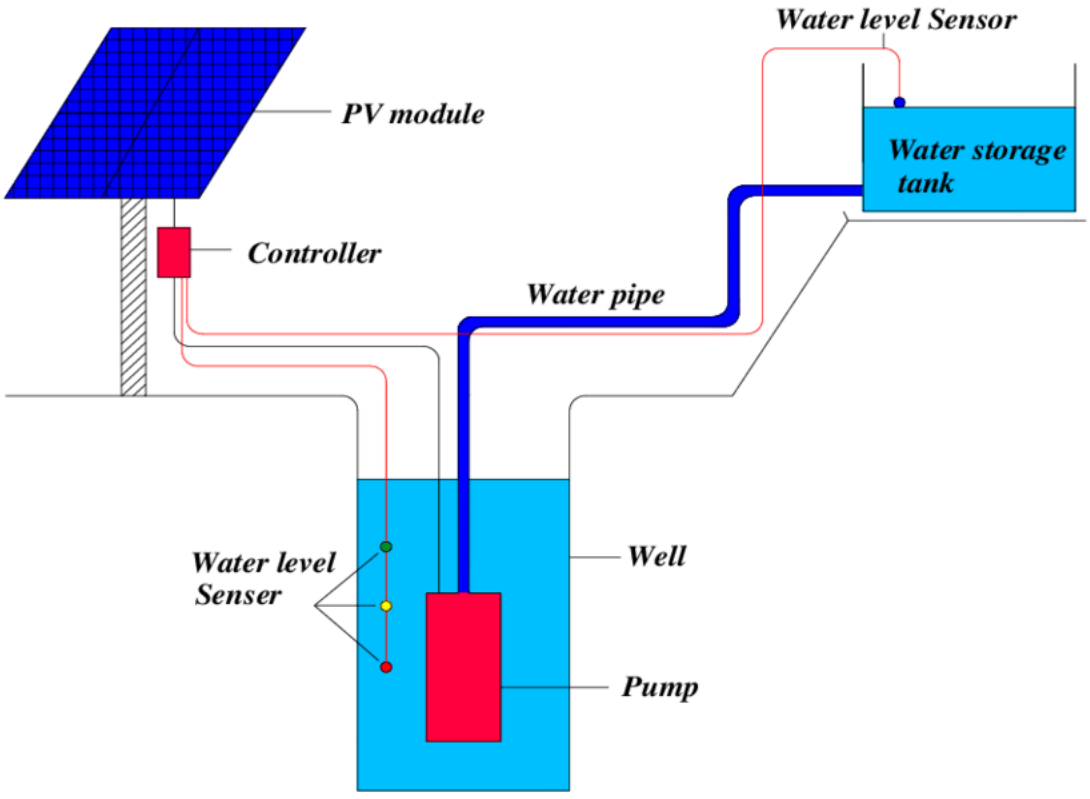


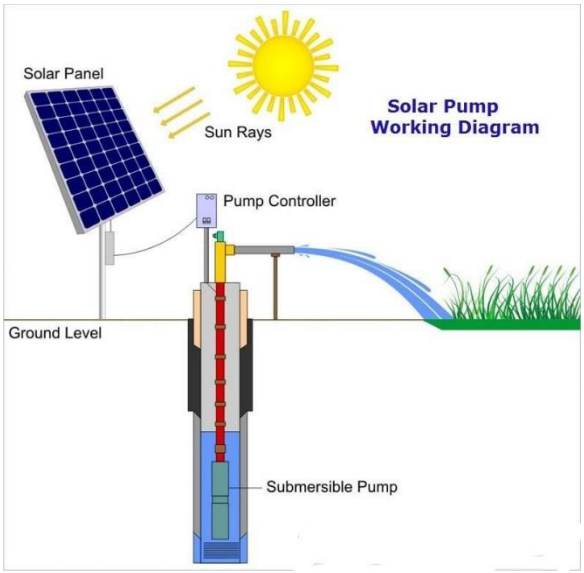
Figure 2 **FUNCTIONING OF SOLAR WATER PUMP**

2.3. SOLAR PUMP TYPES

The solar-pumps are classified into four types namely

1. submersible solar pumps
2. surface solar-pumps

2.4. CLASSIFICATION AND TYPES OF SOLAR PUMPS



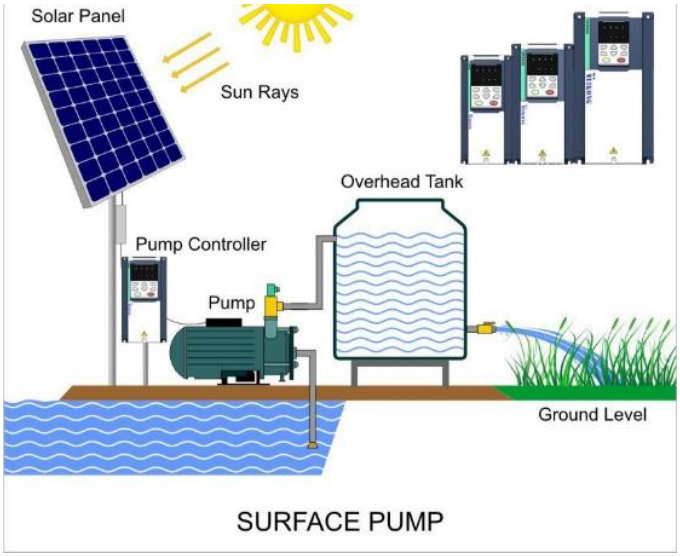


Figure 3 **TYPES OF SOLAR WATER PUMPS**

➢ DIFFERENCE BETWEEN SURFACE AND SUBMERSIBLE PUMPS

SURFACE PUMPS	SUBMERSILE PUMP
The surface pump used in the borehole is a simple centrifugal pump that suction in axial position and its discharge in the radial position. The surface pump is usually installed just on the ground surface of the borehole, a	Submersible pumps use in borehole applications have little difference from the normal submersible pumps used in industrial applications and other purposes. A submersible pump is a pump that can be submerged inside the water.
Winter storms can really affect the productivity and results of a surface pump because it is not below the freezing line, which can cause trapped water to expand inside the pump which could lead to several problems like freezing.	One huge thing is their efficiency; water pressure will naturally force water into a submerged pump rather than utilizing energy to do so.
Flash floods, wildlife, and thunderstorms can also be a great risk because surface mounted pumps are not as shielded from their surroundings, unlike submersible pumps.	Being submerged all the time, submersible pumps do not require manual priming, which can easily become a very time consuming chore.
Another disadvantage is the amount of energy surface pumps use; the water must first be moved up out of a water source by a suction force before it can actually reach the pump, this process requires a lot more power than an apparatus that already has the water	Surface mounted pumps are also known to be much louder, and since it is on the surface, it just looks out of place. If you plan on using a water pump near a home or just want to keep nature looking natural, opting for the submersible may be the option for you.

readily available	

Table No.1

All in all, the main aspect related to the efficiency of a solar water pump is based on three variables including pressure, flow and input power to the pump.

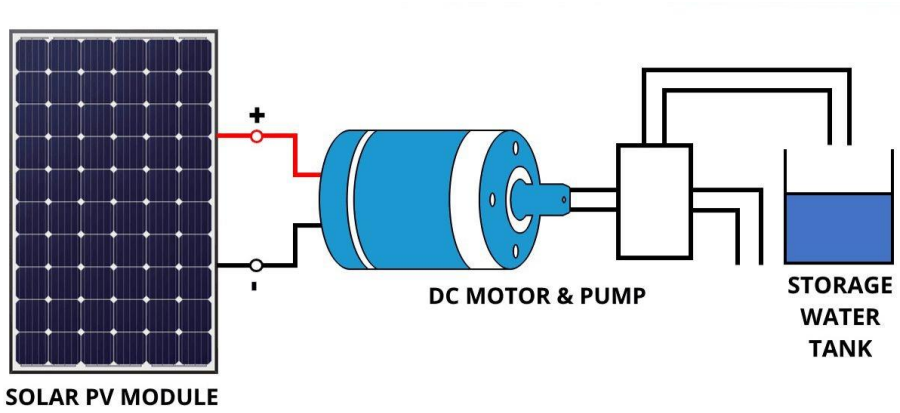


Figure 4 **DC POWERED PUMP**

Wire-to-water efficiency is the commonly used metric that determines the overall efficiency of a solar water pump (as the ratio between the hydraulic energy that comes out of the pipe and the energy coming over the electrical wires through solar panels).

➢ Why solar-powered water pumps are the ideal way to boost agriculture in remote areas?

A solar-powered water pump is a concept that is environmentally-friendly. More importantly, it is a concept that gets rid of any power grids or fossil fuels used to pump water out of the ground. Below, we are listing the advantages and disadvantages of their use.

➢ ADVANTAGES

- Low Operation costs since fuel is not needed and system run on sunlight
- No dependency on erratic or expensive fuel chain supply (avoid also the risk of fuel theft).
- Low regular maintenance requirements since solar panels and invertors have no moving parts.
- No pollution or noise produced.
- Extended lifetime (good quality solar panels are warrantied for 25yrs, investors typically 6-8 years).

➢ DISADVANTAGES

- Capital costs typically higher than equivalent diesel solutions. However systems prices are increasingly dropping
- Most of application need water storage typically larger than for equivalent diesel systems
- Risk of theft of panels, that are still seen as a valuable commodity in some locations
- System is dependent on solar radiation levels
- Typically spare parts and knowledgeable technicians are only available at capital level

2.5. OVERVIEW OF SOLAR SCHEMES

2.5.1. SCHEMES IN MAHARASHTRA

A. Mukhyamantri Solar Pump Yojana Maharashtra

1. The State Government of Maharashtra started a scheme to provide a Solar Irrigation Pump to the state farmers to promote solar energy, through this scheme the government is providing a 95% subsidy to farmers for setting up solar pumps.
2. India has been a pioneer in adoption of solar pumps at scale. The government has set a target of installation of 1.75 million solar agriculture pumps and solar systems for another 1 million grid connected pumps by 2022 under KUSUM program with up to 60% capital subsidy. Progress, however, is lagging with only 272,700 pumps installed by December 2020.
3. One of the major changes in the market is the way tenders are issued. Until about two years ago, most tenders were issued by state governments. Each tender had different technical specifications and size was typically small at less than 5,000 pumps.
4. The tenders attracted participation mainly from local players resulting in inconsistent implementation and quality standards.
5. Since the appointment of Energy Efficiency Services Limited (EESL) as a central nodal agency, akin to SECI for utility scale solar projects, the tendering process has become more streamlined.

- **Beneficiary contribution**

Category	Beneficiary Contribution for 3HP (Rupees)	Beneficiary Contribution for 5HP (Rupees)
Open	25500 (10%)	38500 (10%)
SC	12750(5%)	19250(5%)
ST	12750(5%)	19250(5%)

Table No.2

➢ Features of the Scheme

The features of the Mukhyamantri Saur Krushi Pump Yojana are as follows

1. Mukhyamantri Saur Krushi Pump Yojana aims to reach out farmers from remote areas where the agricultural feeder is not possible.
2. As per the scheme guidelines, the government will provide solar pumps at subsidized rates for the farmers.
3. Under the scheme, 3HP or 5HP solar pumps would be installed along with the lighting system comprising of 2 LED bulbs, 1 USB port for mobile charging and socket for battery charging.
4. The Government has targeted deployment of 1 lakh Off-Grid Solar-powered Ag pumps in phase manner.
5. Under the scheme, the farmers with less than 5 acres will get subsidy at the rate of 95% of the total cost of 3 HP solar pump while farmers with more than 5 acres will be provided with 5 HP solar pump for Rs.30, 000.

Figure 5

Such type of advertising is done by the Government in the different cities.

(Photo taken at Malegaon stand, Nashik City, MH)

- **Component-A for Setting up of 10,000 MW of Decentralized Grid Connected Renewable Energy Power Plants on barren land:**

Under this component, renewable energy based power plants (REPP) of capacity 500 kW to 2 MW will be setup by individual farmers/ group of farmers/ cooperatives/ panchayats/ Farmer Producer Organizations (FPO)/Water User associations (WUA) on barren/fallow land. These power plants can also be installed on cultivable land on stilts where crops can also be grown below the solar panels. The renewable energy power project will be installed within five km radius of the sub-stations in order to avoid high cost of sub-transmission lines and to reduce transmission losses. The power generated will be purchased by local DISCOM at pre-fixed tariff.

Component A

State	Total Sanctioned	Total Installed
	Solar Capacity (MW)	Solar Capacity (MW)
Andhra Pradesh	0	0
Arunachal Pradesh	0	0
Assam	50	0
Chhattisgarh	30	0
Delhi	62	0
Gujarat	500	0
Goa	50	0
Haryana	65	0
Himachal Pradesh	20	15.25
Jammu & Kashmir	5	0
Jharkhand	50	0
Karnataka	500	0
Kerala	40	0
Ladakh	0	0
Madhya Pradesh	300	0
Maharashtra	**500**	**0**
Manipur	0	0
Meghalaya	5	0
Nagaland	0	0
Odisha	500	0
Puducherry	7	0

Punjab	220	0
Rajasthan	1200	27.5
Tamil Nadu	75	0
Telangana	500	0
Tripura	5	0
Uttar Pradesh	225	0
Uttarakhand	0	0
West Bengal	0	0
Total	**4909**	**42.75**

Table No.3

- **Component-B for Installation of 17.50 Lakh stand-alone solar agriculture pumps**

Under this Component, individual farmers will be supported to install standalone solar Agriculture pumps of capacity up to 7.5 HP for replacement of existing diesel Agriculture pumps / irrigation systems in off-grid areas, where grid supply is not available. Pumps of capacity higher than 7.5 HP can also be installed, however, the financial support will be limited to 7.5 HP capacity.

Component B		
State	**Total Sanctioned Standalone**	**Total Installed Standalone**
	Pumps Installed (Nos)	**Pumps (Nos)**
Andhra Pradesh	0	0
Arunachal Pradesh	50	0
Assam	1000	0
Chhattisgarh	20000	0
Delhi	0	0
Gujarat	3424	459
Goa	200	0
Haryana	37000	34917
Himachal Pradesh	950	251
Jammu & Kashmir	5000	103
Jharkhand	11000	6717
Karnataka	10500	314
Kerala	100	0
Ladakh	600	0
Madhya Pradesh	57000	7234
Maharashtra	**100000**	**2439**
Manipur	150	28

Meghalaya	200	35
Nagaland	50	0
Odisha	5700	821
Puducherry	0	0
Punjab	12000	6666
Rajasthan	65000	29014
Tamil Nadu	6100	1187
Telangana	0	0
Tripura	3100	436
Uttar Pradesh	20000	6842
Uttarakhand	338	0
West Bengal	0	0
Total	**359462**	**97463**

Table No.4

- **Component-C for Solarisation of 10 Lakh Grid Connected Agriculture Pumps**

Under this Component, individual farmers having grid connected agriculture pump will be supported to solarize pumps. The farmer will be able to use the generated solar power to meet the irrigation needs and the excess solar power will be sold to DISCOMs at fixed tariff

Component C				
ate	**Total Sanctioned individual Pump Solar (IPS)**	**Total Installed individual Pump Solar (IPS)**	**Total Sanctioned Feeder Level solar(FLS)**	**Total Installed Feeder Level solar(FLS)**
Andhra Pradesh	0	0	50000	0
Arunachal Pradesh	500	0	0	0
Assam	500	0	0	0
Chhattisgarh	0	0	0	0
Delhi	550	0	0	0
Gujarat	7000	0	500	0
Goa	11000	0	0	0
Haryana	0	0	32927	0
Himachal Pradesh	0	0	0	0
Jammu & Kashmir	0	0	0	0
Jharkhand	500	0	10000	0

Karnataka	0	0	250000	0
Kerala	100	0	2000	0
Ladakh	0	0	0	0
Madhya Pradesh	20000	0	175000	0
Maharashtra	**0**	**0**	**250000**	**0**
Manipur	0	0	0	0
Meghalaya	0	0	10000	0
Nagaland	0	0	0	0
Odisha	0	0	0	0
Puducherry	0	0	0	0
Punjab	0	0	25000	0
Rajasthan	12500	1026	25000	0
Tamil Nadu	20000	0	0	0
Telangana	0	0	65000	0
Tripura	2600	0	0	0
Uttar Pradesh	0	0	30000	0
Uttarakhand	200	0	0	0
West Bengal	700	0	0	0
Total	**76150**	**1026**	**925427**	**0**

Table No.5

2.6.2. SOLAR SCHEMES IN INDIA

Solar water pump is a new technology water pumping system that is powered by solar energy. They are especially beneficial for India's agricultural regions where grid access is limited and cost of fuels like diesel is high**.** The initial investment in a solar pumping system may be higher compared to normal water pumps but it comes with numerous advantages. This is the main reason why small farmers can't install solar water pumps in their fields.

To solve this financial problem of farmers, the government offers various subsidy schemes, with the goal of increasing farmers' yield and income. So let's learn in detail about these various subsidy schemes on solar water pumps in India

1. PM-KUSUM Yojana Scheme

Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) is an Indian central government-sponsored scheme led by MNRE**.** The PM-KUSUM scheme helps Indian farmers in installing solar pumps as well as solar power plants in India

Under KUSUM yojana, you will have to bear only 10% of the total cost. The remaining 30% will be provided by the central government and 30% by the state government as solar pump subsidies**.** In that way, you'll receive a total 60% subsidy on your solar water pump. The remaining 30% will be financed.

Finance Minister Nirmala Sitharaman announced the expansion of the PM KUSUM Scheme, which will provide funds to 20 lakh farmers to install standalone solar pumps. She said while presenting the budget for 2020-21, that 15 lakh farmers would be provided funds to set up grid-connected 15 lakh solar pumps**.**

➢ Implementation arrangement and tendering

1. Once the feeders are identified and implementation model is selected the Implementing agency will conduct educate them about the implementation model and benefits of participation in the scheme.

2. Banks/FIs may also be part of this campaign to provide the loan facilities against the required farmer share. Feeder wise committee of farmers may be formed, which will coordinate amongst the participating members and other agencies involved in implementation of the Scheme.
3. Implementing agency shall invite bids for empanelment of Vendors through transparent bidding process.
4. Empanelment may be state-wide or feeder-wide, as per decision of the state. To ensure quality and post installation services, only manufacturers of solar panels or manufacturers of solar water pump would be allowed to participate in the bidding process. Preferably single vendor may be given responsibility of a feeder to ensure better services and accountability.
5. In case a State chooses to install additional devices for management of feeders, e.g. watchdog transformers and devices deployed under SKY Scheme, tender for the same may be conducted separately as the financial requirement to this end shall be met from the State funds.
6. Real time monitoring is an important aspect in implementation of the component-C and therefore, a separate vendor having expertise in metering, communication and designing the required software for monitoring including getting data through different communication service providers, processing of data using analytical tools, generating reports for monitoring and MIS etc., may be selected.

➢ System Specifications

1. MNRE has already issued updated specifications for stand-alone solar water pumping system vide circular dated 17.7.2019(as amended from time to time),

these specifications also cover specifications for solar modules, MMS and other balance of system.

2. The same shall be adopted as minimum system specifications for solarisation of grid connected agriculture pumps. For grid-tied inverters, applicable BIS/MNRE specifications shall be followed.
3. Protection equipment including surge protection devise, lightning arrestors, earthing,
4. MCB/MCCB/RCCB, etc., shall be provided as per standard industry practice.
5. It will be mandatory to use indigenously manufactured solar panels with indigenous solar cells and modules. Further, motor-pump-sets, inverter/controllers and balance of system should also be manufactured indigenously.
6. The vendor has to declare the list of imported components used manufacturing of equipment used in the solarisation system.

➢ Quality, Efficiency and Maintenance

1. Systems installed under this Program me should meet technical specification and construction standards as specified by BIS and MNRE from time to time. Non-compliance will be taken seriously to the extent of blacklisting of the vendor, in the same manner as specified, apart from taking action under any other law in force. The vendors shall provide valid test certificates for equipment and system, which may be verified from the issuing agency, if required.
2. To ensure the quality, inspection shall be carried out at factory level before dispatch of major items e.g. solar modules, inverter/controller, MMS, etc., during the installation of system and final commissioning of the system. Officers involved in inspection should be domain experts, properly trained and equipped with necessary tools for inspection. An inspection manual and reporting formats with check list may be developed for this purpose.
3. The IA may engage a third party inspection agency for this purpose.

Selected vendors shall be responsible for design, supply, installation and commissioning of adopted solarisation system for grid connected agriculture pumps.

4. Vendors shall mandatorily provide AMC for a period of 5 years from the date of commissioning of the system including insurance coverage for the installed system against natural calamities and theft.
5. AMC will include inspection by Vendor at least once in a quarter and submission of quarterly inspection report of the installed system as per prescribed format. To ensure timely maintenance of the system the vendor shall have one authorized service center in each operational district and a helpline in local language in each operational State. Helpline number shall be indicated on the inverter/controller at suitable location easily visible to the user.
6. The vendor shall attend the complaint registered/informed and resolve the same within a specified timeline. Implementing agency may specify a minimum guaranteed generation during a year from the solar system installed for a specified period and provision of compensation in case of not achieving the same.
7. Before installation, the implementation agency shall conduct survey of the existing pumps proposed to be solarized on the selected feeder. Efforts shall be made for replacement of inefficient pumps conventional AC pumps with five star rated efficient pumps to ensure optimum use of energy. Funds for pump replacement may be provided through applicable Central or State Government Schemes and/or farmers' contribution.
8. State may also devise mechanism to provide bank loan to farmers for pump replacement.
9. Thorough maintenance of selected agriculture feeders is required to maintain feeder

   Availability during sunshine hours. This includes maintenance of 33/11 kV sub-station, 33 kV, 11 kV and LT lines and distribution transformers, etc., on regular basis in a time bound manner.

10. Proper protection system including improved earthing of equipment shall be provided considering possibility of high voltage/current due to multiple generating sources in the feeder selected for solarisation.

2. NABARD Subsidy Scheme

The National Bank for Agriculture and Rural Development is an Indian bank that aims to provide overall possible benefits to small and needy farmers. NABARD offers subsidies for solar power plants and solar water pumps. If a farmer wants to install **a** solar power plant on his property, he will have to pay only 20% of the cost of the solar plant. And to pay the remaining 80%, NABARD offers loans.

Similarly, this bank is offering a loan for installing solar water pumps. The farmers must pay only 60% of the cost of installing a solar pump and the remaining 40% will be subsidized by NABARD. However, this 60% will also be financed by this bank. These low-interest loans are available to anyone. The interest rates will basically depend on RBI's guideline.

3. Pardarshi Kisan Seva Yojana-Uttar Pradesh

The Uttar Pradesh government has launched the Pardarshi Kisan Seva Yojana. It is a subsidy scheme that provides financial assistance to farmers who want to install solar water pumps in their fields. Through this scheme the UP government aims to reduce irrigation costs and to provide uninterrupted irrigation facilities to farmers.

The solar water pump subsidy will be provided jointly by the central and state governments under this scheme. If a farmer installs a solar powered water pump under Pardarshi Kisan Seva Yojana, he or she will receive a subsidy approximately 90% of the total cost.

4. Punjab Solar Pump Subsidy

When other state governments like Uttar Pradesh and Haryana are providing subsidies to the farmers, how can the Punjab government fall behind? To promote green energy, the Punjab government also launched a subsidy scheme for the farmers to install solar water pumps in the agriculture and irrigation sector.

The Punjab government will provide 75 percent of the total cost as Central Financial Assistance (CFA) to farmers who want to install solar water pumps in their fields under this scheme. It not only assists the farmer in installing an alternative irrigation source, but also helps in reducing carbon footprints in our environment.

5. Mukhyamantri Solar Pump Yojana-Madhya Pradesh

Madhya Pradesh has introduced and implemented the Mukhyamantri Solar Pump Yojana. This is a joint scheme of the central government i.e. Ministry of New and Renewable Energy and the government of Madhya Pradesh. The main objective of launching this scheme is to promote green energy overall in the state.

Under Mukhyamantri Solar Pump Yojana the farmers are only required to pay 10% of the total cost of the project. The state government will sponsor or provide the remaining 90% of the project costs, with assistance from the central government (MNRE)

6. Haryana Solar Pump Subsidy

Haryana is a state with a lot of agricultural land. And how can this happen if the Haryana government does not implement any farmer welfare schemes? The Haryana government has also launched a solar water pump subsidy scheme to help farmers in the state and maintain their best image.

Farmers in Haryana are only required to pay 10% of the total cost under the Haryana solar pump scheme. The remaining 90% will be paid jointly by the central and state governments**.** To get the subsidy, contact your state solar agencies before the installation.

7. Saur Sinchayee Yojana-HP

The Cabinet Committee of Himachal Pradesh has implemented the Saur Sinchayee Yojana. An overall budget of Rs.224 crore is being provided to allot subsidies to the farmers who want to install solar water pumps in their fields.

This scheme will cover around 90% of total cost. This 90% cost will be paid by the state government and the rest of 10% would be paid by the beneficiary (small or marginal farmer of HP) themselves**.** The government of HP is also providing an 80 percent subsidy to medium and large farmers. In addition to all of these subsidies, the state government will provide 100 percent financial assistance to a group of small and marginal farmers / Kisan Vikas Sanghs / Registered Bodies of Farmers.

8. Rajasthan Solar Pump Yojana

The Rajasthan government is also actively promoting solar energy products throughout the state. To encourage solar water pumping systems, the Rajasthan government is also providing subsidies on solar water pumps. Subsidy on solar pumps will reduce the burden of heavy upfront investment.

Rajasthan government works with the central government to provide subsidies for solar water pumps. The state government will provide up to 60% of the total cost under this subsidy scheme, with the owner responsible for the remainder.

9. Surya Raitha Scheme-Karnataka

The government of Karnataka unveiled the Surya Raitha scheme in the state of Karnataka. Under this scheme, an on-grid/grid-connected solar water pump with net-metering feature will be installed**.** They will not only provide you with an alternative source of energy, but will also increase the income you receive from your fields. In Karnataka, the government will provide 90% subsidy under the Surya Raitha scheme and the rest of 10% will be paid by the owner. This scheme is financed by interest-free soft loans from Bangalore Electricity Supply Company (BESCOM).

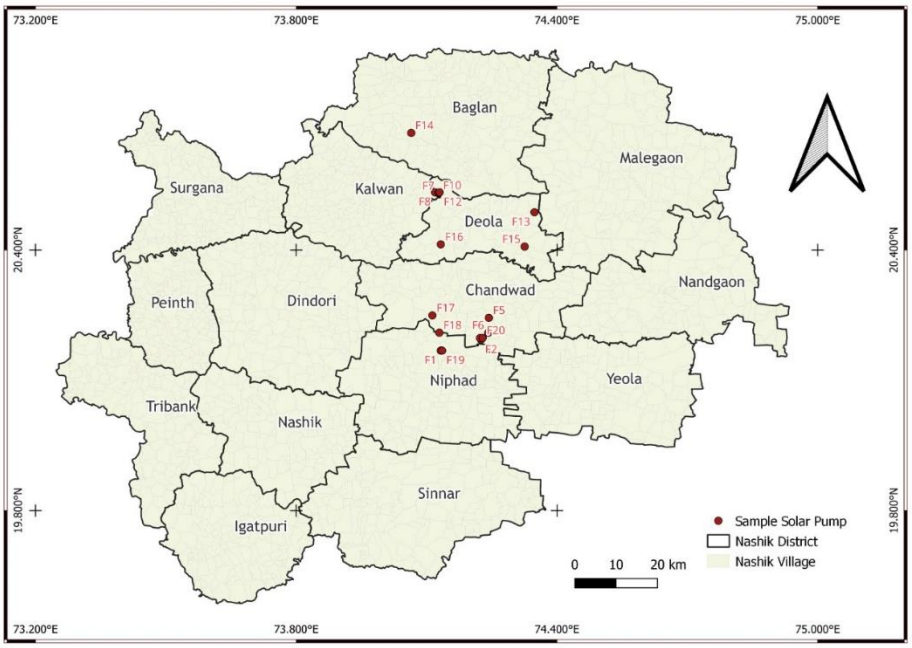
CHAPTER 3

DATA ANALYSIS AND INTREPRETATION

3.1. FIELD VISIT

As proposed in the research project we are supposed to visit the location where solar water pumps are already installed. The main motto behind this field visit is to identify the working, installation process, and installation cost, the total process from staring an application and up to installation.

During the field visit we got to know the different aspects of solar pumps and got the desired information. Also we have found the advantages of the solar pumps along with some minor disadvantages. Investigator had visited the places in two days as Deola, Baglan tehsil including different villages and Chandwad tehsil. During the visit in Deola we got help from Mr.Bhimrao Shewale and Mr.Ravindra Shewale.



Sample mapping of selected farmers

3.2 DATASET

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Farmer	1.Name	2.Address village 2.Address	, 3.Phone No.	4.Gender Male(1) Feamale(0)	5.Age	6.Total Land Holding	7.Year of installation	8.Medium of source Online(1) Offline(2)	9.Are you a government Beneficiary of scheme Yes(1) No(0)	, 10.Total no of days: starting application to final installation - (in Months)	, 11.Total installation cost	-, 12.Power source before solar energy?	13.Crops under irrigation,
				1=Male, 0=Female	(In yrs)	(InAcare)	(Year)	1=Online, 2=Offline	Yes(1) No(0)	(in Months)	(in Rs)		
F1	Raosaheb Bhosale	sarole khurd		1	55	2	2019	1	1	9	16560	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F2	Uttam Ghogare	Pimplad		1	53	6	2016	2	1	12	27000	Disel pump	All vegetables,Grain,Fruitfarm
F3	Arun Chavan	Pimplad		1	58	2	2018	1	1	12	16000	Grid electricity and other	Vegetables and fruits
F4	Pintu Kumbharde	Pimplad		1	35	2	2018	1	1	8	16000	Grid electricity	All vegetables,Grain,Fruitfarm
F5	Subhash Gangurde	Digvat		1	38	1	2019	1	1	7	16000	Grid electricity	Grapes onion
F6	Babaji Thangal	Koltek		1	54	2	2018	2	1	9	17000	Grid electricity	All vegetables,Grain,Fruitfarm
F7	Dadaji Shewale	Khamkheda		1	55	3	2019	1	0	5	250000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F8	Ravindra Shewale	Khamkheda	9766240341	1	48	3	2019	1	0	5	250000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F9	Bhimrao Shewale	Khamkheda		1	45	3	2018	1	0	5	150000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F10	Gopal Shewale	Khamkheda		1	62	4.5	2018	1	0	5	150000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F11	Abaji Shewale	Khamkheda		1	40	15	2018	1	1	6	450000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F12	Kunal Chavan	Nimbole		1	32	15	2018	1	1	6	450000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F13	Devidas	Nadgaon		1	56	6	2020	1	0	5	150000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F14	Jayesh Shinde	Kikwari		1	43	7	2019	1	0	6	200000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F15	Nagu Wagh	Umrane		1	37	4	2019	1	1	8	150000	Grid Electricity	Onion,Wheat,Bajra
F16	Sanket	Pimpaldar		1	35	7	2021	1	0	5	250000	Grid Electricity	Vegetables Onion,Wheat,Every,etc
F17	Kiran More	Deola		1	51	8	2021	1	0	5	250000	Grid Electricity	Vegetables Onion,Wheat,Every,etc

O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
14.Water source	, 15.Kind of irrigation system is being used on solar plant,	16.Type of pump is used	, 17.Capacity of pump (in HP)	, 18.Do you store energy using batteries? Yes(1) No(0)	19.Capacity of battery :	20.Do you ever have pressure and or flow rate problems? Yes(1) No(0) Sometimes(2)	21.Total maintenance cost required in a year :	22.Can you relocate solar panels after installation? Yes(1) No(0)	23.Can you use Solar Water Pump During Cloudy And Foggy Days as it is used in normal weather? Yes(1) No(0)	24. Solar Water Pumps are more useful than Conventional Electric Pumps? Yes(1) No(0)	25.Does The Performance Of The Solar Water Pumps Get Affected Over The Years Of Use? Yes(1) No(0)	26.Is there any failure of solar pump due to heavy use Yes(1) No(0)	27.Difficulties you faced while getting benefits of scheme	28.Any Loss you have faced after installation of solar pump Yes(1) No(0)	29.How Satisfied are you with solar water pump	30.Would you recommend solar panels to others? Yes(1) No(0)	31.Any Loss faced after installing solar panel? ,	32.Any other suggestion	Longitude	Latitude
				Yes(1) No(0)		Yes(1) No(0)		Yes(1) No(0)	Yes(1) No(0)	Yes(1) No(0)	Yes(1) No(0)	Yes(1) No(0)	Yes(1) No(0)	Yes(1) No(0)		Yes(1) No(0)	Yes(1) No(0)			
Bore	Drip	Bore pump	3	0	0	0	0	0	0	1	0	0	0	0	Very Good	1	0	Do not close	20.16837	74.132715
well	Free Flow	Bore pump /DC	5	0	0	2	0	0	0	1	0	0	0	0	Very Good	1	0	Govt. Scheme	20.19337	74.22531
well	Free flow	AC pump	3	0	0	0	0	0	0	1	0	1	0	1	Satisfied	1	1	Due to some	20.19697	74.22413
well	Free flow	AC pump	3	0	0	0	0	0	0	1	0	0	0	0	Good	1	0	Lack of Aware	20.1973	74.223064
well	Free flow sprinkler	AC pump	3	0	0	2	0	0	0	1	0	0	0	0	Very Good	1	0	Lack of Aware	20.24383	74.24339
well	Free flow	AC pump	3	0	0	0	0	0	0	1	0	0	0	0	Very Good	1	0	Give benefit c	20.2094	74.242095
Bore	Drip	Bore pump	5	0	0	0	0	0	0	1	0	0	0	0	Good	1	0	Provide Afford	20.5307	74.127476
well	Free Flow , Drip	AC Pump	3	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Reduce the C	20.53302	74.119408
well , Borewell	Free Flow	AC Pump	3	0	0	0	0	0	1	1	1	0	0	0	Very Good	1	1	Reduce the c	20.53183	74.128374
well , Borewell	Free Flow , Drip	AC Pump	3	0	0	0	0	0	1	1	1	0	0	0	Very Good	1	0	Reduce the c	20.53184	74.12837
well , Borewell	Free Flow , Drip	AC Pump	7	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Reduce the C	20.53288	74.129946
well , Borewell	Free Flow , Drip	AC Pump	7	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Reduce the C	20.53288	74.129946
Well	Free Flow, Drip	AC Pump	3	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Increase Gov	20.48694	74.348398
Well	Free Flow	AC Pump	5	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Increase Gov	20.6695	74.064683
Well	Free Flow	AC Pump	3	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Installation C	20.40795	74.325782
Well	Free Flow	AC Pump	3	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Govt. Scheme	20.56276	74.135826
Well,Borewell	Free Flow,Drip,Sprincle	AC Pump	5	0	0	0	0	0	1	1	1	0	0	0	Good	1	0	Lack of Aware	20.46322	74.174909

3.3 QUESTIONNAIRE OVERVIEW

QUESTIONS	COUNT OF CHARACTERISTICS(FILTER VALUES COUNT)
Farmer	17
1.Name	17
Tahsil	4
2.Address village 2.Address	11
3.Phone No.	
4.Gender Male(1) Female(0)	1
5.Age	17
6.Total Land Holding	9
7.Year of installation	5
8.Medium of source Online(1) Offline(2)	2
9.Are you a government Beneficiary of scheme Yes(1) No(0)	2
10.Total no of days: starting application to final installation - (in Months)	6
11.Total installation cost	8
12. Power source before solar energy?	3
13.Crops under irrigation,	5
14.Water source	3
15.Kind of irrigation system is being used on solar plant,	6
16.Type of pump is used	3
17.Capacity of pump (in HP)	3
18. Do you store energy using batteries? Yes(1) No(0)	2
19.Capacity of battery :	0
20. Do you ever have pressure and or flow rate problems? Yes(1) No(0) Sometimes(2)	3
21.Total maintenance cost required in a year :	0

22. Can you relocate solar panels after installation? Yes(1) No(0)	2
23. Can you use Solar Water Pump During Cloudy And Foggy Days as it is used in normal weather? Yes(1) No(0)	2
24. Solar Water Pumps are more useful than Conventional Electric Pumps? Yes(1) No(0)	2
25. Does The Performance Of The Solar Water Pumps Get Affected Over The Years Of Use? Yes(1) No(0)	2
26.Is there any failure of solar pump due to heavy use Yes(1) No(0)	2
27.Difficulties you faced while getting benefits of scheme	0
28.Any Loss you have faced after installation of solar pump Yes(1) No(0)	2
29.How Satisfied are you with solar water pump	3
30. Would you recommend solar panels to others? Yes(1) No(0)	2
31. Any Loss faced after installing solar panel?	0
32.Any other suggestion	0
Longitude	17
Latitude	17

Table No.6

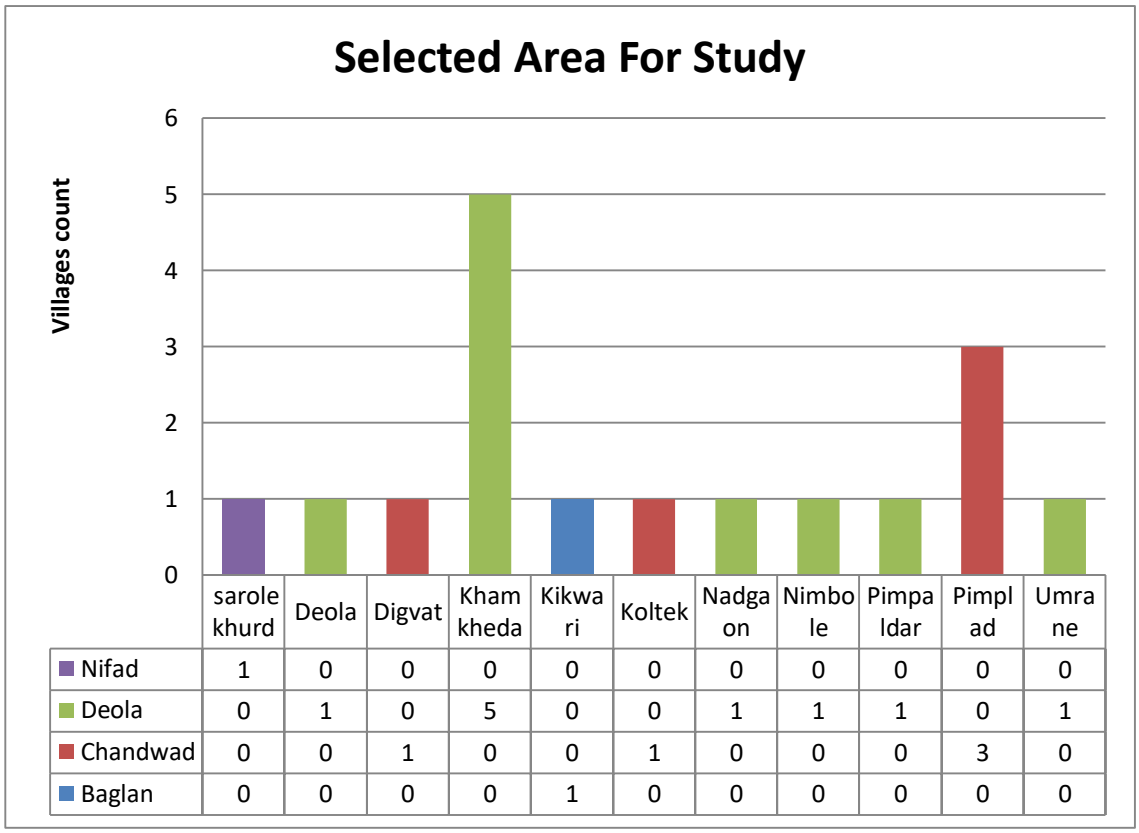
Questionnaire for Primary Data Collection of The Project Named

A Techno-Economic Assessment Solar Energy Application in Agriculture: A Case study of Nashik District

1. Name

This question contains name of the farmer. The count of total farmer is 17.

2. Address



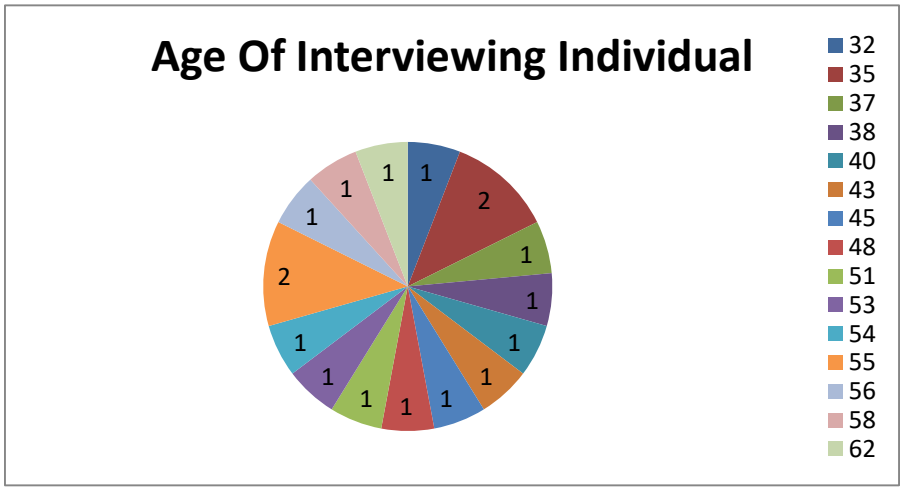
	sarole khurd	Deola	Digvat	Kham kheda	Kikwa ri	Koltek	Nadga on	Nimbo le	Pimpa ldar	Pimpl ad	Umra ne
Nifad	1	0	0	0	0	0	0	0	0	0	0
Deola	0	1	0	5	0	0	1	1	1	0	1
Chandwad	0	0	1	0	0	1	0	0	0	3	0
Baglan	0	0	0	0	1	0	0	0	0	0	0

3. Gender

The research project was totally based on the field visit while only some part was taken from the secondary data. During the project, investigator got a chance to directly interact with the farmers. Here most of the farmers were male but the most important part was

they were accompanied with their female family members also. So while taking this factor, the gender of head farmer was noted here.

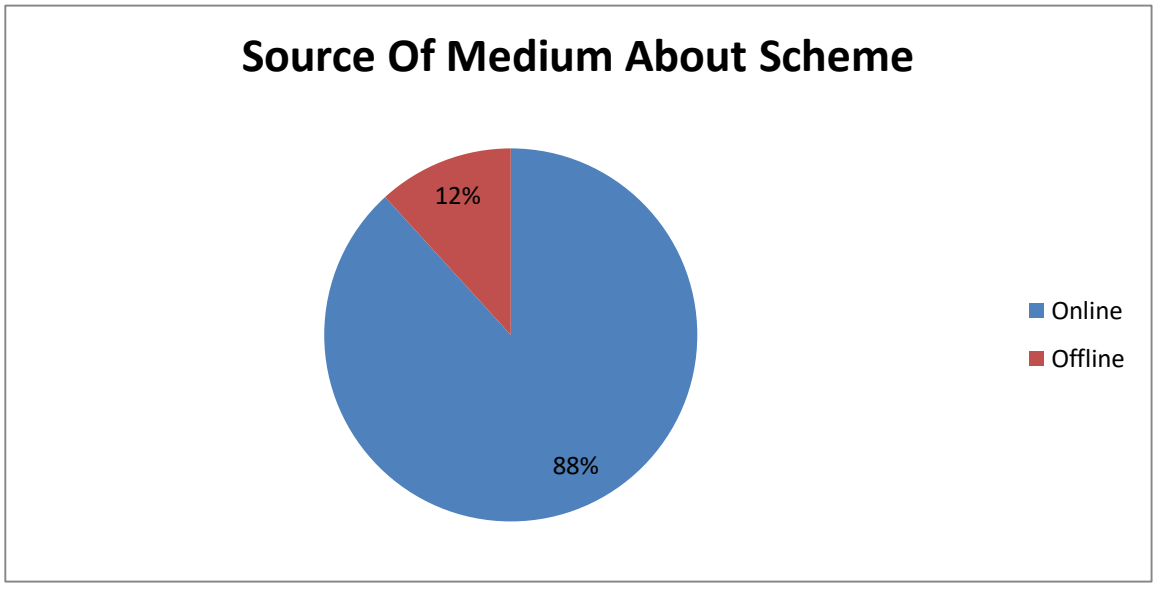
4. Age



The above graph shows the age distribution of individuals.

Most of the farmers were of the middle age group between Thirty to Fifty

5. Medium of source

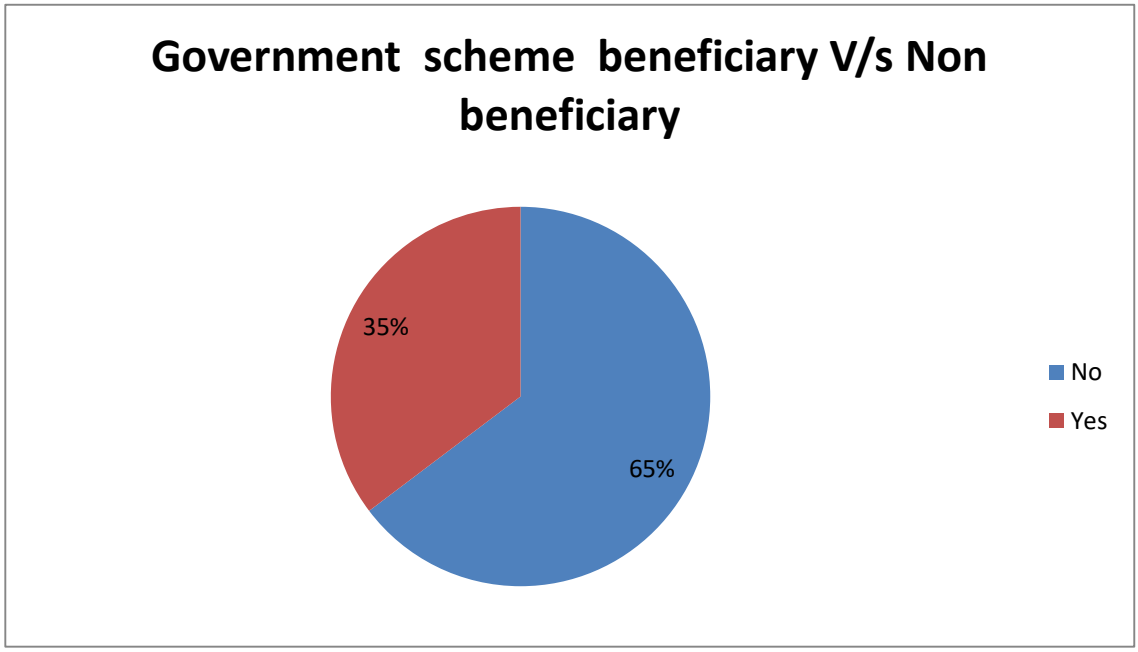


Interpretation of the above pie diagram:-

In the above mentioned graph, the online percentage is higher than offline.

Investigator have found that the important source for awareness of government scheme is effectively done by online way. This is because of all the process and information about the schemes and also the working of the government is done online in very effective manner since last two to three years as most of the farmers mentioned.

6. Are you a government Beneficiary of scheme



Interpretation of the above pie diagram:-

In the proposed research project the investigator have found that the government scheme beneficiaries are less as compared to the private sector. The main reason behind it was the availability of the private entities are more. Also the working of the private companies who provide the solar took less time and their problem solving time is less. That's why most of the farmers are looking forward to take service from the private companies. Farmers also told that the terms and conditions for the government scheme are very complicated and very time consuming.

7. Total installation cost -

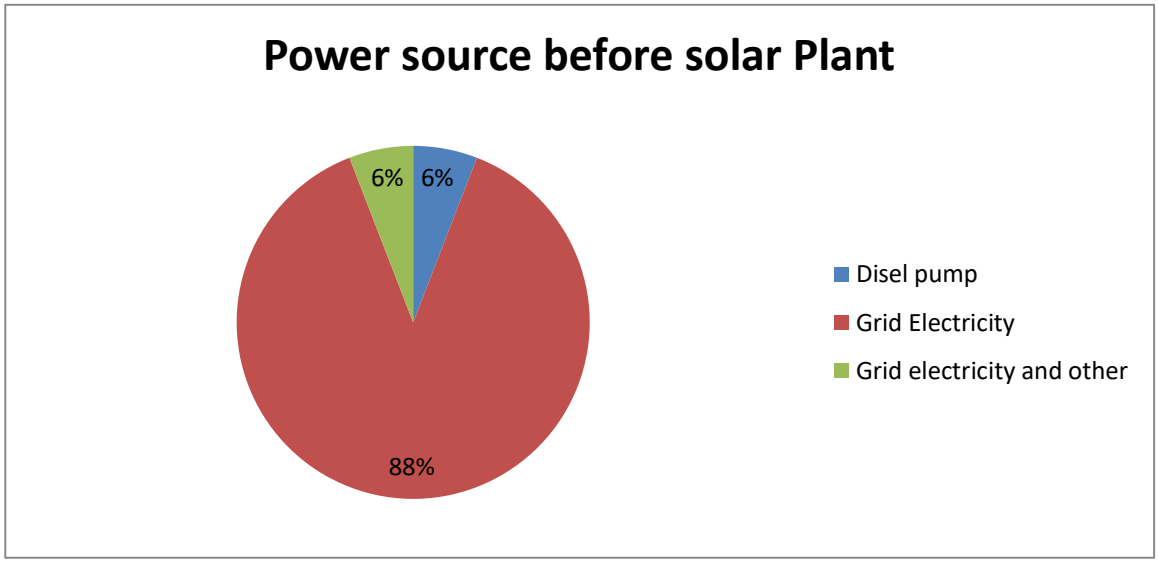
In the below table the cost of solar pump installation is mentioned. Here two aspects are considered that are

1)Beneficiary of government scheme

2)Non- Beneficiary of government scheme

	16000	17000	27000	150000	200000	250000	450000
No	0	0	0	0	1	4	2
Yes	4	1	1	0	0	0	0

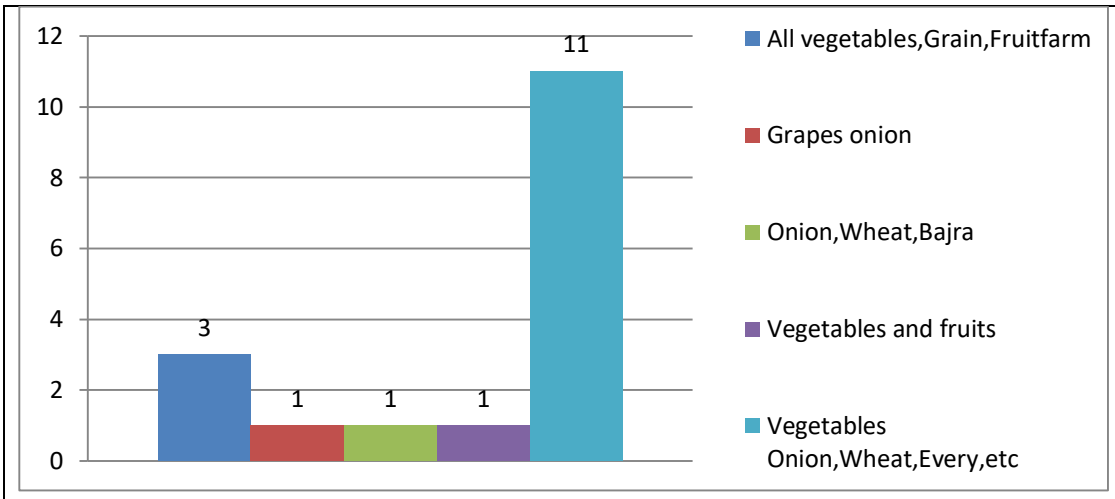
8. Power source before solar energy?



Interpretation of the above pie diagram:-

From above graph researcher found that the people before installing solar panel mostly depends on grid electricity as a power source.

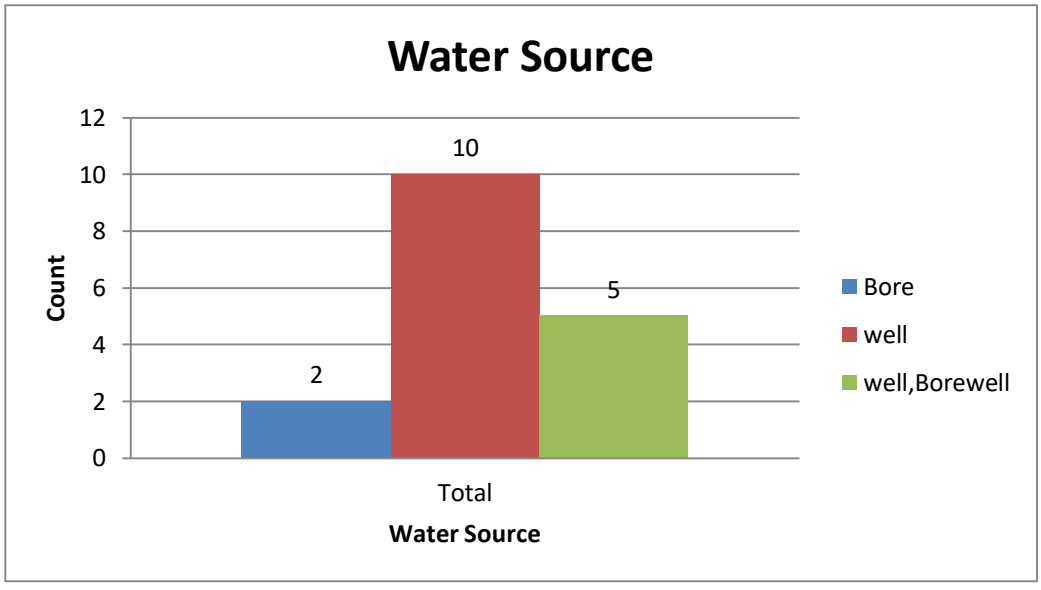
9. Crops under irrigation



Interpretation of the above graph:-

The bar graph tells that people not belongs to any specified crop under irrigation. Investigator found that people willing to take any kind of crop under irrigation after installing solar water pump. Farming is the activity totally depend on the water supply and the main source for the pumps were the diesel pumps and electricity. So the working was totally according to the time of the MECB supply. So farmers was supposed to take such crops which do not need more water supply. So solar panels made them self-efficient in water source according to their own comfortable time.

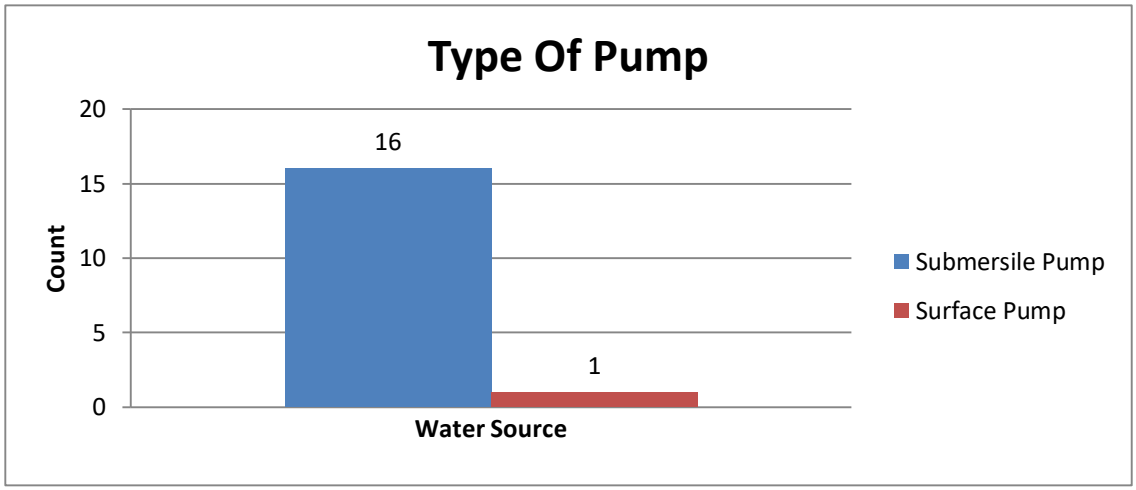
10. Water source



Interpretation of the above graph:-

In the analysis source of water for irrigation of crops researcher found that the mostly used source of water for irrigation of crops is well. Then consecutively bore comes.

11. Type of pump is used



Interpretation of the above graph:-

Mostly farmers using submersible pump type .Rarely farmer using another one. Because farmers stored water in wells. Due to this it will be easy to those farmers to used submersible pump.

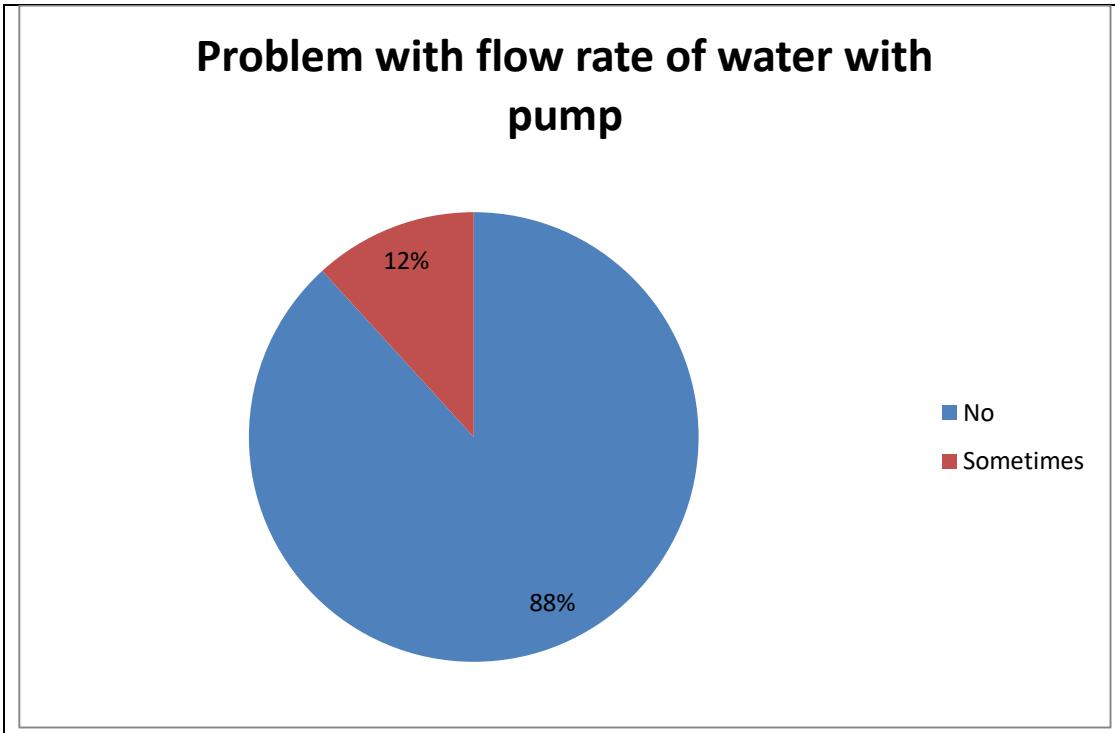
12. Do you store energy using batteries?

Almost all farmers that investigator had visited, no one has stored the energy. The main reason behind this was the high cost of the batteries and they also required the huge space required for the battery setup.

13. Capacity of battery :

As investigator had visited to the farmers, most of the farmers having the power pump of 3Hp. Because the area chosen for the primary data collection was having less crop intensity as the farmers was heavily reliable on the one or two crop patterned also was the small land holders on which the 3Hp pump is sufficient. Only one farmer was having 5Hp pump due to the large land holding compared to the other farmers.

14. Do you ever have pressure and or flow rate problems?



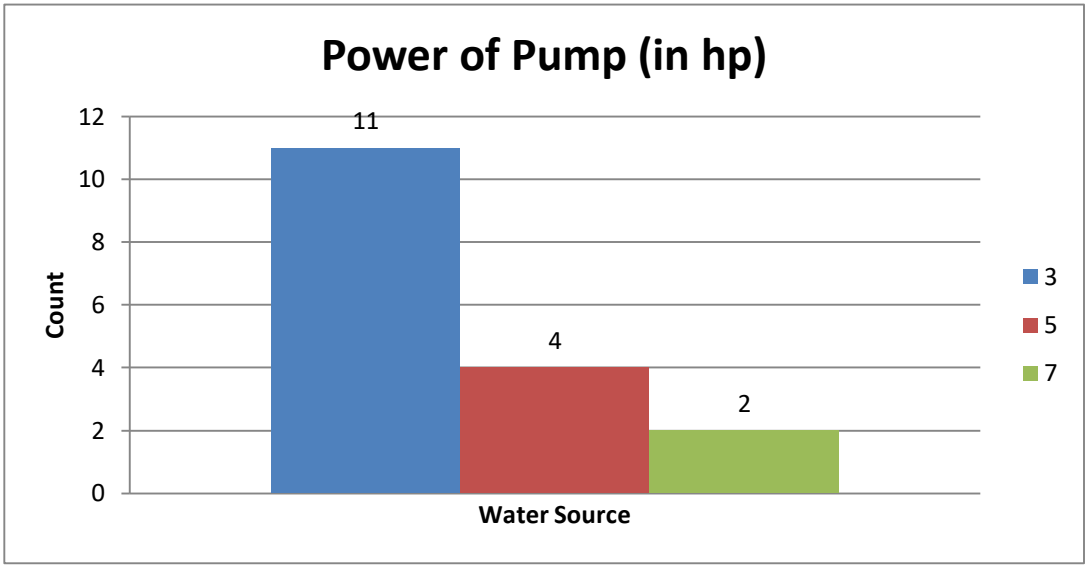
Interpretation of the above pie diagram:-

From the pie chart it is clear that most of people not facing issue related for flow rate of water

15. Total maintenance cost required in a year :

Investigator have found the maintenance cost is almost zero. But the farmers also told that some natural hazardous as well as some man made incidences such as stone pelting may harm the panels.

16. Capacity of Pump



Interpretation of the above graph:-

Each solar water pump has different capacity and it measured in HP. The mostly used pump is 3hp water pump. Investigator also found 5hp water motor installed in one farmers field.

17. Can you use Solar Water Pump during Cloudy and Foggy Days as it is used in normal weather?

Here, Investigator have found mix reply from farmers. Some told that they work properly in all seasons while some of them told that the efficiency of the solar got reduced in foggy or cloudy climate.

18. Do Solar Water Pumps are more useful than Conventional Electric Pumps?

As an investigator I found that the most of the farmers were happy after installing the solar panels. Because they are low maintenance even though the installation cost is high.

Electric pumps are totally dependent on the electricity supply and the time from the

MECB is not same for all the days. So sometimes it is in day or sometime it is in night. That's why the solar panels are more useful in this type of condition.

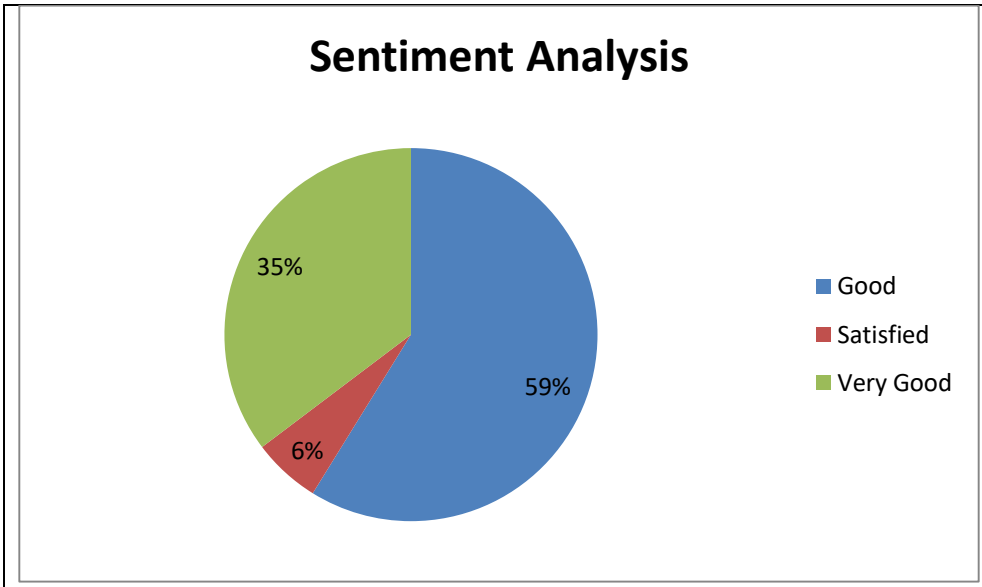
19. Does The Performance Of The Solar Water Pumps Get Affected Over The Years Of Use?

Most of the farmers that investigator had visited were less than a year experienced in solar panels. But after consulting with them investigator got to know that only damage can affect the solar working.

20. Difficulty you faced while getting benefit of scheme.

This was the main focused part of the research. As we all have very well known about the different schemes are landed by the state governments as well as by the central government. But after interacting to the farmer we got to know that the being beneficiary of the government scheme was quite difficult as compared to the private company. Government had also stopped the application forms for the scheme due to high number of the application. So most of the farmers have installed the solar panels from the private entities.

21. How Satisfied are you with solar water pump



Interpretation of the above graph:-

Almost all the farmers were satisfied with the working of the solar water pumps. Investigator has analyzed the farmer's reaction and found that the main reason for being less satisfied is due to low working in the hazy and cloudy weather.

22. Would you recommend solar panels to others?

Almost all farmers have recommended the solar panels. Even though the installation cost is high compare to other sources, but the maintenance cost is almost none.

23. Any Loss faced after installing solar panel?

After interacting with the farmers, the chances of loss is only after the natural hazardous or after the manmade instances like stone pelting. Usually normal storms, or fast blowing wind does not affect the panels. In one situation investigator got to see one farmer's panel was broken due to stone.

24. Any other suggestions.

After completing the research the investigator found some common suggestions they are

as follow.

1. Increase in the allotment quantity under the government schemes for solar panels.
2. Government should control the working of the private companies as their charges are high.
3. There must be reduction in the installation cost of the solar.
4. Increase awareness among the farmers.

CHAPTER 4

4.1 CONCLUSION

The government sponsored scheme of solar water pump beating the problem of load shading which leads to flexible irrigation by farmers to the crops instead of irrigating at night due to load shading problem. The beneficiary of solar water pump are very satisfied as the researcher observed in analysis. The clean or green energy generation by solar without affecting environment ecosystem and effective in long term motivating individuals to install solar pump without help of government subsidies. Some individuals are ready to install solar pump in agriculture on private basis.

The load shading problem in rural area mostly affects agriculture. On the basis of data analysis, the researcher concluded that the government agricultural scheme related to solar pump is beneficial to the farmers due to positive response from farmer's side.

The scheme is really beneficial at ground level. But some farmers are not eligible for scheme due to documentation and scheme strict rules .Also Due to expense of diesel pump farmers willing to install solar water pump without taking government scheme benefit.

4.2 HYPOTHESIS TESTING

After collection of all the data hypothesis testing is as follows.

a) **Hypothesis number 1 - Due to Government subsidies, the beneficiary count is rising day by day.**

   After collecting all the data from primary sources, Investigator had analyzed the data in chapter number 3(point no.3.3, question no 6) named Data analysis and Interpretation.

   Analysis concluded that due to awareness conducted by the government and the scheme subsidy provided to the farmers, the number of the solar water pumps are

increasing. Farmers are also suggesting the scheme to other farmers in their village and among the people thew know.

Hence, Hypothesis number 1 is proved.

b) **Hypothesis number 2 - Because of the government subsidies, private sector is not having that much scope in the solar panels field.**

After collecting all the data from primary sources, Investigator had analyzed the data in chapter number 3(point no.3.3, question no 6) named Data analysis and Interpretation.

Although the scheme subsidy is provided to the farmers, terms and condition for the scheme are too complicated and the fund disbursement is having long time duration. Also the panels provided under the scheme are having only 9 plates. Therefore, private companies are also providing panels and almost 65% farmers under research was having solar installed by private companies.

Hence, Hypothesis number 2 is not proved.

4.2 RECOMMENDATION

1. Government should encourage mutual solar pump installation to the group of farmer.
2. Government should do properly auditing of such schemes on regular interval to avoid benefit to the wrong person

APPENDIX A

➢ REFERENCE

1. **https://kusum.mahaurja.com/benef_reg/Kusum-Yojana-Component-B**
2. **https://pmkusum.mnre.gov.in/**
3. **https://www.ctara.iitb.ac.in/en/mtech-project/solar-pv-irrigation-maharashtra**
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7. **https://easa.com/**
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APPENDIX B

Questionnaire for Primary Data Collection of the Project Named

A Techno-Economic Assessment Solar Energy Application in Agriculture: A Case study of Nashik District

1) Name
2) Address
3) Phone No
4) Gender Male ☐ Female ☐
5) Age
6) Total Land Holding
7) Year of installation
8) Medium of source
9) Are you a government Beneficiary of scheme Yes ☐ No ☐
10) Total no of days: starting application to final installation –
11) Total installation cost -
12) Power source before solar energy?

    Grid Electricity ☐

    Diesel Power ☐

    Other ☐

13) Crops under irrigation
14) Water source

    Well ☐

    Bore well ☐

River/Dam ☐

Other ☐

15) Kind of irrigation system is being used on solar plant

Sprinkler ☐

Free Flow ☐

Drip Irrigation ☐

Other ☐

16) Type of pump is used

Submersible pumps ☐

Surface pumps ☐

DC pump ☐

AC pump ☐

17) Do you store energy using batteries?

Yes ☐

No ☐

18) Capacity of battery :

19) Do you ever have pressure and or flow rate problems?

Yes ☐

No ☐

20) Total maintenance cost required in a year :

21) Can you relocate solar panels after installation?

Yes ☐

No ☐

22) Capacity of Pump

23) Can you use Solar Water Pump during Cloudy and Foggy Days as it is used in normal weather?

Yes ☐

No ☐

24) Do Solar Water Pumps are more useful than Conventional Electric Pumps?

Yes ☐

No ☐

25) Does The Performance Of The Solar Water Pumps Get Affected Over The Years Of Use?

Yes ☐

No ☐

26) Difficulty you faced while getting benefit of scheme.

27) Difficulties faced before installation of solar panel

28) How Satisfied are you with solar water pump

29) Would you recommend solar panels to others? Yes ☐ No ☐

30) Any Loss faced after installing solar panel?

31) Do Solar Water Pumps are more useful than Conventional Electric Pumps?

Yes ☐ No ☐

32) Any other suggestions.

APPENDIX C

LIST OF VISITED FARMERS

Farmer	1.Name	Tahsil	village
F1	Raosaheb Bhosale	Nifad	sarole khurd
F2	Uttam Ghogare	Chandwad	Pimplad
F3	Arun Chavan	Chandwad	Pimplad
F4	Pintu Kumbharde	Chandwad	Pimplad
F5	Subhash Gangurde	Chandwad	Digvat
F6	Babaji Thangal	Chandwad	Koltek
F7	Dadaji Shewale	Deola	Khamkheda
F8	Ravindra Shewale	Deola	Khamkheda
F9	Bhimrao Shewale	Deola	Khamkheda
F10	Gopal Shewale	Deola	Khamkheda
F11	Abaji Shewale	Deola	Khamkheda
F12	Kunal Chavan	Deola	Nimbole
F13	Devidas	Deola	Nadgaon
F14	Jayesh Shinde	Baglan	Kikwari
F15	Nagu Wagh	Deola	Umrane
F16	Sanket	Deola	Pimpaldar
F17	Kiran More	Deola	Deola

APPENDIX D

VISITING PHOTOS

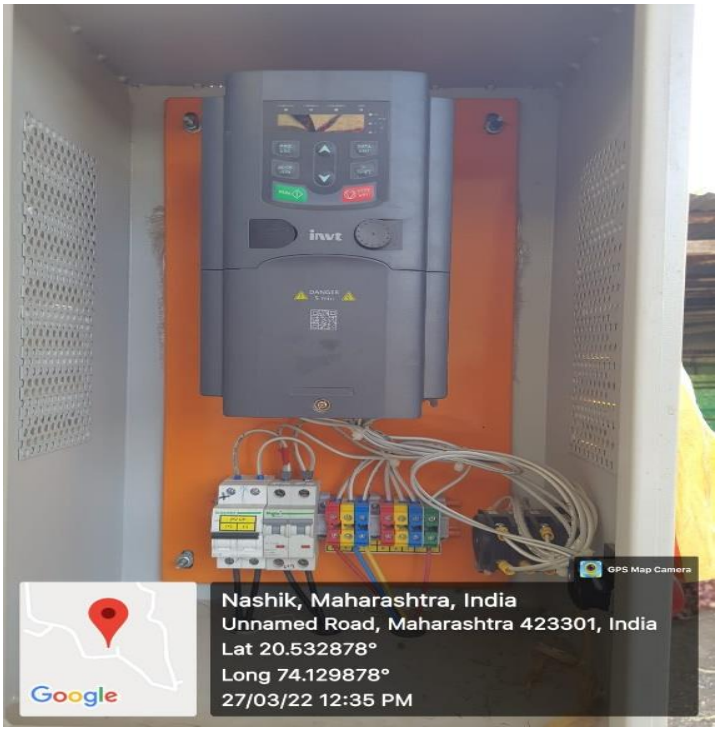

Figure 6 **5hp pump motor can be seen in the picuture**

Figure 7 **Solar panel having Nine plates with the government subsidy**

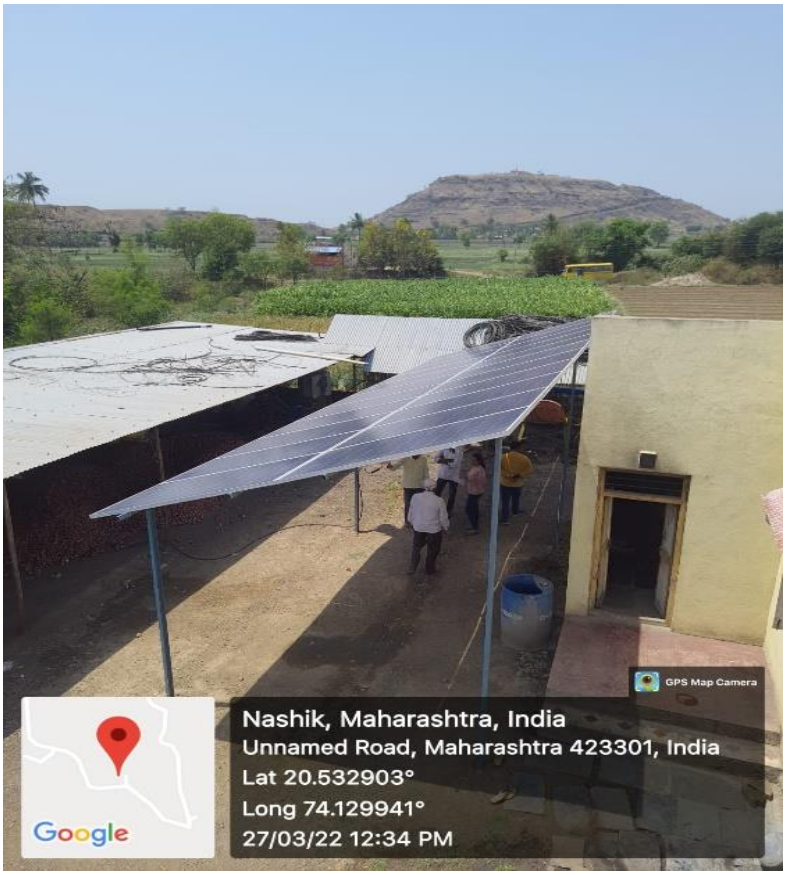

Figure 8

Solar panel is installed in about 15 Meter height for better performance. As the farmer was having obstacle to get sunlight so he installed it on such height. Due to this height, the performance time of the solar have increased for averagely Two hours a day comparing to the solar panels installed on lower height

Figure 9

Investigator Prathamesh can be seen with the farmer in Khamkheda village of Deola tehsil.

Figure 10 **Picture taken by Investigator Prathamesh in the field.**

Figure 11 **Clear sunlight increases the efficiency of the solar pumps.**