CCSMFA

Research Documentation

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RESEARCH TIMELINE

1. Gather data through secondary research about water resources and wastage in India.
2. Get insights on farming practices in India and the US
3. 09/18 – 09/21 Prepare questions to ask to farmers in America
4. 09/23 -09/24 Interview local American farmers to understand about their farming practices and digitalization in agriculture to derive a systems model
   target: about 3-4 farmers
5. 09/25 – 09/28 Based on the insights from secondary research and the interview with American farmers prepare a questionnaire for Indian farmers
6. Interview farmers in India to understand about their farming practices, needs, desires and fears to understand what motivates them and what according to them are the problems in farming
   target: about 2-3 farmers
7. 10/10 – 10/15 Do a comparison contrast between the farming practices in the U.S. and India to find out if the farming practices in a developed country could be taken as an inspiration to conserve water in Indian agriculture.
8. 10/20 -10/28 Validating the data gathered through research by consulting an expert on his knowledge and opinions.

1. THESIS TOPIC

Water conservation on the farms of western Maharashtra, India.

2. PROBLEM OVERVIEW

India is one of the fastest growing economies in the world. Many metro cities in the country are on the growth route through national projects such as 'smart city' and 'clean India campaign'. Due to the boom in IT industry for the past decade, many people have well-paying jobs and strive for a better lifestyle. Although, there is one problem that is majorly faced by almost every Indian today – the problem of water shortage. "As per the international norms, a country is classified as water stressed and water scarce if per capita water availability goes below 1700 m3 and 1000 m3, respectively. With 1544 m3 per capita water availability, India is already a water-stressed country and is moving towards turning into water scarce."[1]

Despite the boom in IT industry, "agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India."[2] Farming has been the prime occupation in majority of Indian households for decades. The real turning point to the Indian agriculture occurred in early 1960s through the green revolution, after which, the agricultural sector progressed towards the "methods of agronomic technology utilization to increase yields"[3]. "Today, India ranks second

[1] https://www.oav.de/fileadmin/user_upload/5_Publikationen/5_Studien/170118_Study_Water_Agriculture_India.pdf
[2] https://en.wikipedia.org/wiki/Agriculture_in_India
[3] https://en.wikipedia.org/wiki/Green_Revolution_in_India

worldwide in farm output"[4]; and yet, unfortunately, "the agricultural sector consumes over 80% of water resources and has barely 35% of irrigation efficiency."[5]

The thought behind this topic is intended to go about exploring the possible solutions to the problem of water shortage faced by the average Indian citizens. The bigger picture suggests that India is facing a severe water crisis, and one of the main reasons for that is the misuse of water in the agricultural sector. According to the experts at 'The Energy and Resources Institute', "Improvement in water use efficiency in the agriculture sector would result in huge overall water saving".[6]

The reason behind choosing this topic was in my personal experience of being an Indian citizen. I am a part of the generation that witnessed the issue of water shortage becoming increasingly prominent. Every day of every summer, the government, the media, and the common man spends on worrying about whether there is going to be enough water to get us all through the summer. According to the statement stated above, majority of water is consumed in the agricultural sector. Due to which, I want to explore the possibilities of water conservation in the agricultural sector.

[4] https://en.wikipedia.org/wiki/Agriculture_in_India
[5] http://southasia.oneworld.net/peoplespeak/water-woes-shortage-or-wastage#.Wa3K8MiGNPZ
[6] http://southasia.oneworld.net/peoplespeak/water-woes-shortage-or-wastage#.WbhyK8iGNPa

3. PROBLEM STATEMENT

India received about 4% of the total rainfall in the world. Out of that 4% the country manages to use about 20% of the water. That 20% is further divided into the following – 5% for domestic sector, 15% for industrial sector and 80% for agricultural sector. Within agriculture, 90% of the water goes towards surface irrigation and the domestic sector is left with the smallest portion of the water distribution. This creates an irony that 17% of the world's population resides in India and it has to rely on 0.04% of the total rainfall in the world[7].

Exploration of the problem

From the secondary research I discovered two main areas of problem

1. Reliance on groundwater for about 70% of irrigation needs:

   "India is the largest user of groundwater in the world. It uses an estimated 230 cubic kilometers of groundwater per year - over a quarter of the global total. More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater."[8]

   The most common source of groundwater in India are wells. These wells are generally located within or on the outskirts of villages. Hence it is the most accessible source of drinking water for majority of households. When that water gets exhausted on agriculture, people in the villages face a massive water shortage. Due to this situation, especially during summer, the villagers have to rely on water-supply via tankers.

[7] https://www.oav.de/fileadmin/user_upload/5_Publikationen/5_Studien/170118_Study_Water_Agriculture_India.pdf
[8] More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater.

2. Irrigation techniques utilize only 35% water: The majority of Indian farmers use the method of surface irrigation. The method of surface irrigation in general has only about 60% rate of efficiency. [9] While that is the general case, in India due to lack of awareness on water conservation and low purchase power the irrigation techniques have a low rate of efficiency. Thus, majority of the water goes to waste.

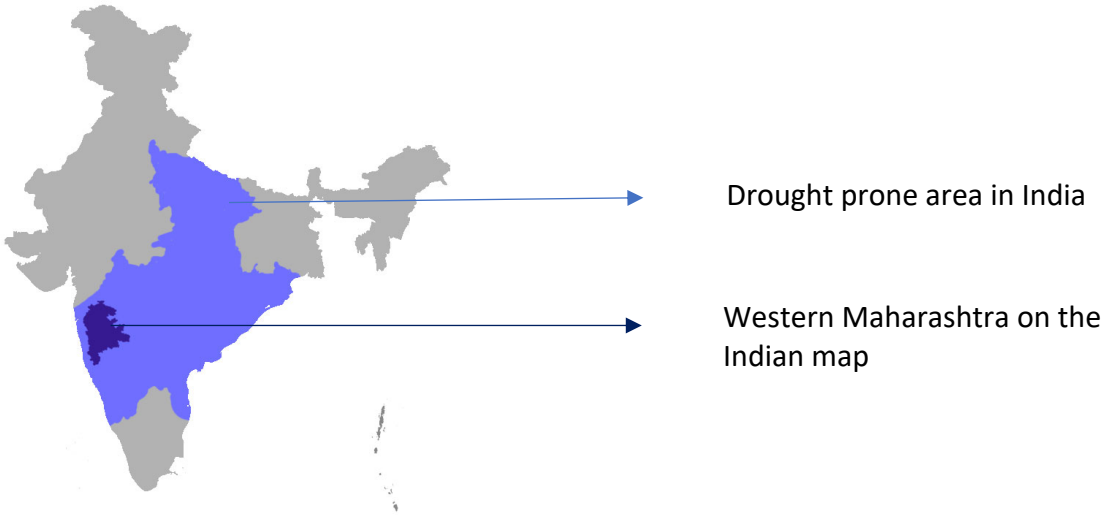
[9] http://www.fao.org/docrep/t7202e/t7202e08.htm

4. TARGET AUDIENCE/MARKET

My target audience is the government, village committees and farmers of the districts of western Maharashtra. The state of Maharashtra is located on the western coast of India.

Western Maharashtra consists of five districts:

Pune, Solapur, Satara, Sangli and Kolhapur. "This region is a prosperous belt and is famous for its sugar factories. Farmers in the region are economically well off due to fertile land, good irrigation."[10] Although, this part comes under the belt of the drought prone areas in India.



Farmers: Farmers of this region could be an ideal sample to conduct a research upon, as they are well off and can afford to own digital devices which could play a crucial part in a system driven by technological advancements.

Government: "82% of the rural population of the state of Maharashtra is dependent upon agriculture for livelihood. 71% of the agricultural land in the state is irrigated by

[10] https://en.wikipedia.org/wiki/Paschim_Maharashtra

groundwater".[11] The Maharashtra government is formed by the same political party that exists in the central government; which makes it easy for the policies of the central government to reflect on the state politics.

[11] http://www.indiawaterportal.org/articles/maharashtra-groundwater-development-and-management-act-2009

5. AREA OF OPPORTUNITY

From the secondary research, I came up with two main areas of opportunity:

1. Optimization of water usage in surface irrigation
2. Conserving rainwater for domestic usage

In order to evaluate the potential impact and problems, I created the following comparison chart:

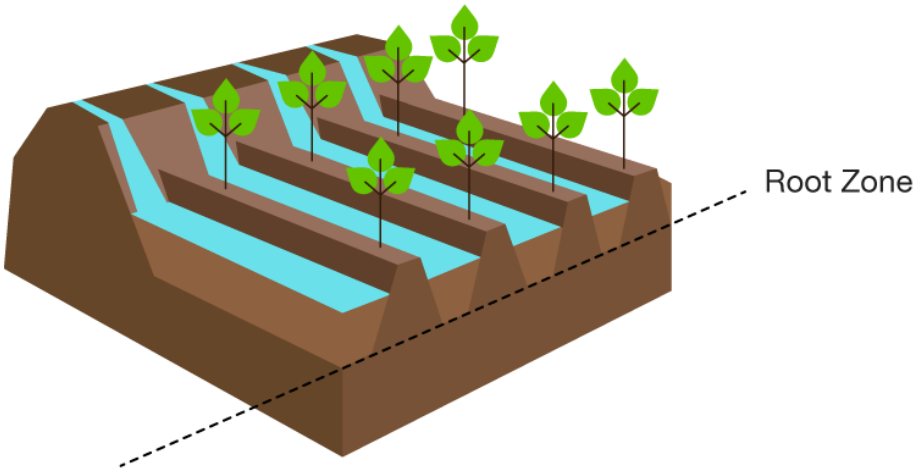
Whom to persuade	What to convince them of	Impact of reaching them	Research and rationale	Potential difficulties
Farmers	Conserving rainwater for domestic water needs	Using the conserved rainwater for domestic use will reduce the stress on groundwater resources such as wells	Currently, the groundwater accounts for 80% of domestic needs and 70% irrigation needs. If rainwater is conserved for domestic use, it will reduce the stress on the groundwater	conserving rainwater will need a new infrastructure which might demand for space and funding
	Optimizing the water usage in traditional surface irrigation method	If implemented by most farmers, it would reduce the water usage upto a few percents	80% of India's water resources are distributed for agriculture to boost the economy. Even if 1% water in agriculture is optimized, it will provide a percent more to the domestic needs	Lack of motivation to optimize water usage
	Use of sprinkler or drip irrigation instead of using the surface irrigation	If implemented by most farmers, it would reduce the agricultural water usage upto a great level	Currently only 3% of the farmers use drip or sprinkler irrigation: which are the methods of controlled irrigation that allows great amount of water optimization	It will take a long time to convince farmers to switch to the sustainable irrigation methods as it will require funding, different infrastructure and stepping out of their comfort zones
Village/ town Council	Implementing the methods of sustainable farming in the village/ town	If implemented by most farmers, it would reduce the agricultural water usage giving access to more water for domestic use	Village/ town councils are elected by the residents of that area and they are accountable for law enforcement and wellbeing of the residents. Hence they can be the agents in implementing the sustainable irrigation methods in a village/town	Lack of motivation, a careless attitude which formulates a reluctance to implement the new, sustainable techniques

After the comparison of the approaches I chose “optimization of water consumption in the traditional method of surface irrigation” as my area of opportunity. The reason choosing that approach is because surface irrigation is the most traditional technique of irrigation in India. Hence the farmers are familiar with it. This technique is cost

efficient. Hence optimization of water in this technique will not put the farmers through any financial burden or infrastructural learning curve.

Functioning of surface irrigation technique

The following diagram depicts the surface irrigation functioning:



In the method of surface irrigation, water is released in the field from the high point of gravity to the low point of gravity through furrows or didges. The water is allowed to flow free in the field for a number of hours. While that is the method in use, many farmers are not aware of the fact that the plants only require the amount of water that reaches till their root zone. Any water that percolates beneath the root zone goes to waste. Due to the lack of awareness and lack of availability of any technique to control the water application to the farm, a great amount of water is currently getting wasted. Even if 50% of the farmers were to control the water usage in agriculture, it would result in 5% of agricultural water conservation. This would double the amount of currently

available drinking water and reduce the problem of water shortage for domestic use. However, this area of opportunity would have one potential problem – the farmers may not be motivated to optimize water usage.

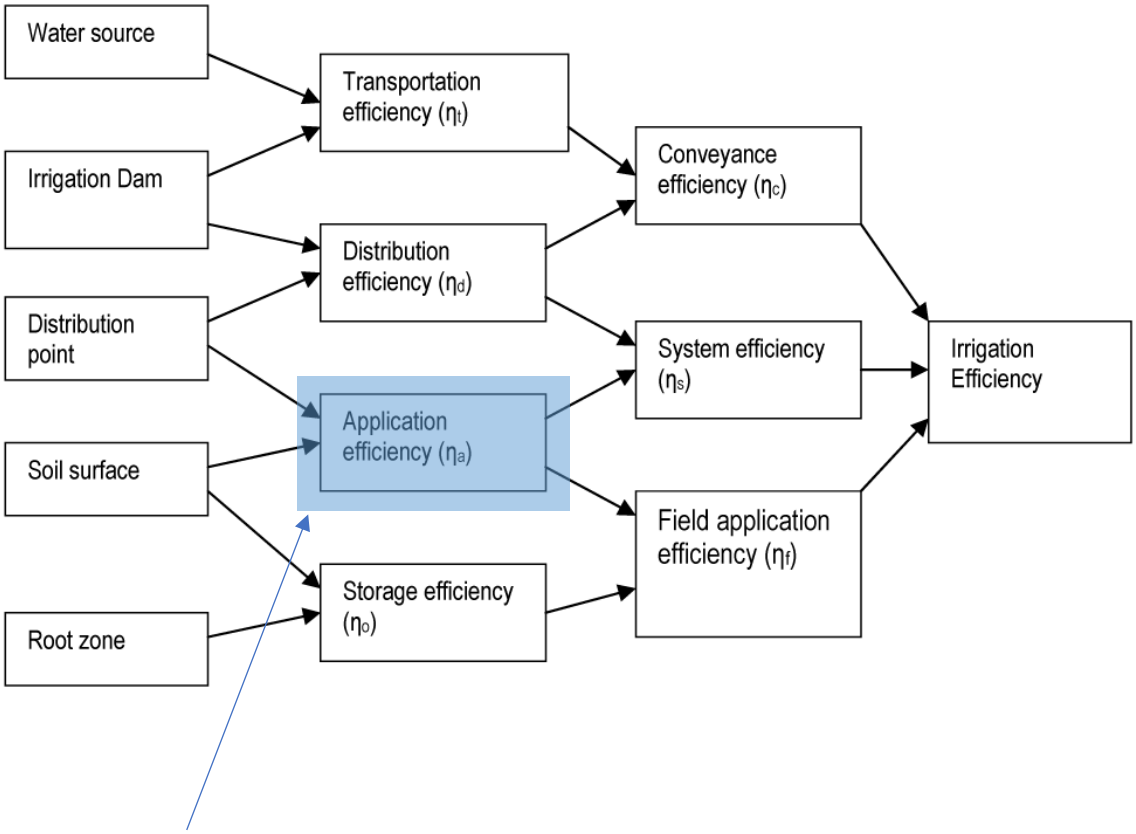
Surface Irrigation and Drip Irrigation comparison

	Surface Irrigation	**Drip irrigation**
Description	Surface Irrigation is the group of application techniques where water is applied and distributed over the soil surface by gravity.	Drip irrigation systems distribute water through a network of valves, pipes, tubing, and emitters.
Efficiency	40-50%	90%
Advantages	Irrigation management is very easy and does not require modern technology and can largely build on local traditional knowledge Adapts well to small land holdings and does not require high financial input Adapts easily to flat topography and can function without outlet drainage facilities Works well with short-term water supplies Irrigation allows full utilization of rainwater and can achieve high application efficiencies;	Maximum use of available water. No water being available to weeds. Maximum crop yield. High efficiency in the use of fertilizers. Less weed growth and restricts population of potential hosts. Low labor and relatively low operation cost. No soil erosion. Improved infiltration in soil of low intake.

	Adapts well to moderate to low infiltration rates and allows easy leaching of salts.	Ready adjustment to sophisticated automatic control. No runoff of fertilizers into ground water. Less evaporation losses of water as compared to surface irrigation. Improves seed germination. Decreased to tillage operations.
Disadvantages	Requires level land to achieve high efficiencies (maximum land elevation fluctuation should not be greater than half the applied irrigation depth) Soils with high infiltration rates require small field sizes, which interferes with mechanization. Difficulty to apply small irrigation quantities, excess water is difficult to evacuate, particularly during times of excess rainfall Plants are partly covered with water sometimes over extended periods (in low infiltration rate soils) Small basins require extensive delivery channels and are not easily adaptable to tractor mechanization	Sensitivity to clogging Moisture distribution problem Salinity hazards High cost compared to furrow. High skill is required for design, install and operation.

Basis of an Irrigation System Efficiency

Key factors in determining the efficicncy of an irrigation system



6. PRIMARY RESEARCH

Contextual Inquiry

- Research goal:

  Understanding the process of irrigation that Indian farmers follow, along with their needs, opinions, and awareness about water usage; to find out the loopholes that cause water wastage in order to design for a solution to conserve water.
- Target Audience:

  Farmers of the western part of the state of Maharashtra in India that belong to Gen X and use surface irrigation as the main source of irrigation.
- Research sample: 5 Indian farmers

Question segments:

1. General questions: This section contained the general background questions about the farmers in order to make them comfortable, along with some questions related to the basic information about their farm in order to set the context to further questions.
2. Irrigation related questions: These questions were intended to understand the farmer's farming and irrigation related habits and pain points.
3. Views and opinions: The questions in this section aimed at understanding the farmers' opinions and viewpoints on water conservation as well as the general drought situation.
4. About my design intervention: The questions in this segment were directed around my design intervention to understand the farmers' reaction and feedback on it.

Interview questionnaire in English:

General Info

1. Name
2. Highest level of education (discipline of study, if applicable)
3. Name of the village or community
4. Tell me about your family
5. How long have you been farming?
6. How did you learn the farming techniques?
7. What is the size of your farm?
8. What kind of crops do you take? Kharif/Rabi

Irrigation related Info

1. How long after the plantation do you usually irrigate your farm?
2. What method/technique of irrigation do you use?
3. What source of water do you use for irrigation? Ground water or canal?
4. Do you know about drip or sprinkler irrigation?

   If yes, can you tell me why do you use the surface irrigation?
5. Can you walk me through the process of how you irrigate your farm?
6. Do you know how long (how many hours/minutes) you irrigate for?
7. Do you know approximately how much water gets spent on irrigating your farm?

   If yes, how do you know?
8. Have you ever faced a drought situation?

If yes, how did you manage to irrigate your farm in that case?

9. Are there any difficulties that you have faced while irrigating your farm?

   If yes, what do you usually do when those difficult situations occur?

Farmer's Views

1. What according to you are the biggest problems of the farmers in Maharashtra?

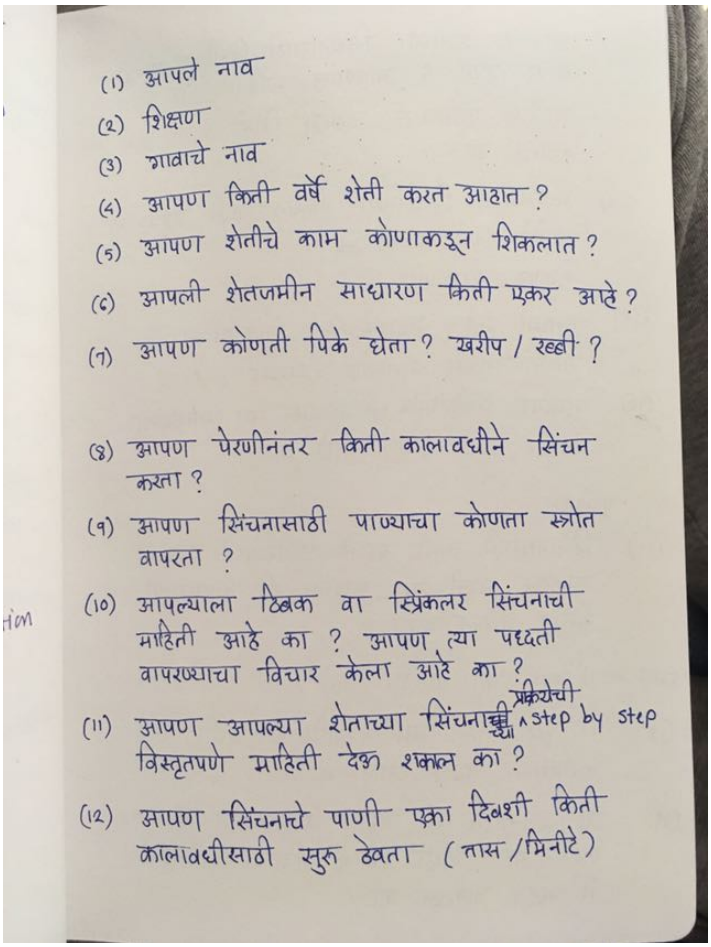
   Why?
2. Has anyone that you know ever faced any of these problems?
3. What do you think would have a positive impact on these problems?

About my idea…

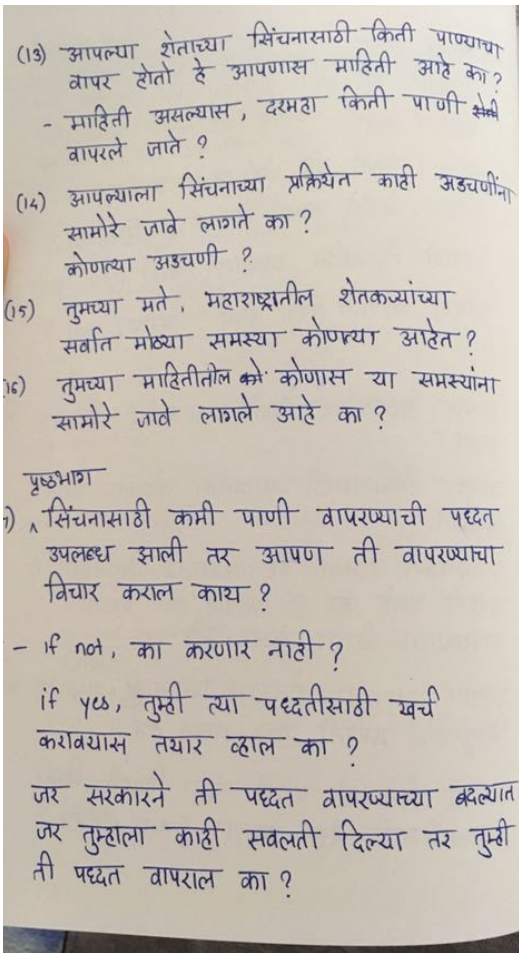
1. What if there was some way you could use less water in the irrigation process that you use? Would you consider taking that option?

   If yes, why? If no, why not?
2. Would you be willing to buy it if the government was to provide it to you in a subsidized price?
3. What if the government gave you something in return for using less water for irrigation?
4. What would you like the government to give you for using less water for irrigation?
5. Why that particular thing?

Research questions translation in Marathi



(1) आपले नाव
(2) शिक्षण
(3) गावाचे नाव
(4) आपण किती वर्षे शेती करत आहात ?
(5) आपण शेतीचे काम कोणाकडून शिकलात ?
(6) आपली शेतजमीन साधारण किती एकर आहे ?
(7) आपण कोणती पिके घेता ? खरीप / रब्बी ?
(8) आपण पेरणीनंतर किती कालावधीने सिंचन करता ?
(9) आपण सिंचनासाठी पाण्याचा कोणता स्त्रोत वापरता ?
(10) आपल्याला ठिबक वा स्प्रिंकलर सिंचनाची माहिती आहे का ? आपण त्या पद्धती वापरण्याचा विचार केला आहे का ?
(11) आपण आपल्या शेताच्या सिंचनाच्या प्रक्रियेची step by step विस्तृतपणे माहिती देऊ शकाल का ?
(12) आपण सिंचनाचे पाणी एका दिवशी किती कालावधीसाठी सुरु ठेवता (तास / मिनीटे)



(13) आपल्या शेताच्या सिंचनासाठी किती पाण्याचा वापर होतो हे आपणास माहिती आहे का ?
- माहिती असल्यास, दरमहा किती पाणी वापरले जाते ?
(14) आपल्याला सिंचनाच्या प्रक्रियेत काही अडचणींना सामोरे जावे लागते का ?
कोणत्या अडचणी ?
(15) तुमच्या मते, महाराष्ट्रातील शेतकऱ्यांच्या सर्वात मोठ्या समस्या कोणत्या आहेत ?
(16) तुमच्या माहितीतील कोणास या समस्यांना सामोरे जावे लागले आहे का ?

पृष्ठभाग

(17) सिंचनासाठी कमी पाणी वापरण्याची पद्धत उपलब्ध झाली तर आपण ती वापरण्याचा विचार कराल काय ?
- if not, का करणार नाही ?
if yes, तुम्ही त्या पद्धतीसाठी खर्च करावयास तयार व्हाल का ?
जर सरकारने ती पद्धत वापरण्याच्या बदल्यात जर तुम्हाला काही सवलती दिल्या तर तुम्ही ती पद्धत वापराल का ?

<u>Short interviews of American farmers</u>

- Research goal:

  Understanding the process of irrigation that American farmers follow, along with their amount of water usage and efficiency of irrigation.

- Target Audience:

  Farmers from around the Detroit area that use surface irrigation technique

- Research sample: 5 American farmers

Questions:

1. What is the size of your farm?
2. What crops do you usually take?
3. What source of water do you usually use for irrigation?
4. Approximately how long do you usually irrigate for in a day? (hours or minutes)
5. Approximately how much water do you require for irrigation per month?

Responses

Do you use surface irrigation?	What is the size of your farm?	What crops do you usually take?	What source of water do you usually use for irrigation?	Approximately how long do you usually irrigate for in a day? (hours or minutes)	How much water do you require for irrigation per month?
Yes	40 Acre	Potatoes, onions and other root crops	Well	Not more than 3-4 hours	About 2700 gallons per acre
No					
Yes	4 acres - greenhouse	potted flowering	reservoir/ pond	3-4 hours	1800 gallons per acre
No					
Yes	800 Acre	corn, beans, coliflower and many more	pond + canal. Depends on price	2-3 hours	1000s of gallons
Yes	1000 acre	corn, coliflower, potatoes, beans etc	city water - canal	4 hours	a few thousand gallons

7. PRIMARY RESEARCH CONCLUSION

1. Indian farmers use 8 times more water than American farmers: when asked the American farmers about their water usage they told that they irrigate 30-40 acres of land for 3-4 hours. Whereas, Indian farmers irrigate 10 acres of land for about 8 hours.
2. Two of the main pain points that the Indian farmers face is unavailability to a good quality seeds and fertilizers at an affordable price. Due to the lack of availability of quality seeds and fertilizers the farmers end up using low quality of seeds and fertilizers that result in them having a poor quality of yield that results in low profit, at the end landing them in debt.
3. The Indian farmers have a lack of availability to regular electricity supply that affects the functioning of the water pump. If there is no electricity during the day, the farmers switch the pump on at night and let the water run throughout the night which causes a great amount of water waste.