

Project 3 (Jan - May 2024)

FINAL PROJECT REPORT

A Digital Tool for Farmers to Manage Farming Resources & Activities

Guided by Prof. Girish Dalvi

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M.des Interaction Design (2022-2024)

IDC School of Design, IIT Bombay

Approval Sheet

Interaction Design Project 3 titled "A Digital Tool for Farmers to Manage Farming Resources & Activities" by Vinay Kumar (Roll Number 22M2250) is approved for partial fulfillment of the requirement for the degree of 'Masters in Design' in Interaction Design at the Industrial Design Centre, Indian Institute of Technology, Bombay.

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for external
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Declaration

I declare that this written document represents my ideas in my own words. Where others' ideas or words have been included, I have adequately cited and provided references to the original sources. I also declare that I have adhered to all the principles of academic honesty and integrity and have not misrepresented, fabricated, or falsified any idea, data fact, or source in my submission. I understand that any violation of the above will call for disciplinary action by the institute and can also evoke penal action from sources that have not been properly cited or from whom proper permission has not been taken when needed.

A handwritten signature in black ink, appearing to read 'Vinay Kumar', with a stylized, cursive script.

Vinay Kumar

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Acknowledgment

In this journey, I've come to realize that I'm not alone; things have evolved like rhizomes, interconnected and collaborative. Many teachers have played a crucial role in shaping my thinking, especially in design thinking. I extend my heartfelt thanks to everyone who has supported me, both directly and indirectly.

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Abstract

The backbone of rural India is farming in the Indian context. It is a major source of income and employment for people. The agriculture practices still follow traditional farming practices. The project aims to develop techniques to help farmers in their crop cycle. To understand it better we focused mainly on Mundapar village of Seoni District in Madhya Pradesh. Where Paddy and wheat farming is a mostly grown crop. We have interacted with the farmers and followed up throughout the project, this has given us the insight that. Most of the farmers are still following traditional practices. Whereas farmers are practicing grain-based farming, advancements in grain type have changed the perception of field area, resource calculation, scheduling, and soil health card integration. There are many other challenges and it is a wicked problem to solve, for this project's aim is to build an application based on the farmer's (taking input during the design process) need feature of the application to provide a digital map of their field with the integration of soil health card data, also it allows farmers to manage resources. This application is mostly farmers-centric, and farmers can update data on their fields.

This project started with focusing on the agriculture practices in Mundapar village of Seoni District Madhya Pradesh, where paddy and wheat farming is mainly cropped throughout the farming cycle. Our main goal was

to understand the current traditional practices, their benefits, challenges, and technological advancement in farming. To comprehend the problem-solving design product, we have divided the whole project into three stages.

Stage 1. We have combined the design project with DRS focus to understand the current practice through interviewing, co-creation activities, and field visits with farmers. Insights from this study gave a brief understanding of the current farming.

Stage 2. After Finalizing the basic roadmap for a design project, we prototyped and again interviewed and included the farmers in the design process. We have shown them the features, use cases, and paper prototypes screened. It helped to finalize the required feature which can help farmers in their crop cycle. So we have finalized the development of a mobile application that can help farmers schedule activities, calculate resources, integrate soil health card data, and map their fields.

Stage 3. Developing an application prototyping and testing with the participants

This project will give the platform to farmers that they can create field maps where they will be able to plan resources, management, activity planning, and soil data integration will be possible.

Introduction

The farming field is a wicked problem-solving activity. Our project started with finding challenges in the farming community through the lens of technological and interaction problem-solving design approaches. Current technological advancements have affected farming, such as the hybridization of seeds, advanced pesticides, fertilizers, etc. These advancements keep evolving, and coping with them will help farmers use them in a meaningful way. In this study, we are focusing on farming practices in Mundapar village of Seoni District, Madhya Pradesh. In this region, paddy and wheat are the seasonal cycle crop rotation farming practices. We have spent time with the farmers and researched to understand traditional area calculation, comparing that with GPS-based area calculation, which suggests that farmers estimated 7.41% more area. Along with this, we have interviewed farmers, conducted co-creation activities, and accompanied them in farming to elicit challenges. The study reveals that farmers are looking for something to help them with resource management and scheduling of farming activities. These challenges are numerous, affecting new farmers, while experienced farmers are seeking more advanced methods for soil health. The government provides them with soil health cards, but the challenge lies in how to interpret and use them in farming-related decision-making.

About Project

Project Objective

The Goal of the project is to move farmers toward precision-based farming instead of grain-based farming.

Design Goals

- Farmers should be able to manage resources.
- Farmers should be able to visualize fields.
- Farmers should be able to share resources among the community.
- Equipment sharing and ranting.
- MSP Registration process.
- Farmers should be able to integrate soil health cards with field maps.
- Scheduling of activities.

Motivation

Personal:

Belonging to a farming family, I noticed that, as a newcomer to farming, I faced many challenges during the lockdown, particularly in scheduling tasks and calculating results. To address these challenges, I conducted an experiment that helped farmers schedule their resources according to parcel size. Encouraged by its success, I am now planning to develop this experiment into a mobile application.

This project will not only assist me in gaining a deeper understanding of farming but also provide opportunities for interacting with the farming community, understanding their challenges, and learning from their experiences. Additionally, it will involve writing, as I will need to document the development process and user feedback and study user behavior to ensure the application meets the needs of its users.

Rational:

Resources are calculated based on the land size, so it is a starting point for any farming activity. If this data is clear, then resources, scheduling, and management-related decisions can be made accordingly. At present, farmers are utilizing the traditional grain-based farming process, but advancements in agriculture suggest moving towards precision-based farming practices.

Village Location

We are focusing on the Mundapar Village, Seoni, Madhya Pradesh.



Figure 1. Mundapar Village Location

Target Audience

We are focusing on farmers who have a basic understanding of mobile technology. For this project, farmers in Mundapar village are using the mobile application for farming activities and are interested in adopting new technology. These farmers are primarily engaged in paddy and wheat farming practices.

Primary User

Primary users are farmers who have farming paddy or wheat farming land. It is for the farmers who have less experience in farming or experienced farmers who are phasing challenges in resource management. Also, farmers

who are interested in using soil health card data for farming and resource calculation.

Secondary User

This application focuses on precision-based farming, where farmers can mark their fields for various purposes such as businesses, shopkeepers, equipment renting, leasing land, etc. Additionally, this data can be utilized for secondary purposes. The secondary beneficiaries of this application are stakeholders who are indirectly involved in farming activities.

Stakeholders

Based on our primary and secondary research, we have mapped the agencies involved in farming activities. The primary stakeholder in all farming activities is the farmer. Following the farmer, we have identified resource providers who support farming activities. These are depicted in light green color. Additionally, there are tertiary stakeholders indirectly linked to farming activities. Moreover, farmers are utilizing online information found on the internet for their dairy farming activities.

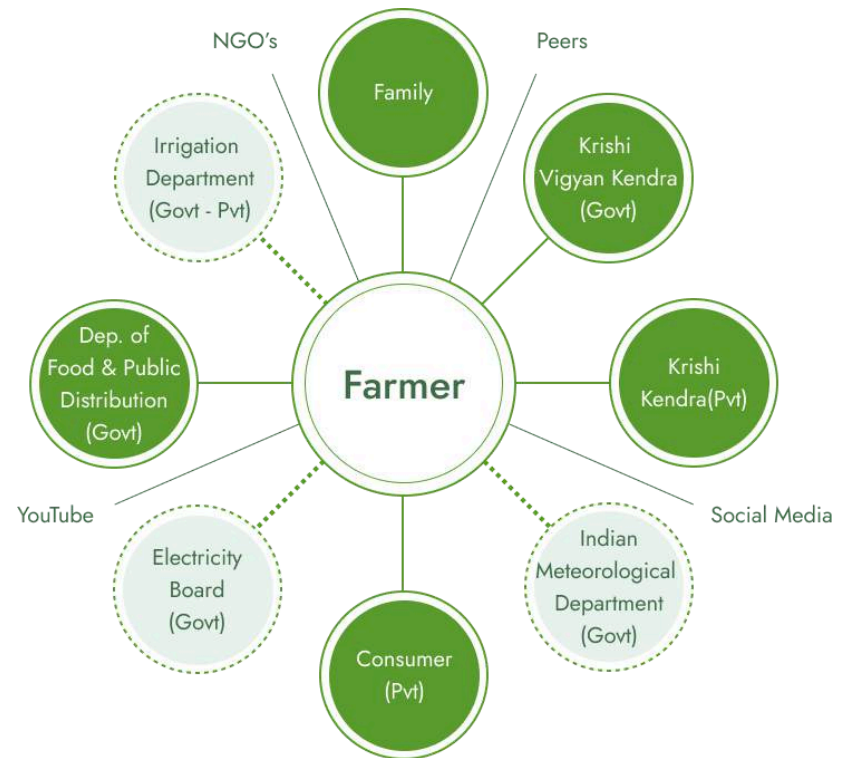


Figure 2. Stakeholder Map

Secondary Research

Building on extensive research in Sub-Saharan countries, particularly by Calogero Carletto, Sydney Gourlay, and Paul

Winters[1] in their study "From Guesstimates to GPStimates," which focused on self-estimated land areas compared to GPS-based absolute land areas, it is interesting to understand this in the Indian context. We seek to explore farmers' estimated land areas versus GPS-based measurements, assessing the significance of any identified error rates. Additionally, we aim to investigate the potential impact of these differences on resource allocation. There are farmers' own biases associated with land size estimation as they are a spectacle about it, as this data can be used for TAX collection, this is one of the reasons that we find local units of measurement in the abstract farm[3]. Drawing inspiration from another study by Calogero Carletto in 2013[2], which extensively explored the impact of measurement errors on farm size and productivity in African countries, our study extends this inquiry to the context of land area and resource allocation practices. This research aims to contribute valuable insights into the dynamics of land estimation, potential errors, and their implications for resource planning in the Indian agricultural landscape.

The study of crop area measurement technique [3] presented that many visual land area estimation methods are carried out with an error rate of $\approx 9.4\%$ of the mean and 11% as the average observation error. A study was conducted on text input methods to evaluate this, they used the stage-based experiment design and a similar data

collection method was used for his study. In this study, users are explained about the task and discussion. It is important to know the error in the current area estimation technique derived from the study conducted in African countries[1] which indicates differences in farmers' estimated area and absolute area. In India landform sizes are small and have multiple ownership in the division, because of that many have small land parcels. In these small land parcels, with poor infrastructure, and a lack of farmers' inclination to take risks[10], traditional methods are applied for farming but growing demand and technology in the market require more precise parking methods where fewer resources are required for a higher yield rate.

National Soil Health Card Scheme

The Government of India has launched the soil health card scheme, aiming to provide a detailed report of farmers' soil nutrients. For this scheme, the government has set up government soil testing labs in every district. Under this scheme, soil samples have been collected from farmers and provided a physical card and digital card. In Figure 01 a digital Soil Health Card is attached. When we have asked farmers how does this help them in farming? So it is not understandable because there are details but interpretation and use techniques are unfamiliar for farmers.

19/02/2024, 10:32

Soil health card

मृदा स्वास्थ्य कार्ड

केन्द्र का नाम: Soil Testing Lab Ujjain

पता : KirtiKant Talab, Ujjain, Madhya Pradesh,
456001, India

Test ID: 55867823-146-14-0368

परीक्षण दिनांक : 20 जनवरी 2024

SAMPLE INFORMATION

सर्वेक्षण संख्या : 320
नमूना एकत्रीकरण दिनांक : 6 दिसंबर 2023
Geo Position(GPS) :
75.144444, 23.166667

किसान का विवरण

नाम : किसान पुन बी

पता :

VV, India, 456001, Madhya Pradesh

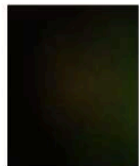
चयनित फसल

Wheat (Irrigated) , Gram , Soybean

प्लॉट का आकार

0.810 Ha

Plot Image



मिट्टी के नमूने का विवरण

उपलब्ध नाइट्रोजन 104.0
KG/HA
श्रेणी : 280 – 560

उपलब्ध फास्फोरस 34.9
KG/HA
श्रेणी : 10 – 25

उपलब्ध पोटेशियम 482
KG/HA
श्रेणी : 120 – 280

पीएच 8.04
श्रेणी : 5.5 - 8.5

इलेक्ट्रिकल कंडक्टिविटी
0.17 DS/M
श्रेणी : < 1

कार्बनिक कार्बन 0.42
W%
श्रेणी : 0.50 - 0.75

उपलब्ध सल्फर 31.0 PPM
श्रेणी : >10

उपलब्ध जिंक 0.31 PPM
श्रेणी : > 0.60

उपलब्ध बोरॉन 0.36 PPM
श्रेणी : > 0.50

उपलब्ध आयरन 6.37
PPM
श्रेणी : > 4.50

उपलब्ध मैंगनीज 7.85
PPM
श्रेणी : > 2.0PPM

उपलब्ध कॉपर 1.26 PPM
श्रेणी : > 0.20

MEASURED SCALE

मध्यम, तटस्थ, पर्याप्त, क्षारीय, थोड़ा
अम्लीय, उच्च (OC,OM)

मध्यम(OC,OM)

नीचा, अपूर्ण

उच्च, ACIDIC, SALINE, अत्यधिक
क्षारीय, नीचा (OC,OM)

चयन नहीं किया गया

संस्तुति

फसल

SOIL CONDITIONER
/ AMENDMENT

मैक्रोन्यूट्रिएंट उर्वरक

सूक्ष्म पोषक तत्व उर्वरक

अस्वीकरण: हमारी रिपोर्ट को पूरी तरह से या आंशिक रूप से पुनः प्रस्तुत नहीं किया जाना है और कानून की अदालत में सबूत के रूप में इस्तेमाल नहीं किया जा सकता है और हमारे पूर्व लिखित अनुमोदन के बिना किसी भी विज्ञापन मीडिया में इसका उपयोग नहीं किया जाना चाहिए इस रिपोर्ट में दर्शाई गई उर्वरक सिफारिश चयनित फसल के पूरे मौसम के लिए है।

Figure 3. Soil Health Card

Precision Farming

In the 20th century, technological evolution has been driving towards the concept of precision agriculture. As these advancements unfold, precision farming practices become increasingly viable. Precision farming focuses on optimizing resources and scheduling to enhance agricultural efficiency. Key considerations revolve around the profitability and efficiency of technology, alongside opportunities for adaptation.[5]

The study indicates a close correlation between precision farming technologies and farmers' perceptions of and requirements for institutional support. This relationship underscores the potential benefits of precision farming in addressing various economic and environmental challenges. Moreover, precision farming indirectly contributes to the achievement of Sustainable Development Goals (SDGs) over the long term.

By leveraging technological innovations, precision agriculture offers solutions to enhance agricultural productivity while minimizing resource inputs[6]. The integration of precision farming techniques allows farmers to make informed decisions, tailor interventions to specific field conditions, and maximize yields sustainably.

Additionally, by promoting resource optimization and environmental stewardship, precision farming aligns with broader sustainability objectives outlined in the SDGs

Geographical Information System(GIS): In Agriculture

GPS-based technological solutions have become widely adopted in agricultural advancement, aiding farmers in various aspects of land management and operation automation. These solutions enable farmers to measure land area accurately, generate topographical maps, and identify ecological issues such as slope and watershed boundaries. By utilizing GPS technology, farmers can create resource maps detailing soil characteristics, land use patterns, and surface water features. Moreover, GPS facilitates automation of farm operations including tillage, planting, fertilizer application, pesticide spraying, irrigation, and harvesting. The high-resolution Digital Elevation Model (DEM) provided by GPS enhances decision-making by supporting soil moisture and fertility models, thereby optimizing agricultural practices for improved productivity and sustainability.[7]

Existing Mobile Application

To understand the current applications working in the farming sector we have used them for a while to know about the features and how users are using that application.

1. Plantix

This application is well known for AI integration in disease identification in plants.

Advantages

- AI integrated plant and disease in identification and suggestions of pesticides
- Fertilizer calculation based on land size.
- Community portal for more interactive interaction between farmers.

Disadvantages

- Generalized Fertilizer calculator of all over India.
- Fertilizer and land size have no relation.
- No suggestions for seed and fertilizer combination, Scheduling can be integrated.

Unique Features

- AI integration.
- Periods for fertilizers used in farming but the amount is wholesome.

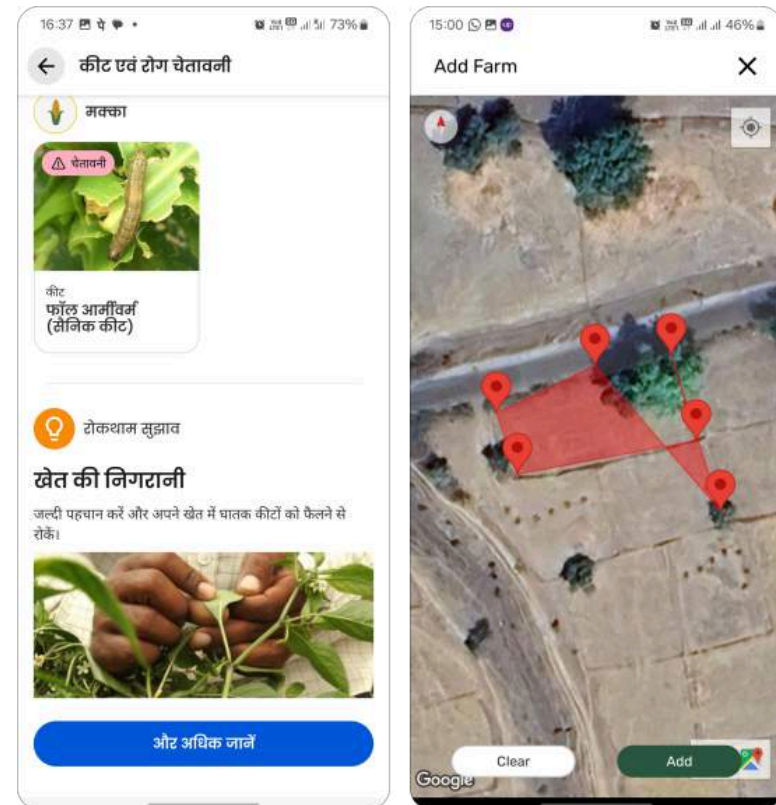


Figure 4. Plantix app land demarcation and disease identification

2. AgriApp

AgriApp provides a variety of farming-related features, including land demarcation, fertilizer calculation, and information about farming practices. However, the main emphasis of the app is on its marketplace, where farmers can conveniently purchase agricultural products.

Advantages

- E-commerce platform for farmers.
- Satellite Insight by landmarking on a map.
- Crop Calendar gives a generic schedule.
- Soil testing laboratories.

Disadvantages

- Minimum Land size is 0.5 acres required.
- Only farm boundaries can be marked.
- The crop calendar is very basic and the same for all soil types.

Unique Features

- Fertilizer Calculator with schedule
- AI chatbot.
- Diary

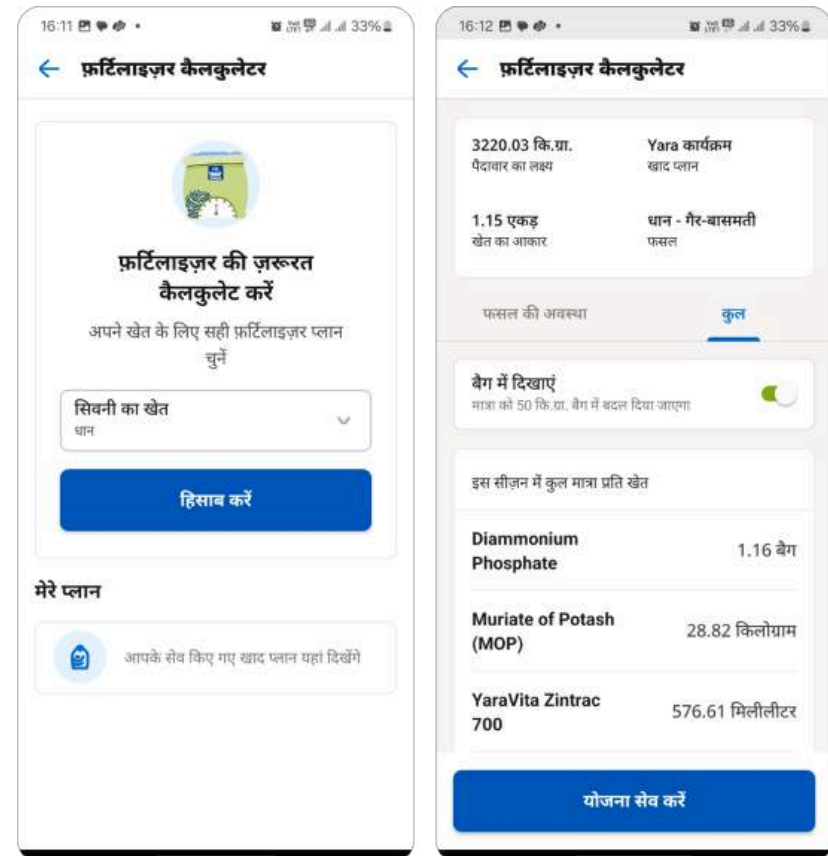


Figure 5. AgriApp fertilizer calculation and scheduling

3. Easy Area

This application is solely dedicated to field measurement. Users can mark their fields using the earth imagery provided by the application. It allows users to create multiple fields within a single map. However, the user interface is complex and difficult to understand, which has led to low adoption among farmers. Additionally, the application lacks relevance to farming activities, further limiting its usability and appeal within the agricultural community.

Advantages

- Clear Imagery to Mark Field.
- Multiple Fields can be marked.
- Allows multiple units of area

Disadvantages

- Not clear labeling of field.
- No schedule of areas.
- Small parcel marking is challenging
- Editing is difficult for farmers and dropped in between.

Unique Features

- Multiple areas can be added in a single map.
- High accuracy in the measured area.

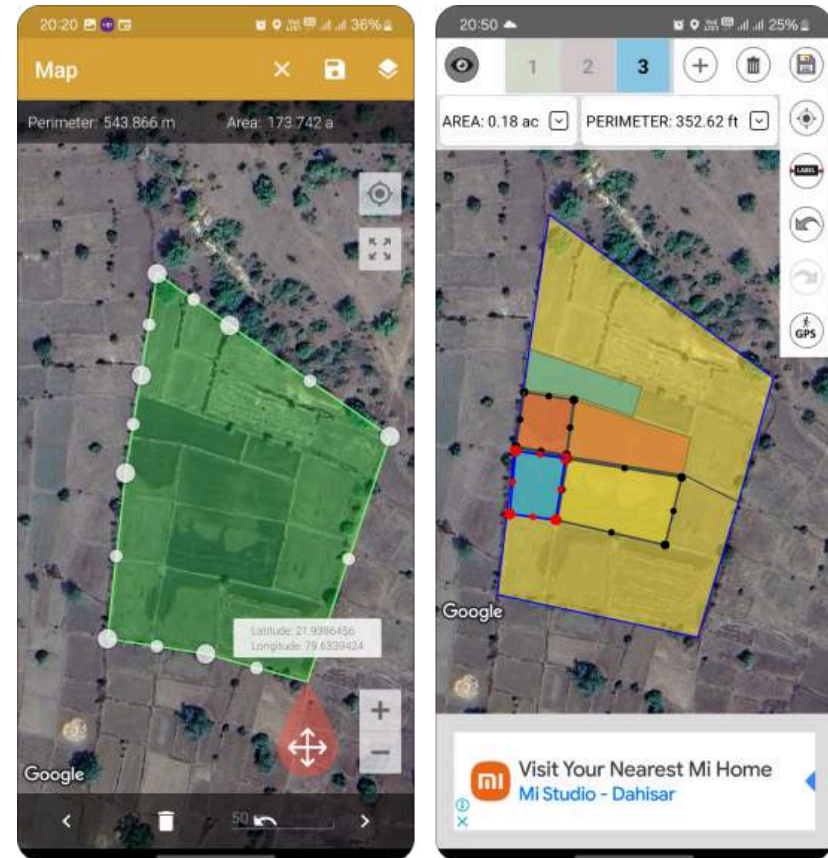


Figure 6. Land Parcel marking in the Earth imagery.

4. Krish-e

The Krish application assists farmers in managing expenses, maintaining records, and ordering products directly from the application.

Advantages

- Fertilizer Scheduling, Crop preparation, and Spray Scheduling are the USP of the app.
- Scheduling of field preparation for paddy, wheat, javar, etc.
- Colander's integration with notification for the upcoming activities.

Disadvantages

- No remarks options are given for the scheduling.
- Fixed ways for all types of services provided by the app.
- A lump sum amount of fertilizer is displayed.

Unique Features

- Added in the crop preparation methods.
- Clear and understandable UI Design.

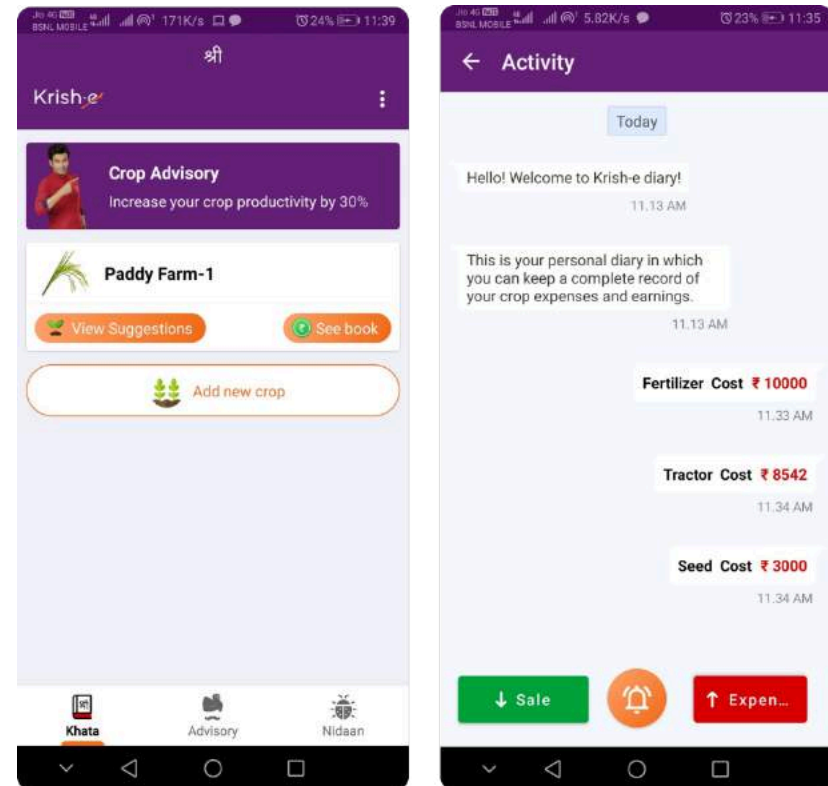


Figure 7. Field Marking and Expense Management

Primary Research

To find out the farmers' perspective for our questions we have conducted Interviews, co-creation activities, and accompanied the farmers to the field.

Interviews are conducted in an informal setting, where we follow the questionnaire with basic questions to start the interview. But farming has wicked challenges During the interview.

Questions

आप का खेत किस गांव में है ?

In which village is your farm?

आप कौन कौन की फसल लगाते हैं ?

Which crops do you grow?

आप के पास लगभग कितने एकड़ जमीन है ?

Approximately how many acres of land do you have?

सारी खेती एक साथ ही है या अलग अलग जगहों पर है ?

Is all the farming together or at different places?

आप खेती के लिए बीज, सोडा, दवाई की मात्रा कैसे नापते है ?

How do you measure the quantity of seeds, fertilizers, and medicines for farming?

आप सभी कुछ खुद से नाप लेते है या किसी की सलाह लेते है ?

Do you measure everything yourself or take someone's advice?

आप को क्या लगता है खेती में पैसा कहा कहा खर्च होता है ?

Where do you think the money is spent in farming?

कभी आपने किसी मोबाइल एप्लीकेशन का उपयोग किया है ?

Have you ever used any mobile application?

जैसे जमीन नापने , सोडा कितना लगेगा देखने, बीज देखने, बाजार भाव देखने इत्यादि के लिए ?

Like measuring the land, seeing how much fertilizers will be required, seeing the seeds, seeing the market price, etc.?

आप कभी कृषि विशेषज्ञ से परामर्श लेते हैं ?

Do you ever consult an agricultural expert?

आप को मृदा परीक्षण के बारे में जानकारी है ?

Do you know about soil testing?

क्या आप कभी मृदा हेल्थ कार्ड का उपयोग करते है, उर्वरक के मात्रा निकलने में ?

Do you ever use a soil health card to determine the quantity of fertilizer?

आप को खेती में कितना फायदा या नुकसान हो रहा उस की गड़ना करते है ?

Do you calculate how much profit or loss you are incurring in farming?

किसी जगह पर फसल में लगने वाले खर्च, सामान, दवाई, इत्यादि का हिसाब रखते है ?

Do you keep track of crop expenses, materials, medicines, etc. at any place?

क्या आप आपस में सुझाव बाटते है?

Do you share suggestions with each other?

किसी ऑनलाइन सलाहकार का अनुसरण करें?

Follow an online consultant?

क्या आप को सरकारी योजनाओं के बारे में जानकारी मिलती रहती है ?

Do you keep getting information about the government schemes?

अगर मिलती है कैसे और कितने समय बाद ?

If found, how and after how much time?

क्या आप पिछले साल की गलतियों को याद रखते हैं ?

Do you remember last year's mistakes?

क्या आप अपने खेत में कितनी पड़ती (अनुपजाऊ) जमीन है ?

Do you know how much barren land is there on your farm?

These questions are gradually modified according to farmers' practices.



Figure 8. Farmers preparing resources for sowing



Figure 9. Paddy Harvesting

Co-Creation Activity

In this activity, farmers are asked to create their field map or explain it so that we can understand. In this activity, farmers act as guides, and I, as a new farmer, learn from them. Farmers teach and explain the tasks they perform in the field and the thought processes behind them. Through this activity, we gain insight into their decision-making processes during farming.



Figure 10. Discussion with farmers

Above picture is the before and after task discussion with farmers to understand the farming practices and how they estimate their land area.

Field Visits

We accompanied the farmers to their fields to understand their farming activities. In the field, we asked them to measure the land area and how it affects their resource calculation. It became evident that land area serves as the basis for all other activities. Farmers primarily rely on traditional grain-based land area measurement methods,

while newer advancements mainly focus on precision-based measurements such as acres or hectares. Consequently, farmers encounter difficulties in adapting to these precision-based measurements. Additionally, we found that some farmers are using GPS-based land measurement applications. These applications provide approximately correct area calculations compared to grain-based measurements. However, farmers face challenges with current applications as they only display individual land parcels' area, rather than providing a comprehensive field measurement.



Figure 11. Wheat farm and Dhura between the small parcels

Dhura or PAAR

The local term used for the elevated border created to separate two small land parcels is called a "bund." These areas are not utilized for farming purposes and are spread throughout the field.

Inferences from Primary Research

- Each method of interaction has a special feature to evoke diverse responses.
- So there are mainly two types of farmers: experienced farmers and new farmers. Each farmer has different requirements.

New Farmers Need

Goals

- Start farming at appropriate time and get a broader picture for the next 5 months.
- Resource Calculation Method
- How many resources are required for the next 5 months and Schedule?
- How to be prepared for the farming failure scenarios.

Needs

- An experts team available to help them throughout the process.
- Experiences and reports of previous years
- Land parcel area calculation
- A database of experienced farmers' knowledge and feedback to predict the next steps.

Inferences

- Quick question and answer portal for the farmers
- Quick suggestions & update based on weather forecast.
- Land - resource based calculation.

Experienced Farmers Need

Goals

- Knowledge of new techniques and fertilizers.
- Record management for used seeds and fertilizers.
- Soil testing report understanding and implication information.
- Market updates for goods and resource price.

Needs

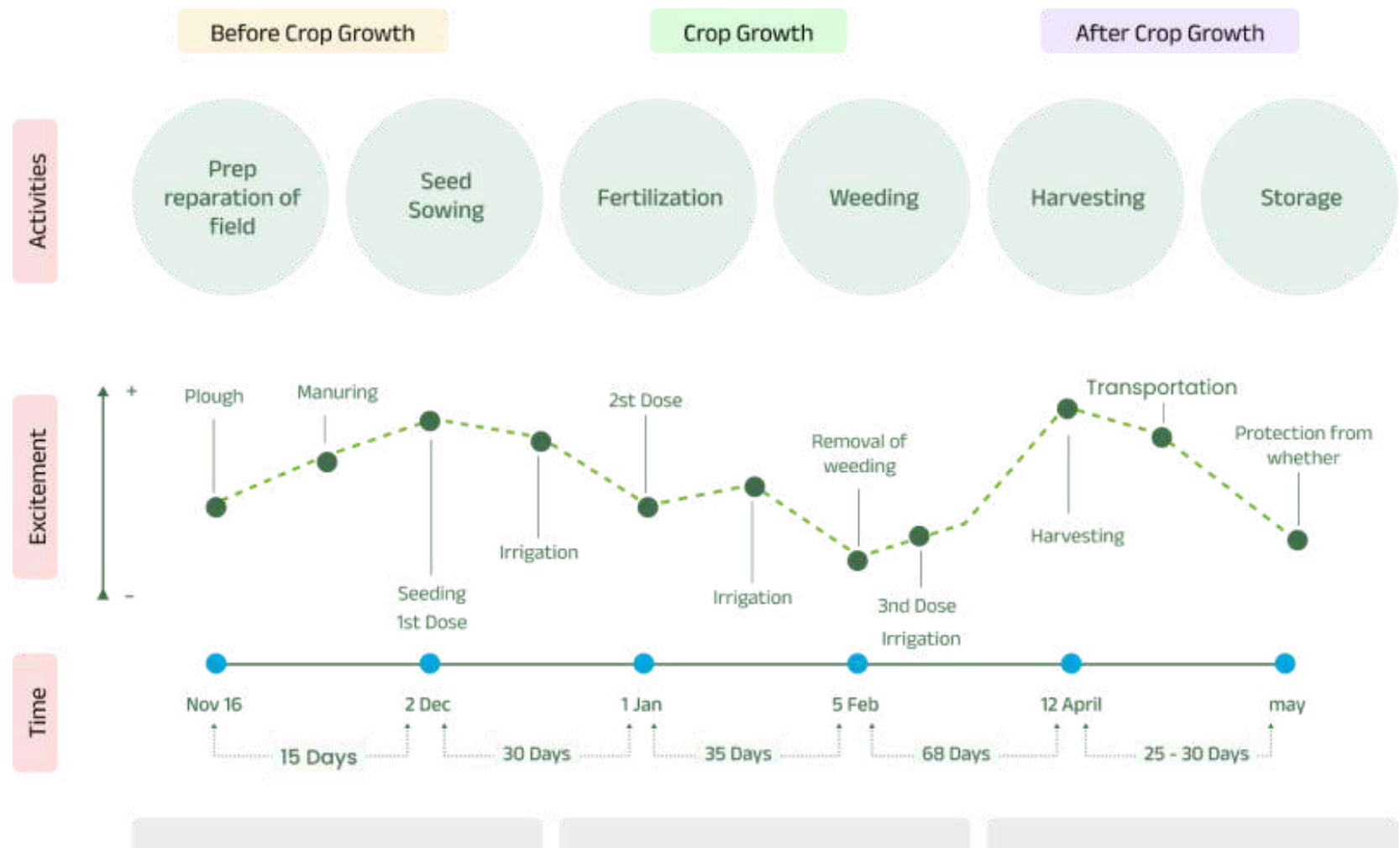
- A diary, Log sheet, notepad for maintaining records
- News Updates regarded farming.
- Soil test report information.
- Tutorials for new techniques and resource availability.

Inferences

- Daily market updates.
- Scheduled and organized resource management.
- Technology understanding.
- Synthesis of soil test.

Crop Cycle Mapping

We have spent time with farmers to understand the crop cycle. During this process, we have taken part in farming activities and interviewed them. This has provided insights into the farmers' perspectives, feelings, requirements, challenges, and suggestions for improvement. We also explored how farming is changing with modern technology and machinery. This was a longitudinal empirical study, conducted with a focus on specific farmers. The crop cycle has been documented specifically for paddy farming in this context.



Goals	• When to Start? • How to Start? • What will be needed? • How much time will it take? • When will Rain start?	• How many resources will be needed? • How to calculate seed and fertilizer? • When and doses of fertilizer? • How to check the health of plants? • When will the sun be the shine?	• How to transport goods? • How to protect goods from rain? • What is the market rate of paddy? • When will mandi start? • How much money I have spent in last season?
Pain Points	• Do not have a schedule for pre-preparation • Do not have weather updates and inferences of farming • Last-minute unavailability of machinery	• Less idea about the land size. • No scheduled & fertilizer calculation method. • Less knowledge about the technology. • Less understanding of weather forecast.	• Quick question and answer portal for the farmers. • No idea about the demand of the market in terms of farm goods. • Less market understanding for good and storage options. • Quick suggestions & update based on weather forecast.
Opportunity	• Pre designed schedule for farming • Daily and crop-related weather updates • Reminders for activities	• Land area calculator • Seed and fertilizer calculation • Training of new technology • Scheduling of fertilizer	• Market rated update portal • Market analysis updates • Weather forecasting suggestions. • Links of the warehouse.

Topography of Land Forms

The region has uneven terrain, with limited flat land. Most farming fields are small, ranging from 0.05 to 0.5 acres. Farmers divide fields into these small parcels for better organization. This is especially important for crop rotation; paddy farming needs smaller parcels to retain water, while wheat, needing less water, doesn't. So, the larger field area is divided into small parcels, similar to Figure - 2, where small parcels have organic shape and size according to topography[15], temporality, and convenience of farmers' capability to manage parcel size. The field is divided by a PAAR which is an uncultivated area. The size of PAAR also varies from 2 feet to 10 feet. In a few cases like field road, it can go up to 20 feet. Also, it is more in width on the two farmers' field boundary. But all the time this land area is calculated in farming land area.



Figure 12. Land Farm in Mundapar Region (Google Earth Imagery)

In the above image, small land parcels are visible, which are divided by the PAAR for managing water flow in the field and for convenience in farming. Thus, one larger land parcel is divided into smaller parts.



Figure 13. Total Field Area



Figure 14. Parcels in Field

Land Area Measurement Techniques

According to our study in DRS, we have identified three types of land measuring techniques used by farmers. One of these techniques is mobile-based measuring, which has been newly adopted by younger farmers and some individuals involved in businesses related to renting equipment to other farmers. Instead of relying solely on farmers' estimations of land area, these individuals use mobile-based area measurement tools for clearer and more accurate measurements of land area.

Farmers Estimated Land Area Measurement

A noteworthy aspect is that most farmers tend to construct a mental model for their fields, incorporating a self-estimated land area. The estimation process primarily relies on eye observation, where farmers gauge the size of their land through visual inspection—a skill that develops with experience.

Farmers typically derive their estimated land area by considering factors such as the number of seeds sown and the amount of fertilizer applied in a given area. The unit of measurement for land area is commonly expressed in Acres, Kudo (equivalent to 0.1 Acre), and Khandi (equivalent to 2 Acres). Among these, Kudo and Khandi are the most popular units employed by farmers, serving as the basis for various calculations in their farming practices.

Mobile-Based Land Measurement

Our study revealed that several farmers utilize mobile applications such as Field Area and Ease Area. These convenient tools leverage GPS technology to pinpoint the user's location and provide Google Maps visuals, enabling farmers to delineate and calculate the size of their land accurately. It is important to note that these applications are designed for general land measurement purposes and are not specifically tailored for agricultural activities. Nevertheless, some farmers have found them to be valuable for assessing the dimensions of their fields and incorporating the collected data into their mental representations of the land.

This mobile-based measuring technique has been newly adopted by younger farmers and by some individuals engaged in businesses related to renting equipment to other farmers. Rather than relying solely on farmers' estimations of land area, these individuals utilize mobile-based area measurement tools for more precise assessments of land area.

Demarcation Land Measurement (Shimanakan by Government)

This method is driven by government employees, wherein farmers have to apply for land demarcation. Based on these applications, the government conducts a demarcation process whereby designated government

officials use area-measuring tools provided by the government to demarcate the land. However, this demarcation is limited to the boundaries of the fields; internal boundary measurements are not allowed in this process. Due to the time-consuming nature and paperwork involved, many farmers avoid undergoing this process for routine purposes. It is primarily conducted when farmers sell or change ownership of their land, or when there is a need to confirm field boundaries.

Our findings revealed that farmers primarily rely on grain-based land area measurement methods for estimating their land area. However, when we compared the farmers' estimated land area with GPS-based measurements, we discovered significant differences between the two. The results indicated a median difference of 7.4%, with new farmers tending to have a higher margin of error, averaging 20% more than the actual land area. In contrast, experienced farmers were found to have less discrepancy, typically ranging from 0% to 5% more than the actual land area. This error is not one time this will continue for years and if resources calculation follows the same. Also, this study shows that farmers overestimate the land area. There are several reasons for the error in land calculation. Roundoff error is where farmers calculate their land in a roundoff of .05 acre. Land farmers are measured once when they purchase, sell, or during demarcation

(Shimankan), in this process, they measure only the outer boundary of the field. So the internal divisions are never measured and documented. Internal partitions are modified when fields are distributed among the family members. Many times fields have organic divisions where the sizes of the small parcels vary. Once a size is fixed it remains the same in the farmer's mindmap. There is no error check to rectify or cross-check. For the new farmers, it is more difficult to address land area estimation so they Rely on other estimated areas. This error is estimated as follows because there are no proper measuring techniques available for small land parcel measurement and this study can question how technological measures can help.



Figure 15. Box Map of Differences in Area Estimation

Expenditure Management

In our primary and secondary studies, we have documented and analyzed the factors that affect farming expenditure and how farmers distribute their budgets. According to our study, this is one of the major impactful factors in farming. In current farming practices, farmers often lag in properly documenting these expenses. We focus mainly on outgoing expenses because they occur throughout the crop cycle in small increments and are easily forgotten over time. In contrast, income is only generated when the crop is sold at markets or local shops, which typically happens two or three times a year.

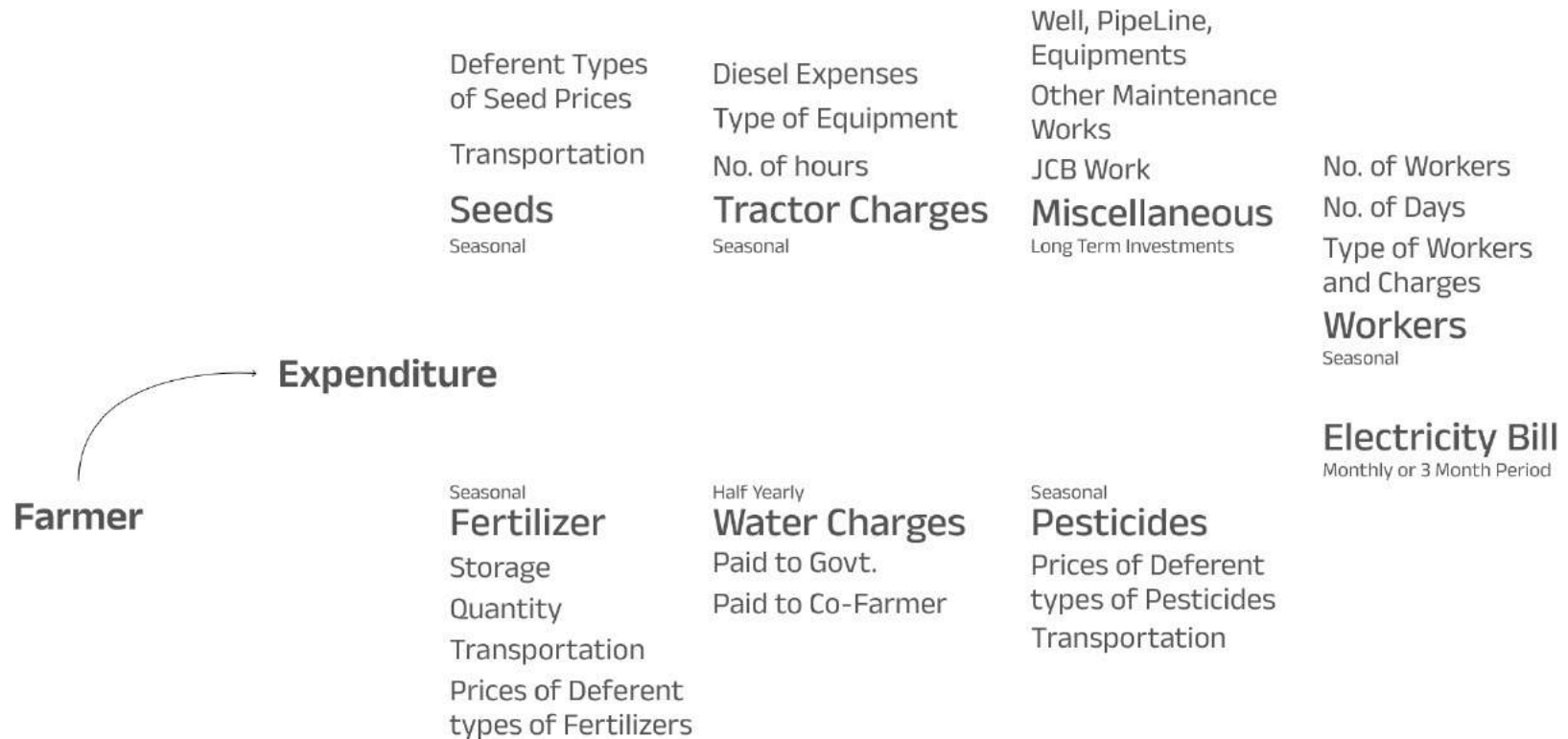
Here, we have documented the major factors that affect expenditure:

- **Seed Costs:** The initial investment in seeds.
- **Fertilizers and Pesticides:** Regular purchases are necessary for crop health.

- **Labor Costs:** Payments for hired labor during planting, maintenance, and harvest.
- **Irrigation:** Costs associated with water supply and irrigation systems.
- **Equipment Maintenance:** Upkeep of farming machinery and tools.
- **Transport:** Expenses for transporting goods to markets.
- **Miscellaneous Supplies:** Various other supplies are needed for day-to-day farming activities.

These documented factors highlight the need for better expense tracking to ensure more efficient budget distribution and overall better management of farm resources.

Expenditure Management(Outgoings)



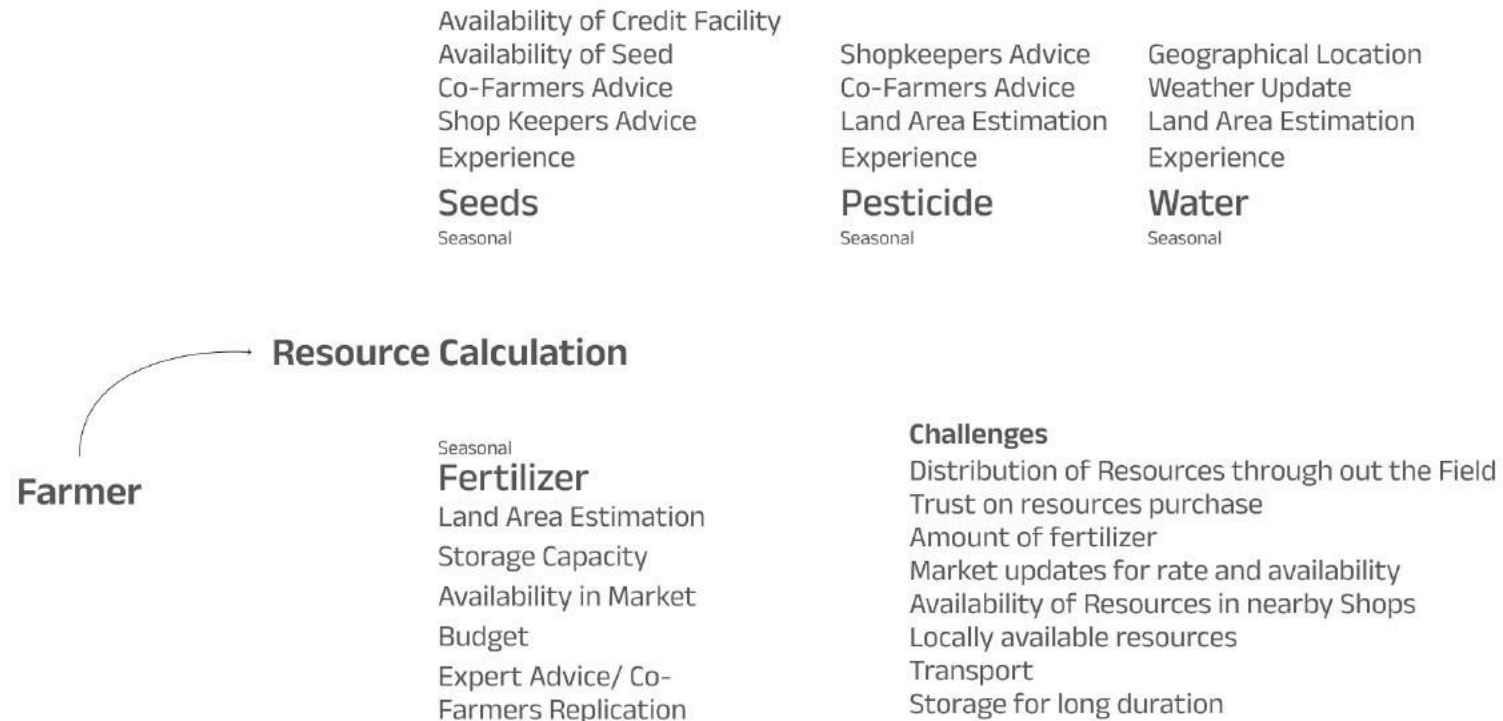
Resource Calculation

In our study, we have documented the mental model of resource calculation followed by farmers, and we have also

consulted farming experts to gain insights into the theoretical perspective of resource calculation. Farmers primarily focus on seed, fertilizers, and field plowing, followed by the human power required for farming activities. The extent of human labor needed depends on the number of family members involved in farming; the more family members working in farming generally results in lower labor expenditure.

Each resource necessitates thorough research for finalization. Therefore, farmers seek advice, and discuss with peer farmers, considering availability, storage, and other factors before making decisions regarding resource allocation.

Resource Calculation



Weather-Based Decisions

According to the study, weather is a significant factor affecting crop yield, prompting farmers to be proactive in predicting weather patterns. Traditionally, farmers have relied on Indian festivals as indicators of weather forecasts. However, there is a growing trend among farmers to seek mobile-based weather prediction tools for more accurate and timely information.

Farmers are particularly concerned about the weather conditions at key stages of the farming process. Firstly, during the early stages of planting when seeds are vulnerable and small changes in weather can have a

significant impact on crop health. Having access to reliable weather predictions at this stage can enable farmers to make more informed decisions, ultimately improving plant health.

Secondly, farmers pay close attention to weather forecasts as the plants begin to blossom and during the harvesting period. Weather conditions during these stages can directly affect crop quality and yield. By leveraging mobile-based weather prediction tools, farmers can better anticipate weather changes and take necessary precautions to protect their crops and optimize harvest outcomes.

Weather Based Decisions

Pre-preparation for farming activities

Cleaning Field
Ploughing in Dry Season
Storage Preparation for seed, fertilizer, and equipment's
Med Badhan Works
Cow Dung Spread in field

Rainfall

During the Sewing & During Crop Growth

Storage of Water
Fertilizer based Decisions
Pesticide Spay time

Rainfall & Wind flow

Harvesting

Best time to harvest
Produce Storage
Preparation
Best time for threshing
Good Time for booking slot in Mandi

Rainfall & Temperature

Next Season



Experiment Design

Experiment for Precision Farming with GIS Tools

We experimented with farmers, focusing on utilizing GIS-based farm mapping as a foundation for informed decision-making. In this experiment, we meticulously marked the farmers' fields on a GIS map, detailing areas of fertility and infertility, as well as including information about trees, water pipelines, wells, and boundaries. Each parcel was assigned a unique number and area, creating a

comprehensive and detailed map. Using this map as a guide, we calculated the seed requirements, as well as the quantities of nitrogen, DAP, and Super fertilizer needed for each parcel. These inputs were then properly distributed throughout the field according to the map. To create this map, we utilized various tools and software including AutoCAD, Google Earth, Excel Sheets, and online converters, ensuring accuracy and precision in our mapping process.



Figure 16: Step 1- Mapping the Land Parcels on Map

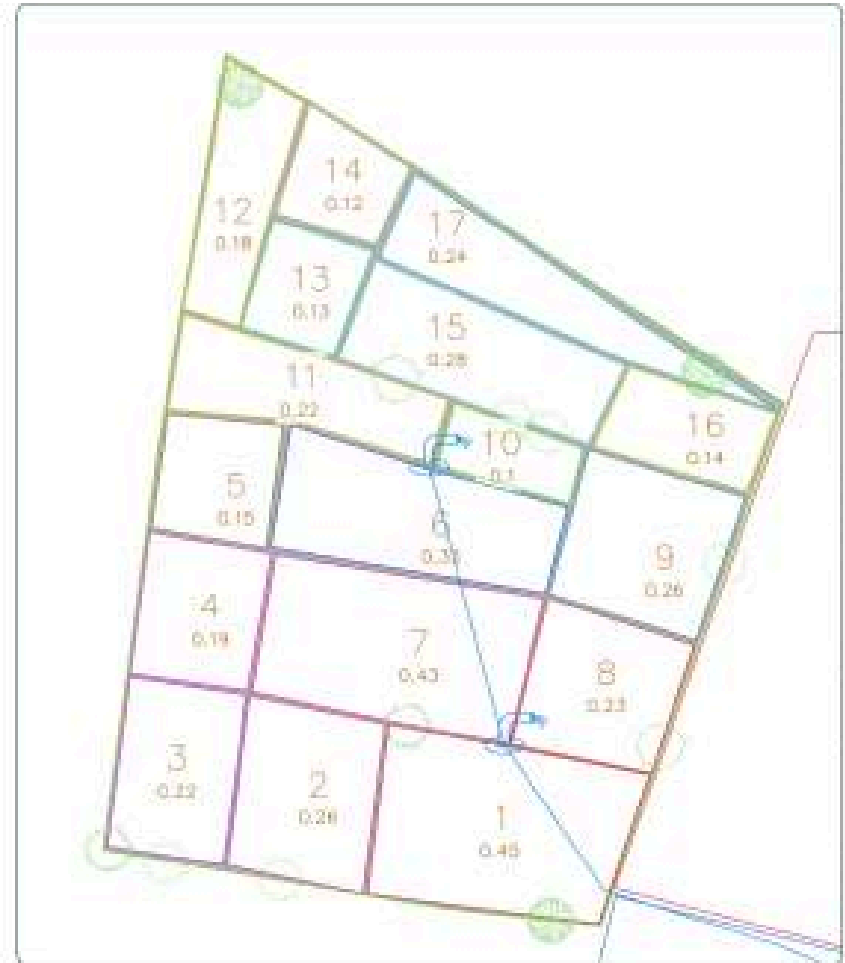
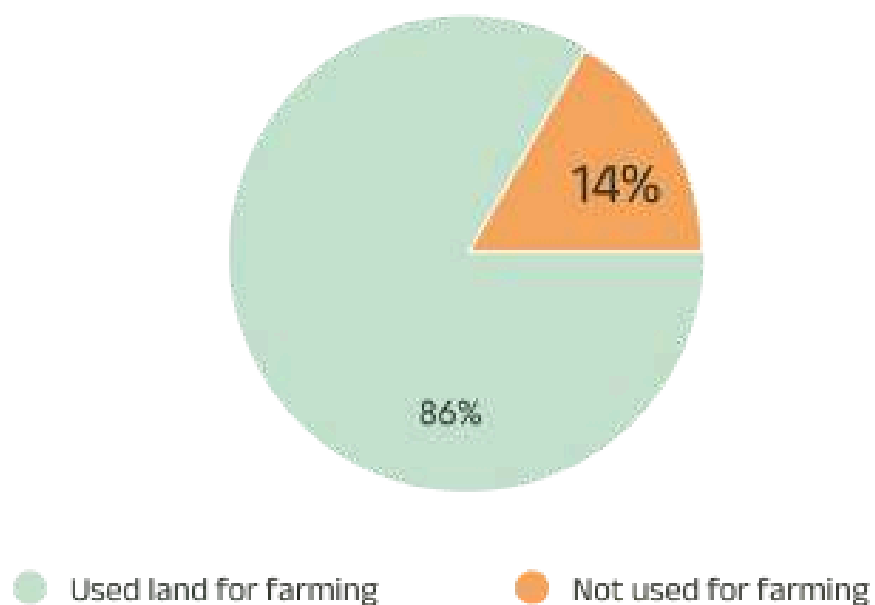


Figure 17: Stage - 2 Tagging each parcel with a unique ID

Total Land Area	Used for farming	Not used for farming
6.34 Acre	5.47 Acre	0.87 Acre
100%	86%	14%

Land Usability Ratio



Seed & Area Calculation		
BANDHI NO.	IN ACRE	GENHU
1	0.11	9
2	0.21	17
3	0.13	11
4	0.16	13
5	0.28	22
6	0.19	15
7	0.20	16
8	0.23	18
9	0.14	11
10	0.13	10
11	0.09	7
12	0.24	19
13	0.13	10
14	0.14	11
15	0.12	9
16	0.16	13
17	0.24	19
18	0.20	16
19	0.41	33
20	0.25	20
21	0.12	9
22	0.41	33
23	0.23	18
24	0.56	45
25	0.08	6
26	0.20	16
27	0.13	10
TOTAL	5.47	437.34

Figure 18: Calculation of land area and resource.

The results of this analysis serve as a guide for farmers, enabling them to make more informed decisions regarding their land management practices. By accurately measuring the size of their cropped land area and optimizing resource allocation, farmers can reduce wastage and maximize efficiency in their farming operations. Furthermore, The GIS-based farm mapping method has become a valuable tool for farmers to use across various crops, promoting uniform seed and fertilizer distribution and leading to consistent crop distribution and growth patterns throughout the field.

Moreover, this experiment has facilitated communication among farmers and farming workers, serving as a medium for sharing information and coordinating agricultural activities. With a clearer understanding of the resources required for their crops, farmers can better plan and budget for expenses, ultimately enhancing their overall financial management practices.

In summary, the adoption of GIS-based farm mapping has proven to be effective in optimizing resource allocation, improving crop distribution and growth, and facilitating communication among farmers. As a result, it has become an invaluable tool for enhancing farm management practices and promoting sustainable agriculture.

Indeed, while GIS-based farm mapping offers numerous benefits, it also comes with certain limitations. One significant limitation is the requirement for someone skilled in GIS technology to create and maintain maps for farmers. This necessitates either training existing personnel or hiring specialized professionals, which can be time-consuming and costly for farmers, particularly those in remote or resource-constrained areas. The process of creating a field map using GIS technology typically involves the use of laptops or desktop computers. This reliance on technology may pose challenges for farmers who lack access to such devices or are not familiar with their operation.

Design Direction

We commenced the design process by first identifying the challenges encountered by farmers in their agricultural activities. Through thorough analysis of the collected data and reviews provided by farmers, we were able to pinpoint the key features necessary for our design project.

Feature Identification

The analysis served as a robust foundation for identifying the features required for our project. These features have been categorized based on the specific needs of farmers and have been further divided between new and experienced farmers.

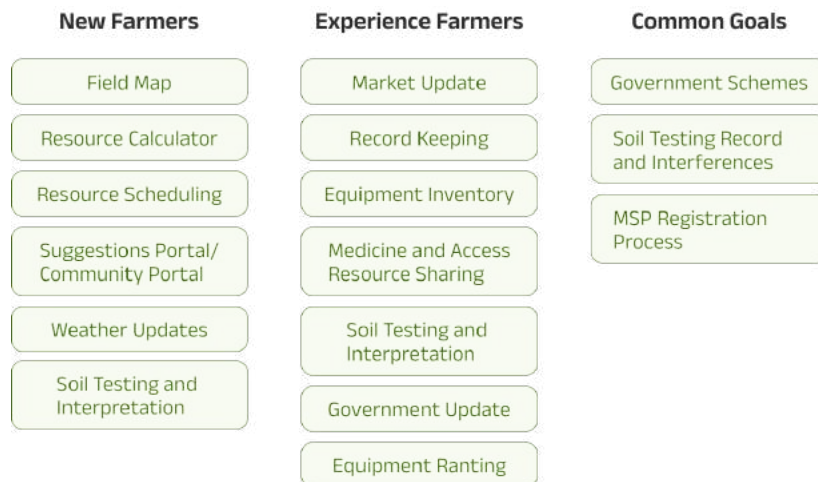


Figure 19. Feature map of Design

Major Design Focus

We are focusing on transitioning from grain-based farming practices to precision-based farming methods. Our primary and secondary research has revealed a growing demand for sustainable farming practices to meet current needs. Therefore, enhancing the sustainability of farming is paramount.

In this project, our focus is on integrating soil health considerations into farming activities, particularly in resource calculation processes. By incorporating soil health data into our calculations, we aim to optimize resource allocation and promote sustainable farming practices. This approach aligns with our goal of improving efficiency and environmental stewardship in agriculture.

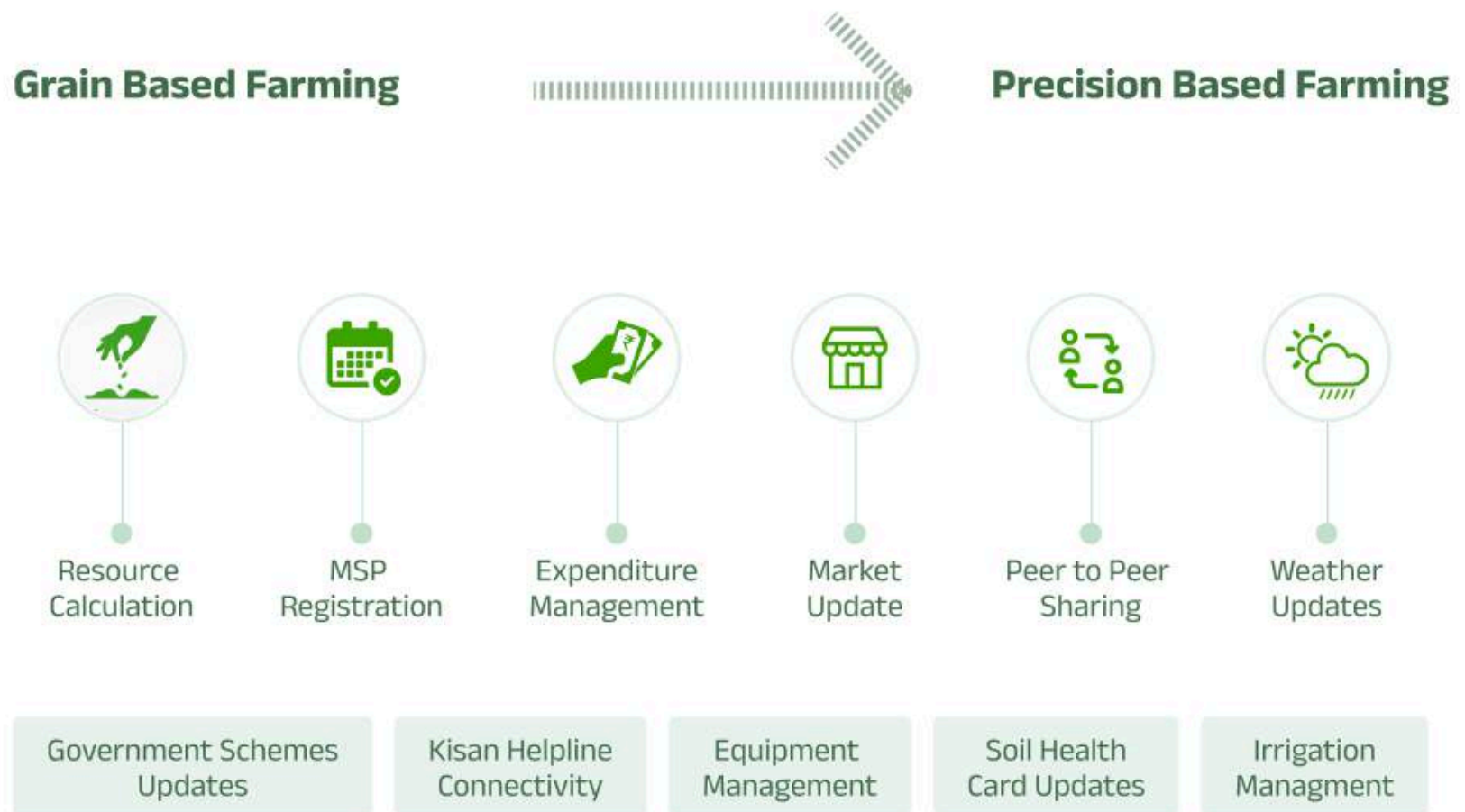


Figure 20. Need of Farmers

Operation-Based Design Approach

There are various approaches to developing a design, and here are three possible ways in which the operation can be developed:

1. Farmer-Centric Approach: In this approach, the design and decision-making process are primarily controlled by farmers themselves. Farmers play a central role in shaping the design according to their needs, preferences, and feedback. This approach prioritizes empowering farmers and ensuring that the design meets their specific requirements.

2. Operator-Based Approach: Under this approach, operators act as intermediaries between farmers and the services provided to them. Operators facilitate the connection between farmers and relevant services, such as technology, resources, or support systems. While operators play a significant role in coordinating operations, farmers may have limited control over the design and decision-making process.

3. Government-Oriented Approach: In this approach, the government takes the lead in controlling and managing the design and operations. Policies, regulations, and directives set by the government dictate the framework within which farming operations occur. While this approach may provide

structure and oversight, it may also limit farmers' autonomy and control over their farming practices.

Each approach has its advantages and considerations, and the choice of approach depends on various factors such as the context, stakeholders involved, and objectives of the design project. Ultimately, the selected approach should aim to effectively address the needs and priorities of farmers while promoting efficiency, sustainability, and inclusivity in agriculture.

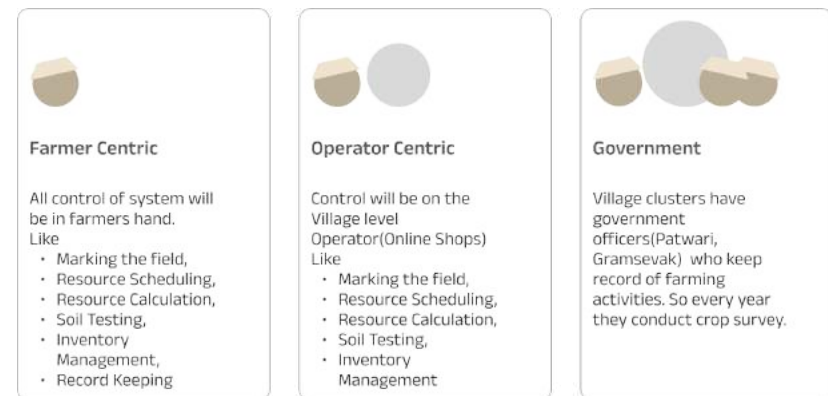


Figure 21. Operation-Based Design Approach

MSP Registration Process

We have identified the MSP (Minimum Support Price) registration process as a significant hurdle for farmers intending to sell their goods to government Mandis. Currently, this process is prolonged, often taking approximately 3-4 months to complete. Through meticulous documentation, we have mapped out the entire process and its ecosystem, recognizing that it is predominantly operated by government and private entities

The existing process heavily relies on operators, leading to inefficiencies and delays. To address this issue, our proposed solution advocates for a shift toward a farmer-operated model. Under this model, farmers would have autonomy to book appointments at their convenience, thereby streamlining the registration process. By empowering farmers to take charge of the registration process, we anticipate improved efficiency, reduced wait times, and enhanced satisfaction among stakeholders.

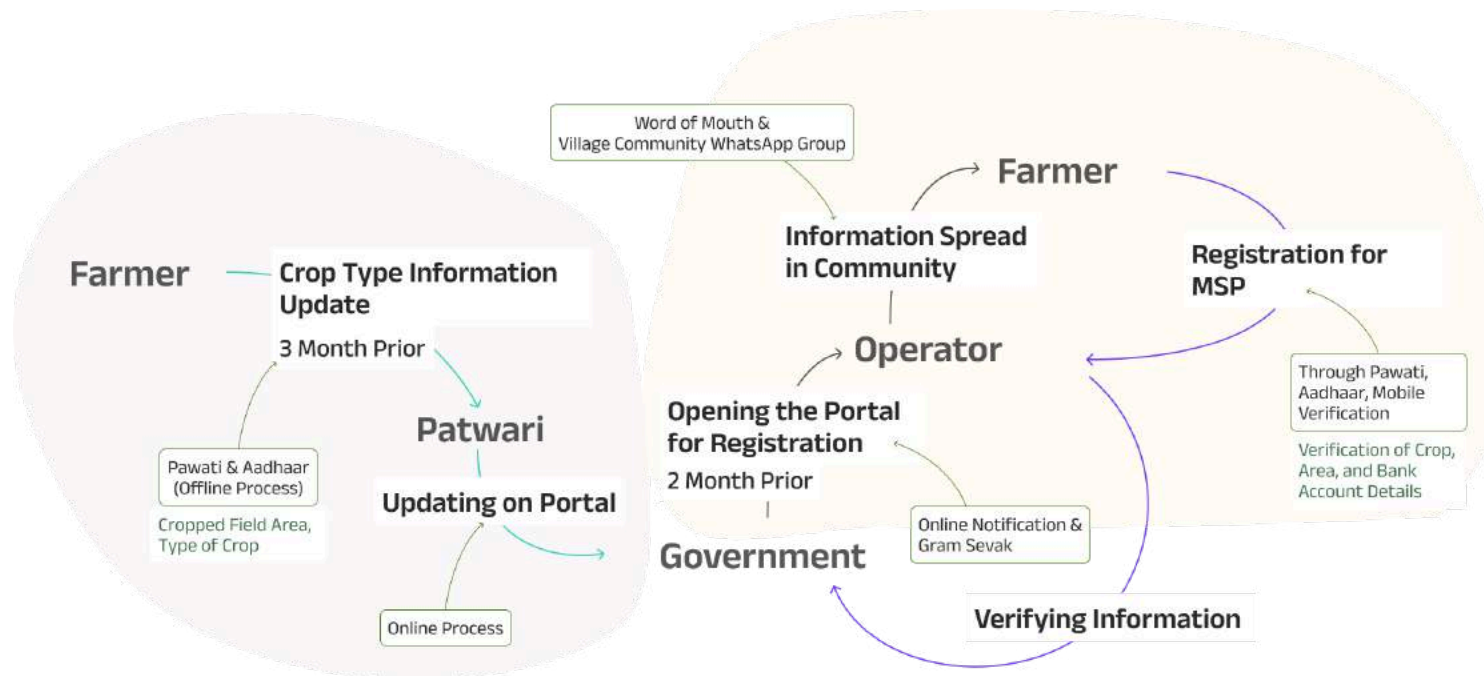


Fig22. Registration Phase 1 Ecosystem

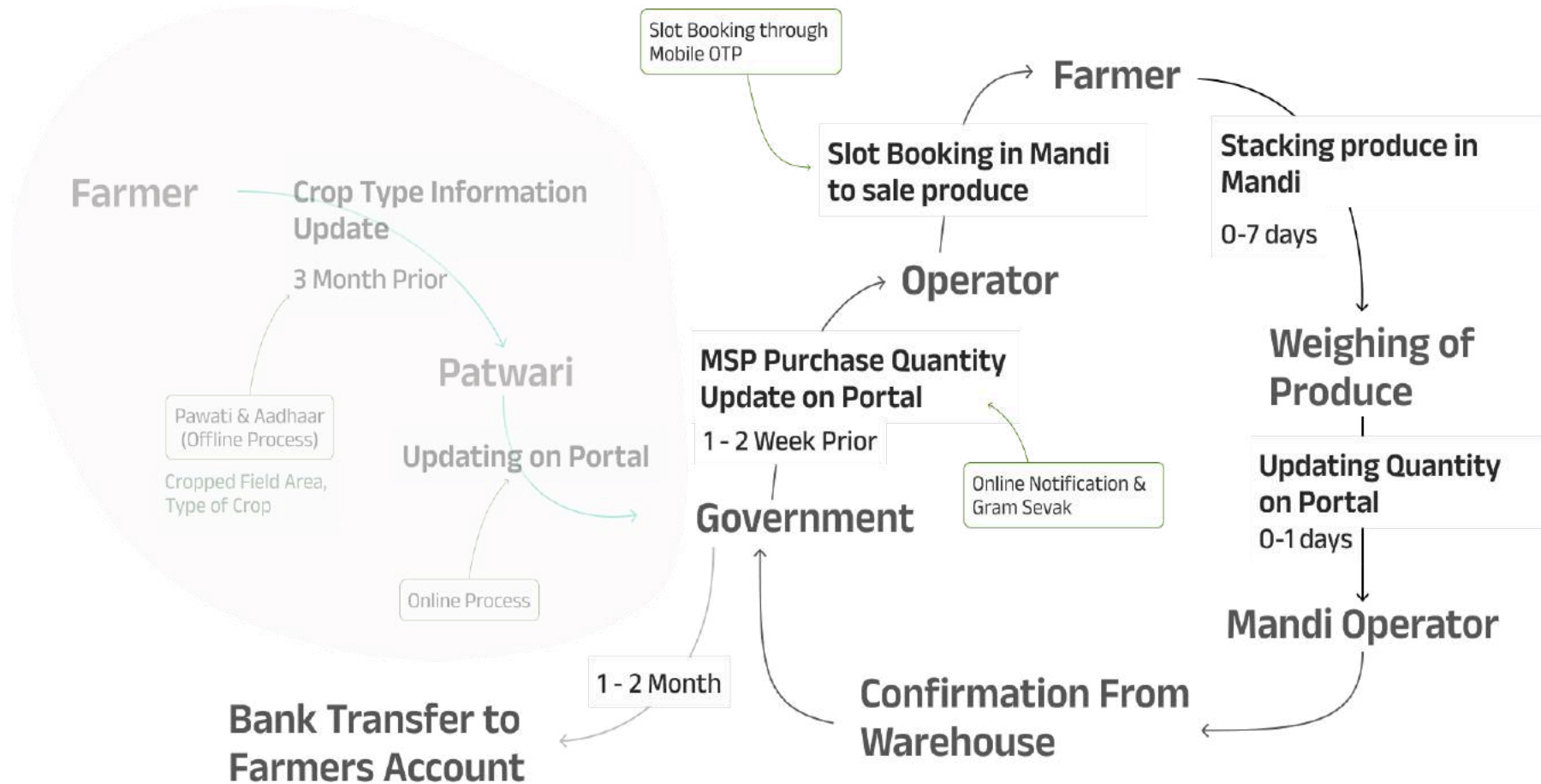


Figure 23. Registration Phase - 2 Ecosystem

Equipment Management

During our study, we uncovered a significant challenge faced by farmers in accessing agricultural equipment, despite the presence of such equipment among fellow farmers in neighboring areas. Building upon this observation, we have proposed an equipment-sharing platform to address this challenge. Through this platform, farmers can register their available equipment, and others from the same or nearby villages can access them as needed. To ensure transparency and efficiency, farmers can rate the equipment based on their experience with it.

To facilitate the implementation of this proposal, we have thoroughly documented and outlined the equipment-sharing ecosystem. By creating a structured platform for equipment sharing, we aim to promote collaboration and resource optimization within farming communities. This initiative not only addresses the immediate challenge of equipment accessibility but also fosters a spirit of cooperation and mutual support among farmers.

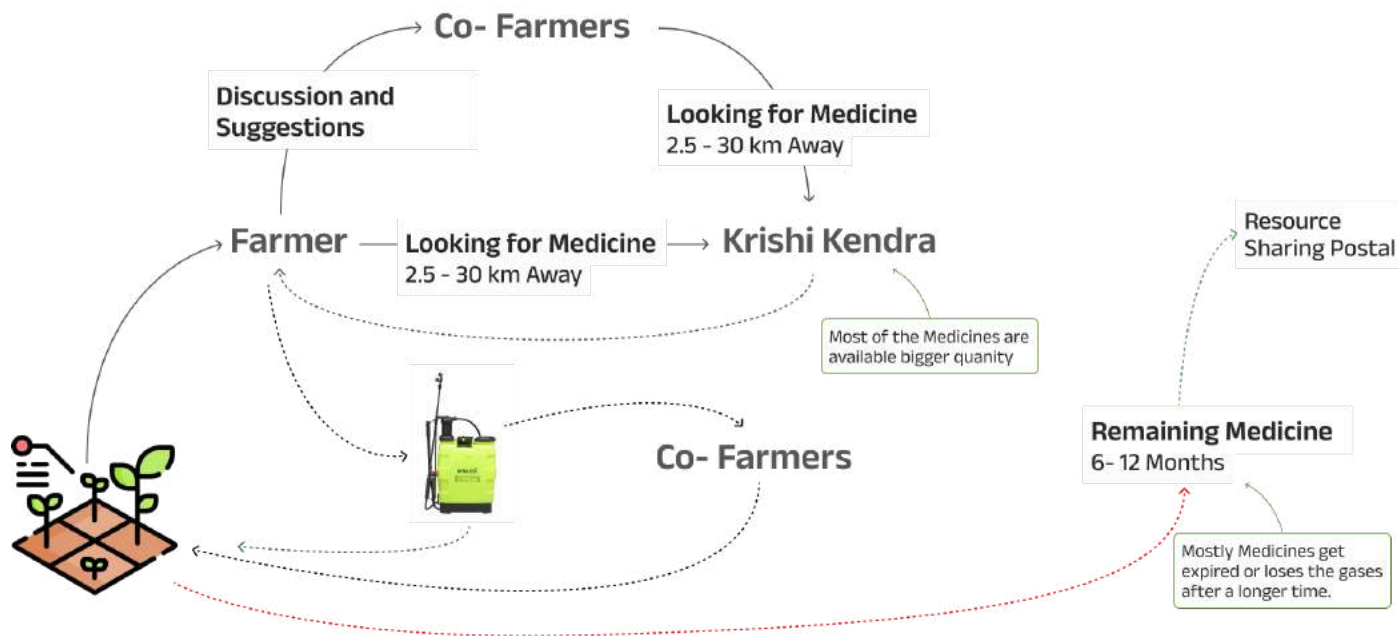


Figure 24. Equipment and Medicine Sharing Among Farmers

Idea/Feature Evaluation Method

Our identified features have been evaluated based on their usefulness, farmers' preferences, current needs as per survey data, insights from agriculture experts, problem-solving capabilities for farmers, or experience-building potential, feasibility, and temporality. Through this assessment, we have determined that not all features are necessary, and some may be temporary, such as the MSP registration process which is subject to change over time.

During our fieldwork, we observed that farmers were facing significant challenges when selling their crops to MSP, highlighting the temporal nature of this aspect. Consequently, based on these findings, we recognize the integration of soil health cards as one of the crucial features that emerged as a priority.

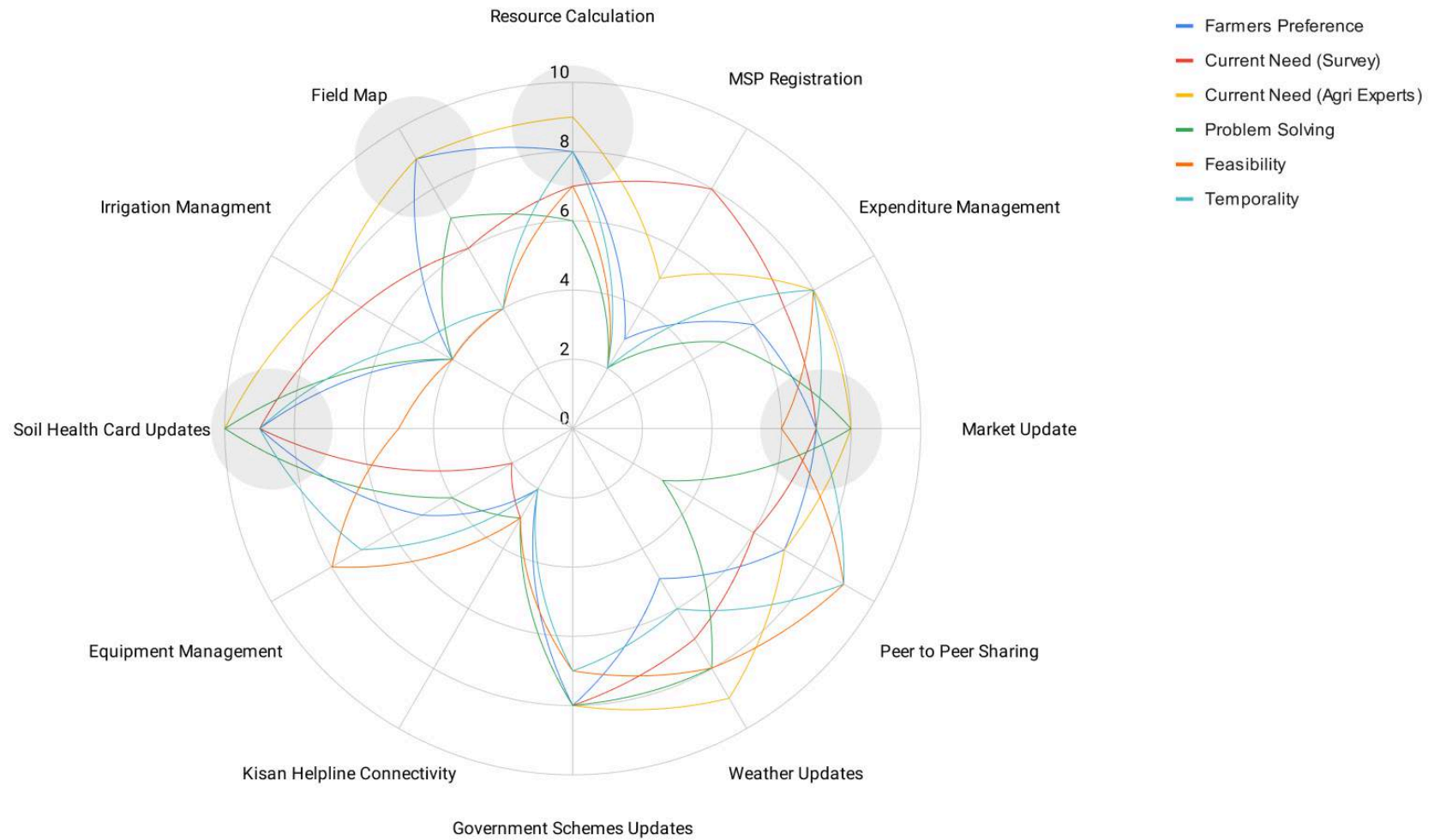


Figure 25. - Feature Evaluation

Ideations

In our efforts to make farming more farmer-operated and precision-oriented, we have identified key features through discussions with farmers and experts.

MSP Registration Process

The MSP registration process consists of two phases. Initially, the government conducted a survey to document both cropped and uncropped land areas. Upon completion

of this survey, the data is uploaded to the government server. Subsequently, farmers need to confirm the uploaded data with the assistance of an operator and may require further support until their goods are sold out in the Mandi. The concept is to establish a system where farmers can independently complete this process. It will transition from an operator-operated process to a farmer-operated one.

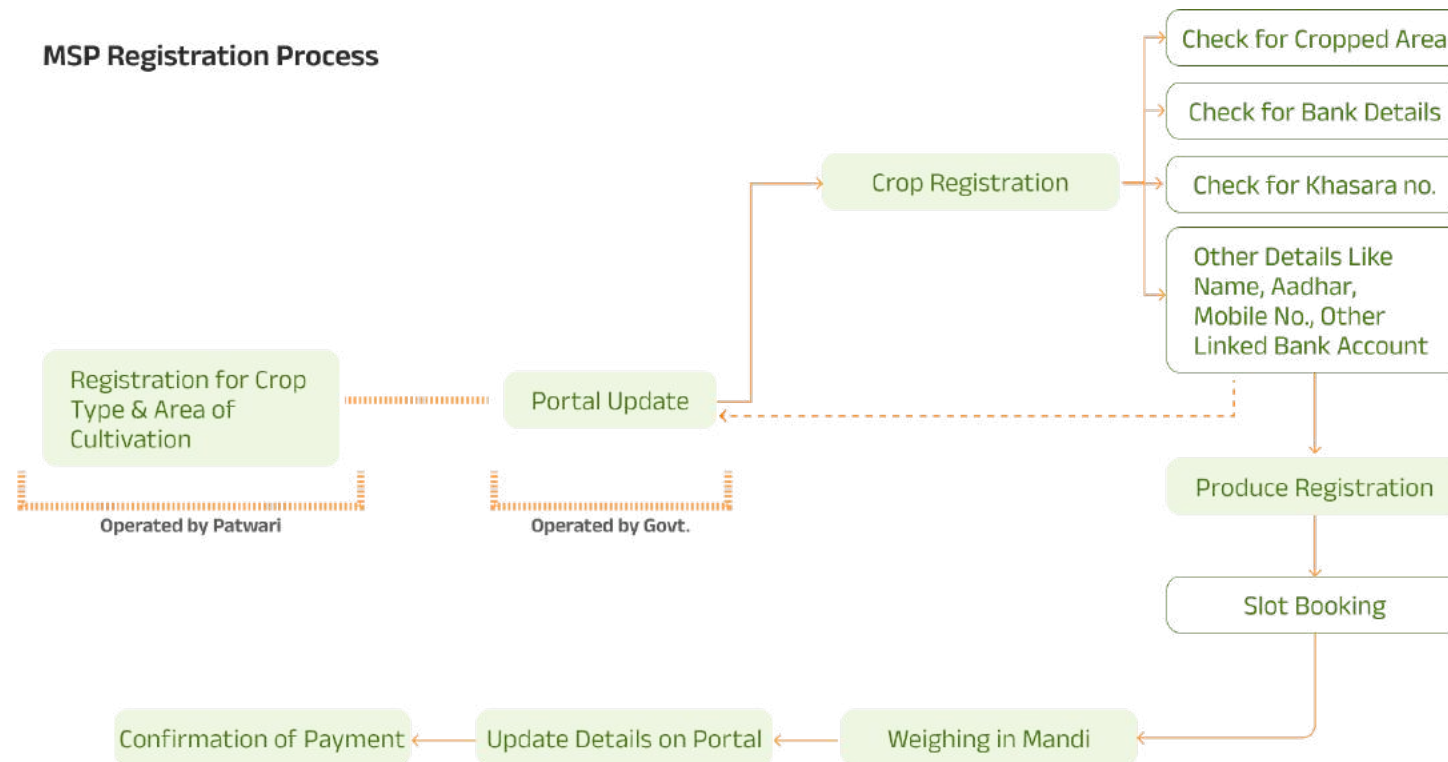


Figure 26. Feature mapping of MSP registration

As we have developed the MSP registration feature, we have created a wireframe for a mobile application to test with farmers.

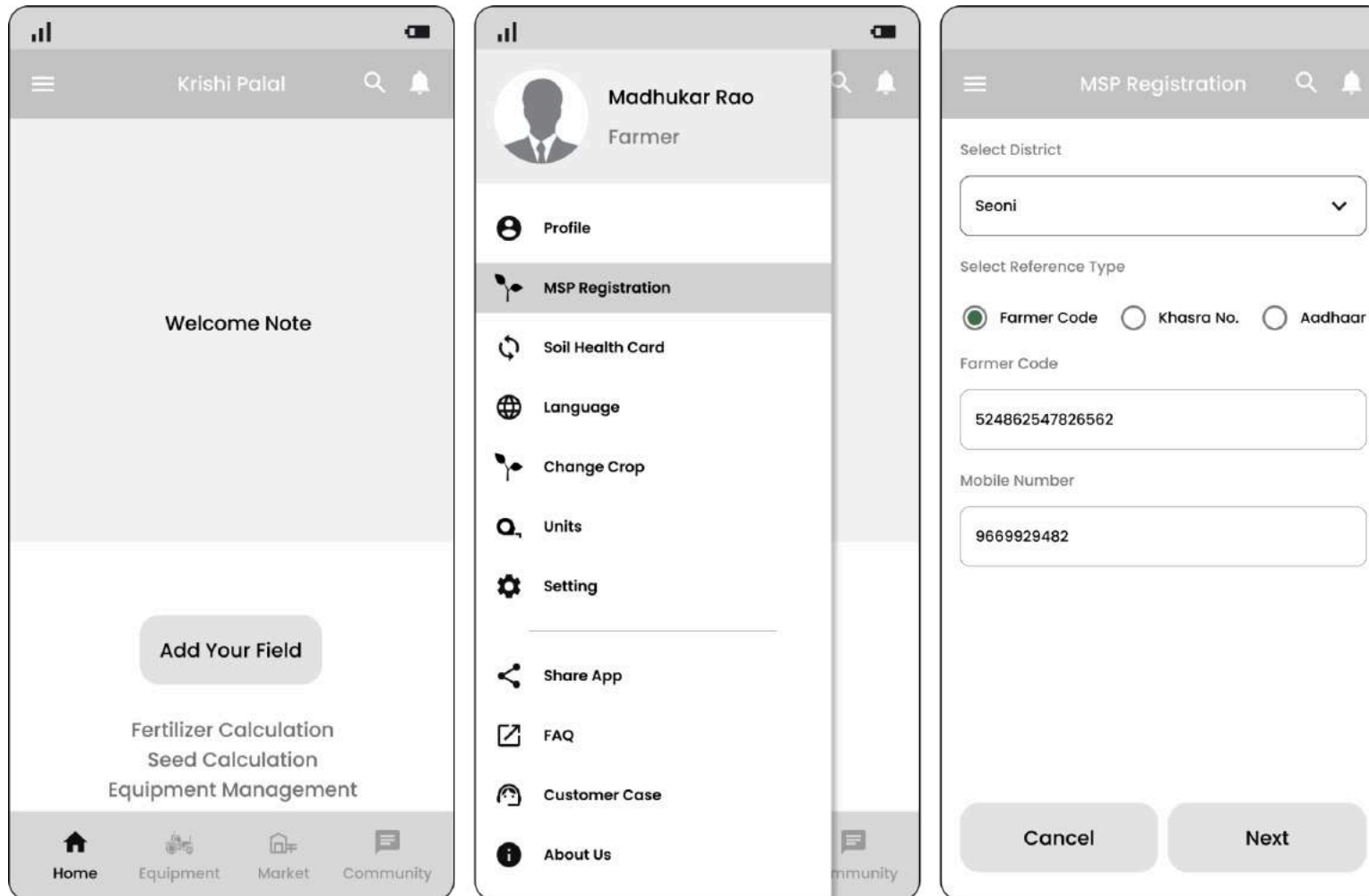


Figure 27. MSP registration process wireframe

MSP Registration

OTP Verification

Enter OTP

X

X

X

X

X

X

Resend OTP in 36 Seconds

[Call verification](#)

*Terms and Condition applied for login in kashi yug

Cancel

Next

MSP Registration

Details of Farmer and Field

Close

Slot Booking

MSP Registration

Select Mandi

Dhobisarra

Select Khasara No. - 1

29/5/1

Select Khasara No. - 2

31/2

Approved Produce Quantity

Khasara - 1

50.4 Quintal

Khasara - 2

32.6 Quintal

Total

83.0 Quintal

Select Date of Sale

27-02-2024

Close

Slot Booking

Figure 28. MSP Registration Process Wireframe

In this application, farmers can log in using their Aadhar number, Khasra number, or Farmers Code, with a mobile OTP verification process for security. Once logged in, they can access information such as their last year's sales, the current year's registration process, and the status of their registration.

Currently, farmers' details are available on government portals and accessible via mobile devices or computers. However, in the current scenario, many farmers rely on operators to access this information. The idea is to consolidate this information onto a single platform with fewer steps required for access. This would streamline the process and empower farmers to access their details directly without intermediaries.

About the MSP registration

Pros:

- Farmers Oriented Registration Process
- Farmer Regulated Decision Making
- Easily available details about farm and Crop
- Record keeping for income
- Farmers will be able to manage
- More transparency in the process

Cons:

- Error checks will be difficult
- Building trust in this will take time

[आवेदन पर्वी प्रिंट करने के लिए क्लिक करें](#)

किसान नया टिकट बनाए

टिकट की स्थिति देखें

किसान की पंजीकृत जानकारी

किसान का नाम	f	पिता/पति का नाम		समग्र आईडी	
मोबाइल न.	*****9428	जिला	सिवनी	तहसील	कुरई
ग्राम	मुंडापार	बैंक			
IFSC Code कोड.	MAHB000054	अकाउंट नं	*****8384	आवेदन/पंजीयन कोड.	
पंजीयन का प्रकार	एमपी ऑनलाइन कियोस्क	पंजीयन केंद्र			

नामिनी/नामांकित व्यक्ति की जानकारी

पंजीकृत रकबे की जानकारी फसत अनुसार

फसल	खसरा नंबर	सिंचित रकबा	असिंचित रकबा	सत्यापन/असत्यापन	आधार से लिंक	पंजीयन केंद्र
धान सादा	29/2/1	0.55	0	गिरदावरी	नहीं	

खरीदी केंद्र /Slot/SMS जानकारी देखें

खरीदी और भुगतान जानकारी

खरीदी और भुगतान जानकारी

धान भुगतान और खरीदी जानकारी

उपार्जन केंद्र	किसान कोड	खरीदी क्रमांक	फसल	खरीदी दिनांक	खरीदी मात्रा	कुल राशि	ऋण राशि	भुगतान योग राशि	स्वीकृत मात्रा	अस्वीकृत मात्रा	स्वीकृत मात्रा लंबित	भुगतान की गई राशि
59137203	2	5		2023.12.30	20.4	44533.2	0	44533.2	20.4	0	0	44532

Figure 29. Farmers' details on MSP Portal.

Field Demarcation

The idea is to translate the farmers' mental model of their fields into a digital or tangible form. During discussions, we discovered that farmers often refer to their fields by unique names, but many people are unaware of these names. Similarly, for resource and area calculation, farmers use their locally popular calculation units. These units are derived from the grain used for sowing the land. However, as seeds, fertilizers, and pesticides are now calculated in terms of acres or hectares, it would be beneficial to measure fields using the same units. This alignment would facilitate consistency and efficiency in farming practices. Here we have made one field map:



Figure 30. Locating their field



Figure 31. Land Parcels Marked on Field



Figure 32. Marking Trees on Field

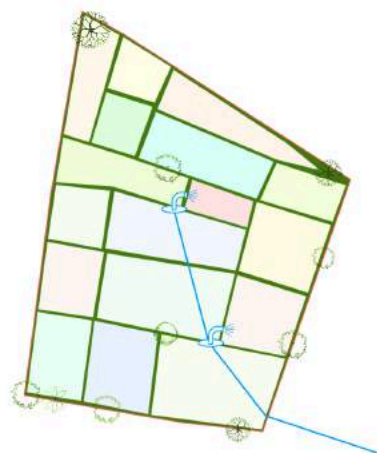


Figure 33. WaterPipe Making on Field



Figure 34. Resource distribution

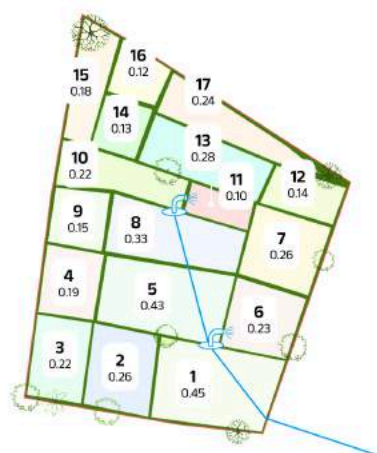


Figure 35. Parcel demarcation and IDs

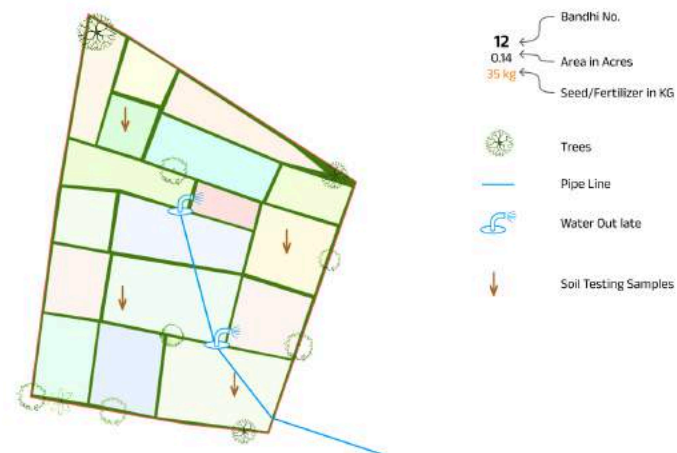


Figure 36. Soil data integration

In this manner, we generate a field map that is detailed with various elements such as area measurements, resources, natural features, pipelines, etc. Farmers have the flexibility to customize the map according to their specific requirements by adding or modifying elements as needed. This technological addition serves to enhance their current farming practices, providing them with valuable insights and tools to optimize their agricultural activities.

Resource Calculation

After comprehending the mental model of the resource calculator in the primary study, we endeavored to devise a solution that allows new farmers to calculate resources based on land area size, departing from traditional experience-based or grain-based methods. Our proposal

involves creating a field map where farmers can mark their land area. This map can serve multiple purposes, one of which is resource calculation. Below are the mapped features of the resource calculation tool:

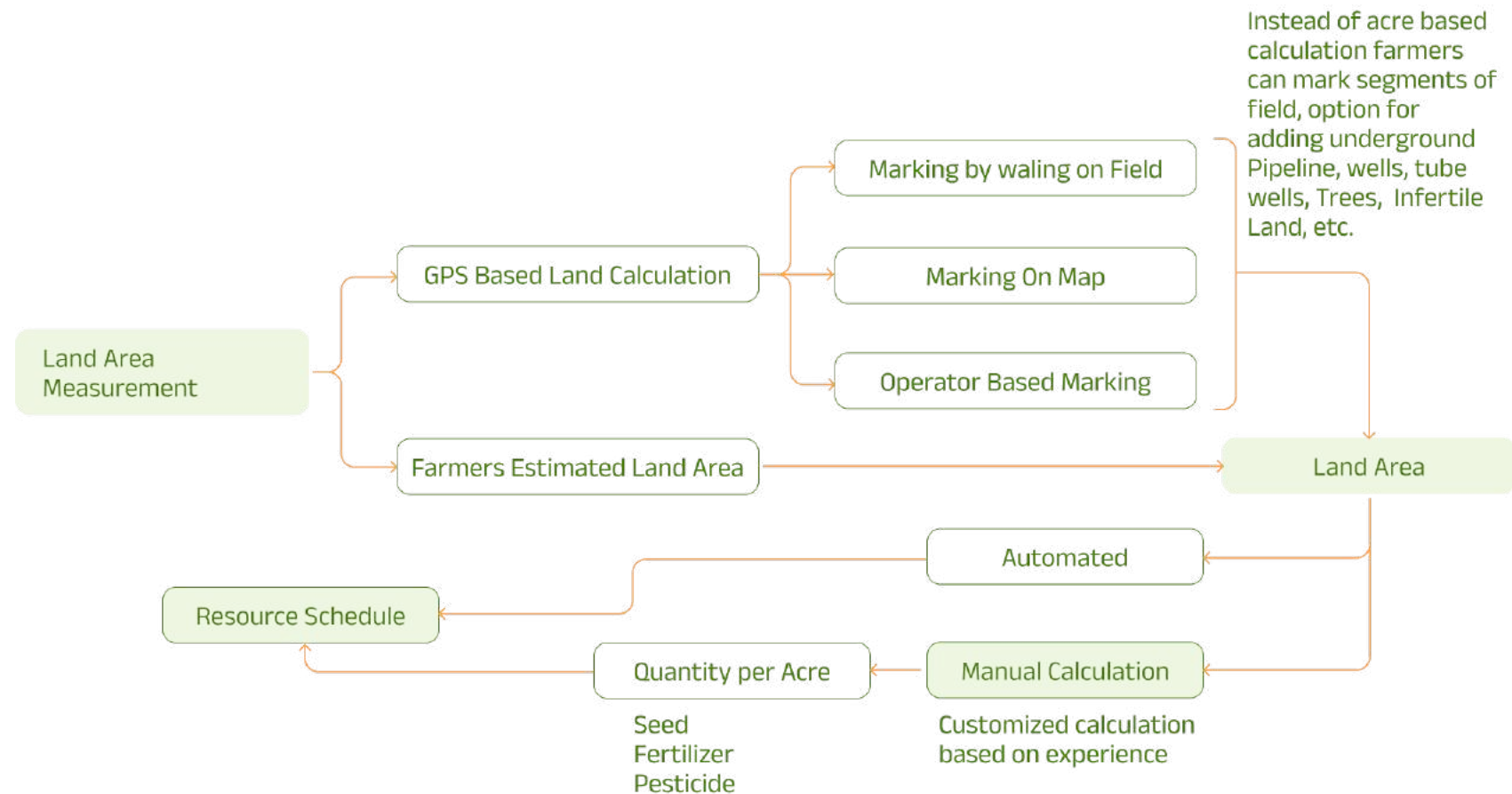


Figure 37. Feature mapping of resource calculation

Based on the resource calculation features, we have developed wireframes for a mobile application. This application will calculate resources based on the field map. If farmers prefer not to add a field map, they can input the total area of the field directly. However, this will result in a generic calculation of resources. Below are the wireframes for the mobile screens:

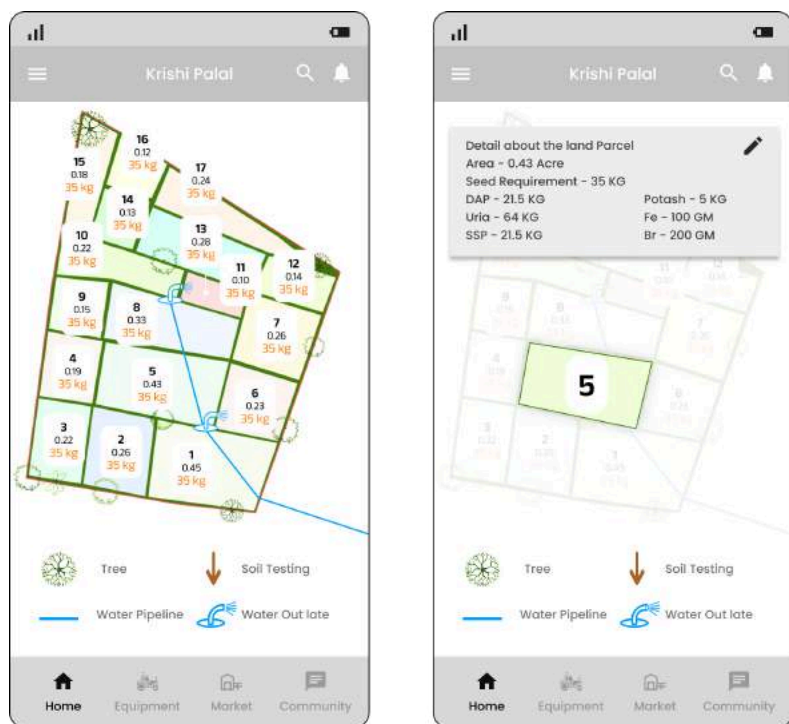


Figure 38. Field map and detail of parcels

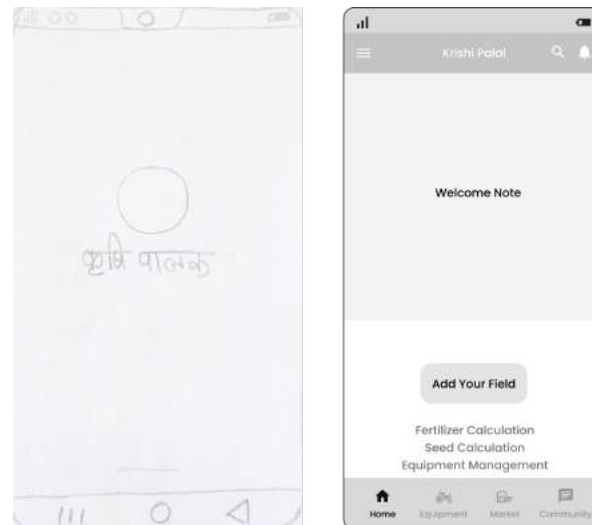


Figure 39. Onboarding

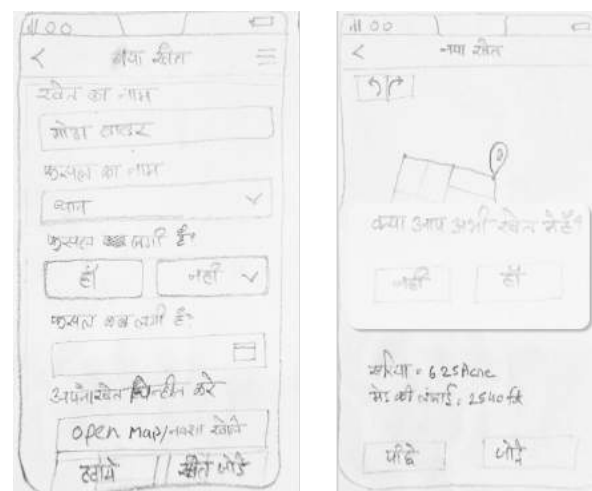


Figure 40. Adding field details

Ideas Testing with Farmers

Pre-Final Design Testing and Idea Evaluation(First Testing of Design)

In stage 2, following discussions and insights from primary and secondary research, we settled on several areas to focus on. One of our key ideas was to integrate participants into the design process. This participatory method aimed to validate the features we were designing and gather feedback from farmers. We conducted group discussions and personal interviews with farmers, during which we presented paper prototypes of mobile application screens for their input and insights. This collaborative approach allowed us to ensure that the features we were developing resonated with the needs and preferences of the farming community.



Figure 43. Presenting Ideas to Farmers



Figure 44. Discussion with Farmers

After discussing the features, we presented them with paper prototypes of the mobile application for their use. The process was mediated by me.



Figure 45. Prototype Testing

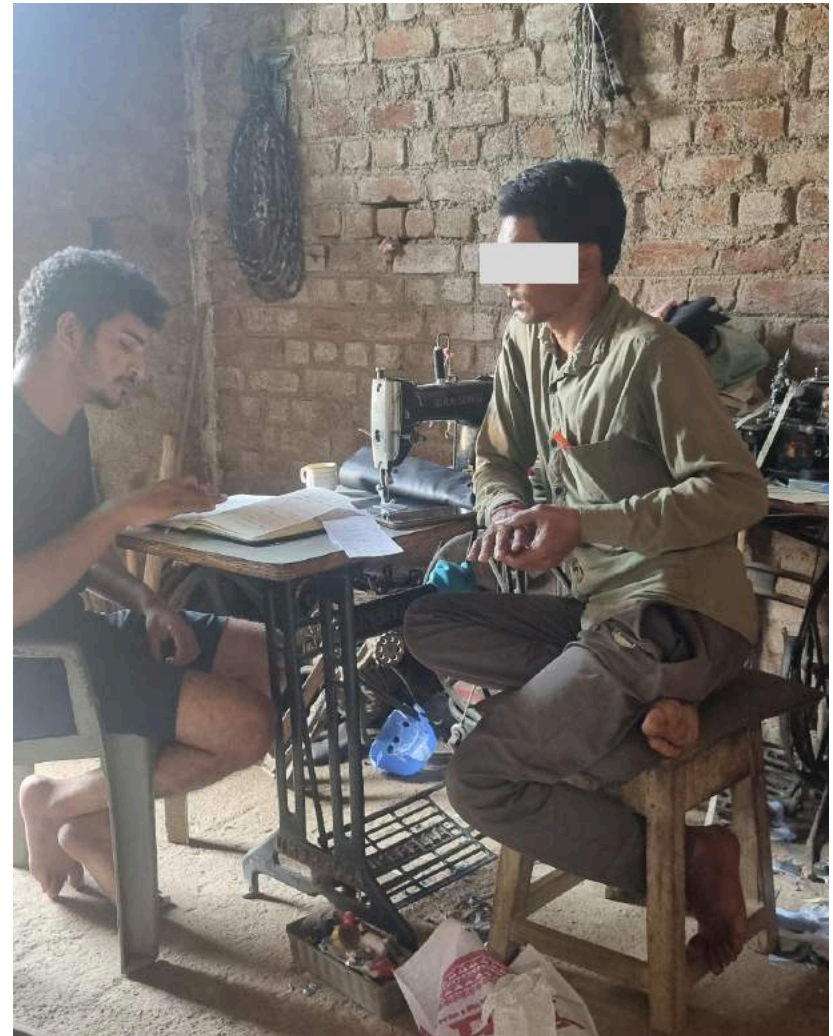


Figure 46. Ideation and Prototype Testing

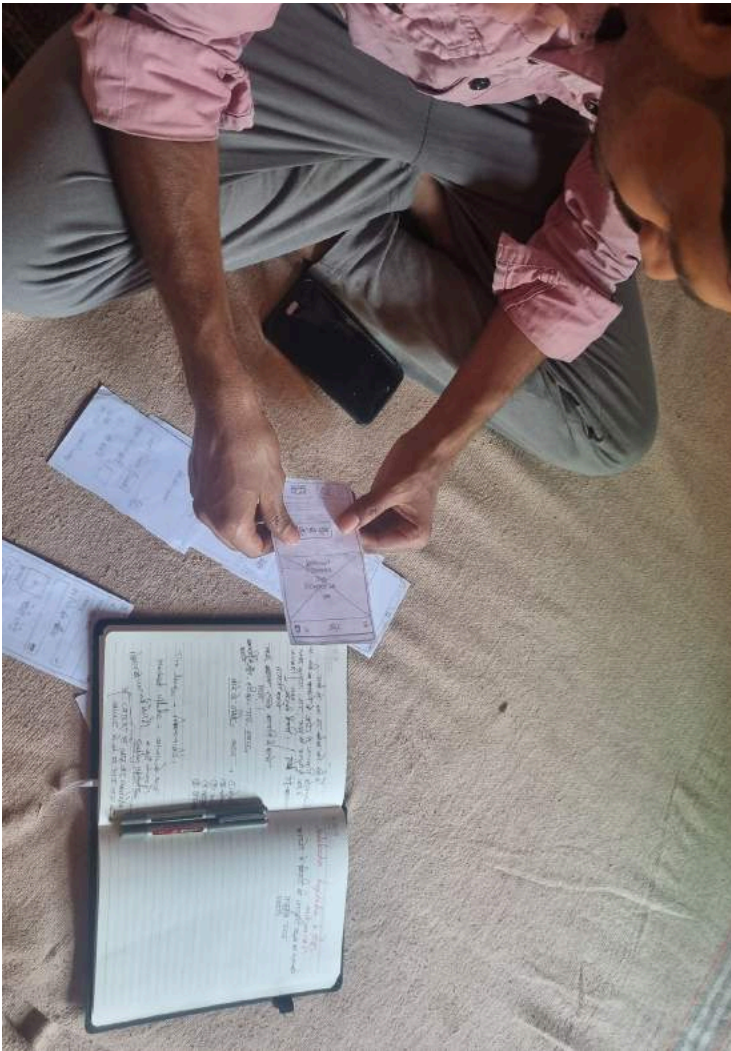


Figure 47. Ideation and Prototype Testing



Figure 48. Prototype Testing

Inferences from User Study

1. After discussions with farmers about the design, we observed that the MSP registration process is well functioning currently. Having one person from the village to handle the process ensures efficiency and provides employment opportunities. Additionally, farmers appreciate the convenience of receiving information about registration through the village WhatsApp group, reducing the need for them to dedicate significant time to the process. However, farmers desire access to information after selling their goods at the Mandi. They suggested incorporating details about previous years' sales into the application. Therefore, while MSP registration remains important, it is not an immediate priority.
2. Regarding the equipment sharing idea, farmers acknowledged its potential usefulness, particularly if an equipment repository could be established. However, they currently manage equipment sharing locally, relying on personal networks to identify available equipment. The primary challenge faced is remembering whom they borrowed equipment from previously. Despite this challenge, farmers feel that it can be managed without a mobile application and, therefore, it is not an immediate requirement.
3. The idea of medicine sharing and establishing a repository is deemed useful by farmers. Often, farmers find themselves with surplus or leftover medicines, which are eventually wasted. Instead of discarding these medicines, the concept of a repository where farmers can sell them at a marginal price could be highly beneficial, especially for small-scale landowning farmers. This approach not only helps prevent wastage but also provides an opportunity for other farmers to access necessary medicines at an affordable cost. Overall, it offers a practical solution to address the issue of surplus and supports the farming community by facilitating resource-sharing and cost-saving measures.
4. The idea of field area mapping or field marking on a map was presented to farmers, and their response was enthusiastic. They were intrigued by the prospect of having a colorful and detailed map of their fields, which they had never seen before. After explaining the concept further, farmers expressed that this mapping would assist them in various ways, such as facilitating discussions about the farm, addressing challenges related to resource distribution and calculation, and maintaining records of their yield and resource management. They began discussing how they could effectively

utilize this tool. However, the challenge identified was that many farmers are not tech-savvy and would require assistance to implement these plans effectively.

5. The integration of soil health card data presents a similar challenge for farmers, as they often possess soil nutrient details but struggle with interpreting this information effectively. If these data can be translated into farming resource calculations, it would significantly aid in precision-based farming. Moreover, it would assist farmers in optimizing resources and expenditure by providing valuable insights into soil health and nutrient levels. This integration holds the potential to revolutionize farming practices, allowing farmers to make informed decisions based on comprehensive soil data and ultimately improving agricultural productivity and sustainability.
6. Peer-to-peer information sharing is crucial, especially considering that platforms like YouTube and Facebook predominantly feature content from agriculturally dominant states such as Punjab, Haryana, Maharashtra, and some from South India. However, farmers in other regions may not find relevant information tailored to their needs. Creating a platform where farmers can share

information and ask questions would be invaluable. This platform could serve as a community portal for local farmers, facilitating knowledge exchange and collaboration. Farmers have suggested the use of an app called Public App, which allows individuals to share quick local news updates. Incorporating similar features into an agricultural-focused platform could greatly benefit farmers by providing them with access to timely and relevant information specific to their region.

7. Government scheme updates are often slow to reach villages, and sometimes they fail to reach them altogether. While technological access and internet availability can provide full access to information, the main issues lie in confidence, understanding the process, and knowing how to approach it. Government officers are allocated to different regions, but the information is not always disseminated effectively among villages, leading to a lack of communication and accessibility to government portals. Although there are many websites available for information, they are also not easily accessible to farmers. Therefore, a useful feature could be a platform where government schemes are regularly updated and easily accessible to farmers.

Final Design Idea

Redefined Features

After discussing the previously selected features and evaluating them with farmers, we have identified the most proficient and usable features according to both farmers and experts. These features have also been compared with existing available applications. It was found that currently, there is no available application that specifically provides

land area-based resource calculation for farming purposes. While some applications allow farmers to calculate land area, they do not cater to farming and resource calculation needs.

Following our prior interactions with farmers, we have finalized the following features for the development of our mobile application:



Figure 49. Redefined Mobile Application Features

Detailing out the mobile application based on the insights and features detailing

Resource Calculation

Its directory connected to land size also changes with the weather, quality of resources, and application method to farm. In this project, we are focusing on land-based resource calculation and giving farmers the freedom to manipulate it based on their requirements. In this process, soil health card data is incorporated to make informed

decisions according to soil health. In our research, most of the time, farmers depend on elders, co-farmers, or someone else to help them decide what quantity they should apply in the field. This dependency increases for new farmers.

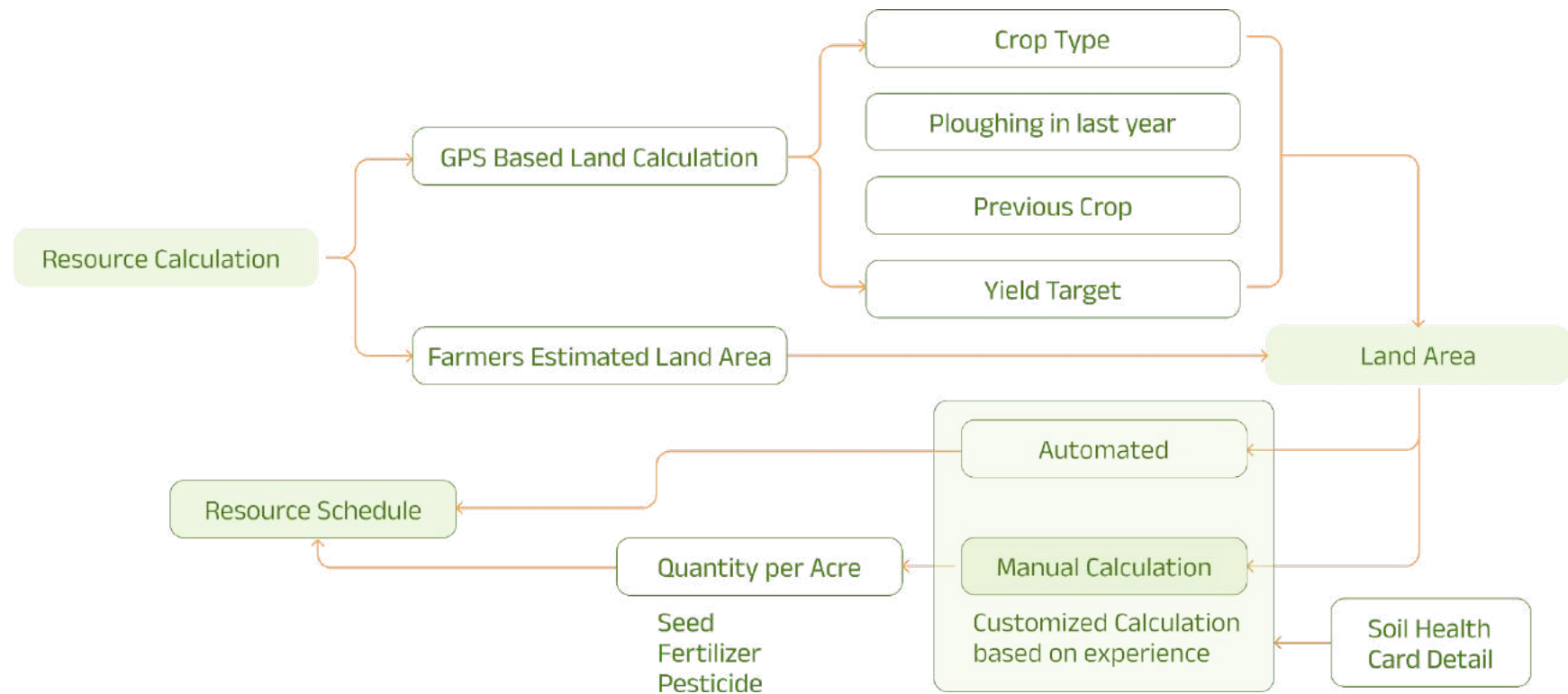


Figure 50. Resource Calculation

Land Area Measurement

Landmarking on Earth Imagery: A Step-by-Step Guide

This proposal outlines a method for farmers to mark their land on earth imagery. We have researched existing applications and land area measurement tools to develop this user-friendly approach.

Flexible Marking Methods:

Farmers can choose between two methods to define their land area:

1. **Walking the Boundary:** Physically walk the perimeter of the field to mark its borders. Additionally, walk smaller internal plots (parcels) for more detailed demarcation.
2. **Marking on Earth Imagery:** Conveniently mark fields directly on satellite or aerial images from any location.

Freedom and Personalization:

This system offers flexibility to farmers. They can mark their land based on their preferred method and label fields according to their own naming conventions.

Beyond Land Demarcation:

This landmarking feature goes beyond just defining land boundaries. Farmers can also mark other crucial features on their land, including:

- Trees
- Water pipelines
- Water outlets
- Soil sample collection points
- Entry points (wells, borewells)
- Editing existing building forms (motor house, etc.)

This comprehensive approach creates a complete picture of the farm, empowering farmers with valuable data.

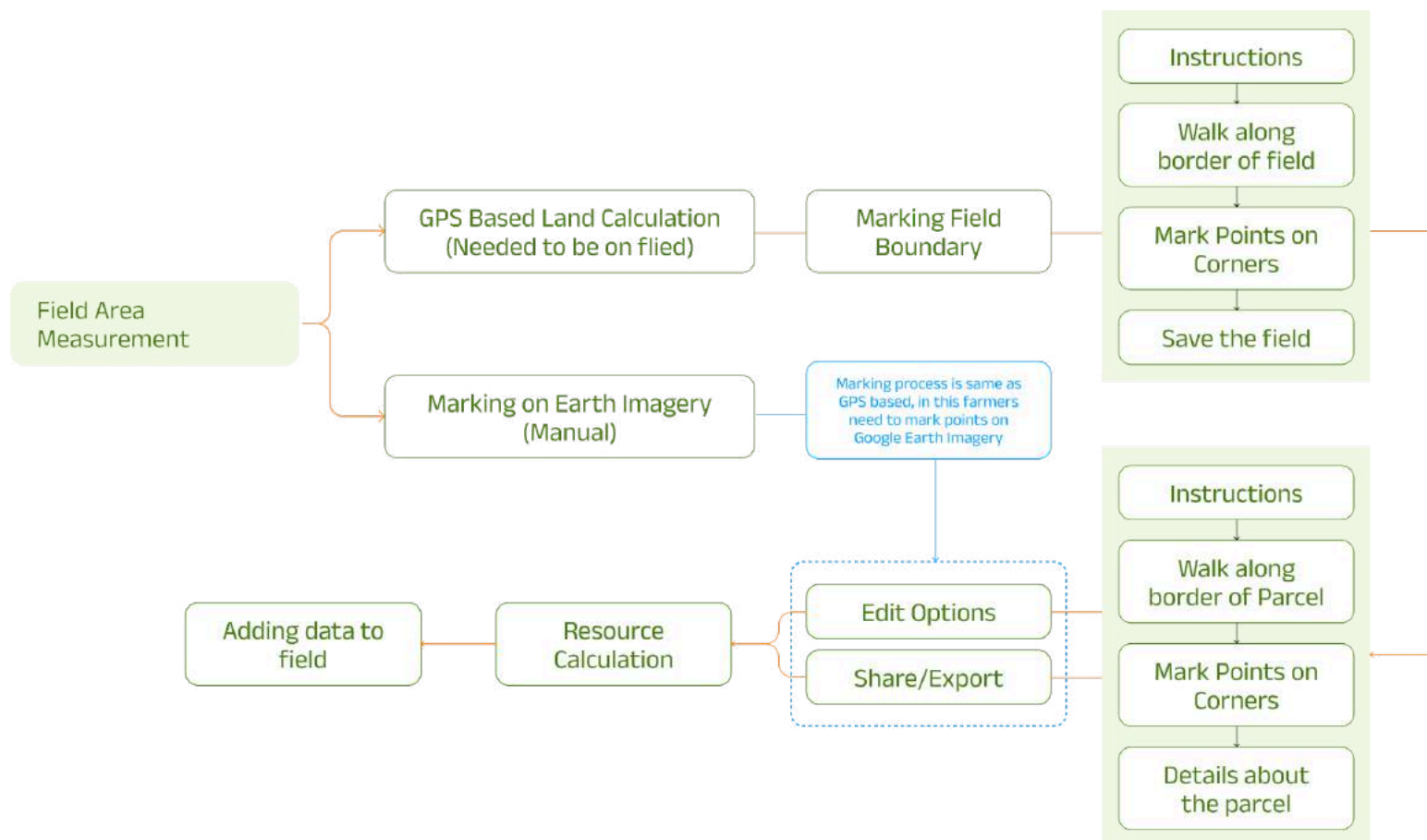


Figure 51. Field Area Measurement

Soil Health Card Integration

Our study has found that farmers have conducted soil testing and received soil health cards. If farmers want to check soil health, they can do so at district-level soil testing labs. In the application, we have integrated online soil health data from the government server to provide quick

and error-free data. This data will be fetched by the soil testing ID. Once the data is fetched, it will be linked to the existing fields. This soil data helps farmers achieve better resource calculation for their farms.

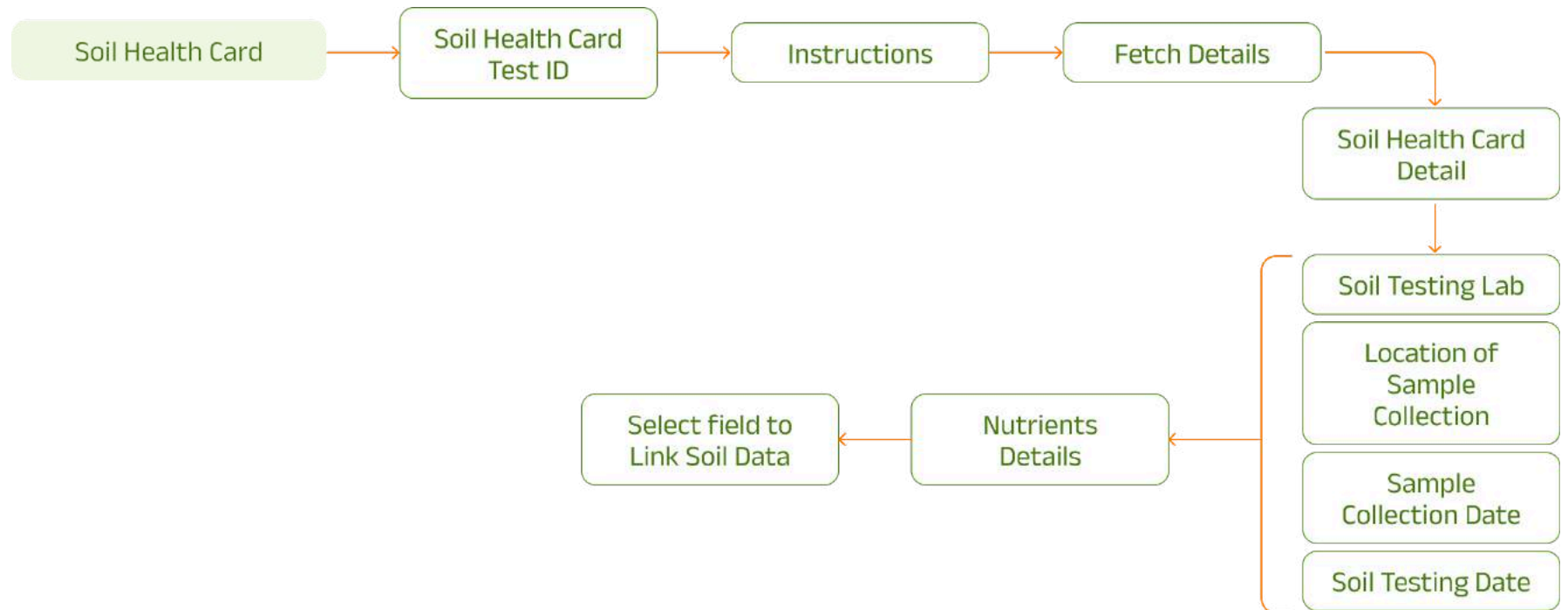


Figure 52. Soil Health Card Data

Mobile Application Design

We have developed and prototyped the mobile application based on user feedback and the usability of the features. Currently, the mobile application is designed in Hindi and English. Colors, text, and images are chosen from the local context to ensure they are more relatable for users.

Information Architecture

For high-resolution Images of Information Architecture Please [Check Here](#)

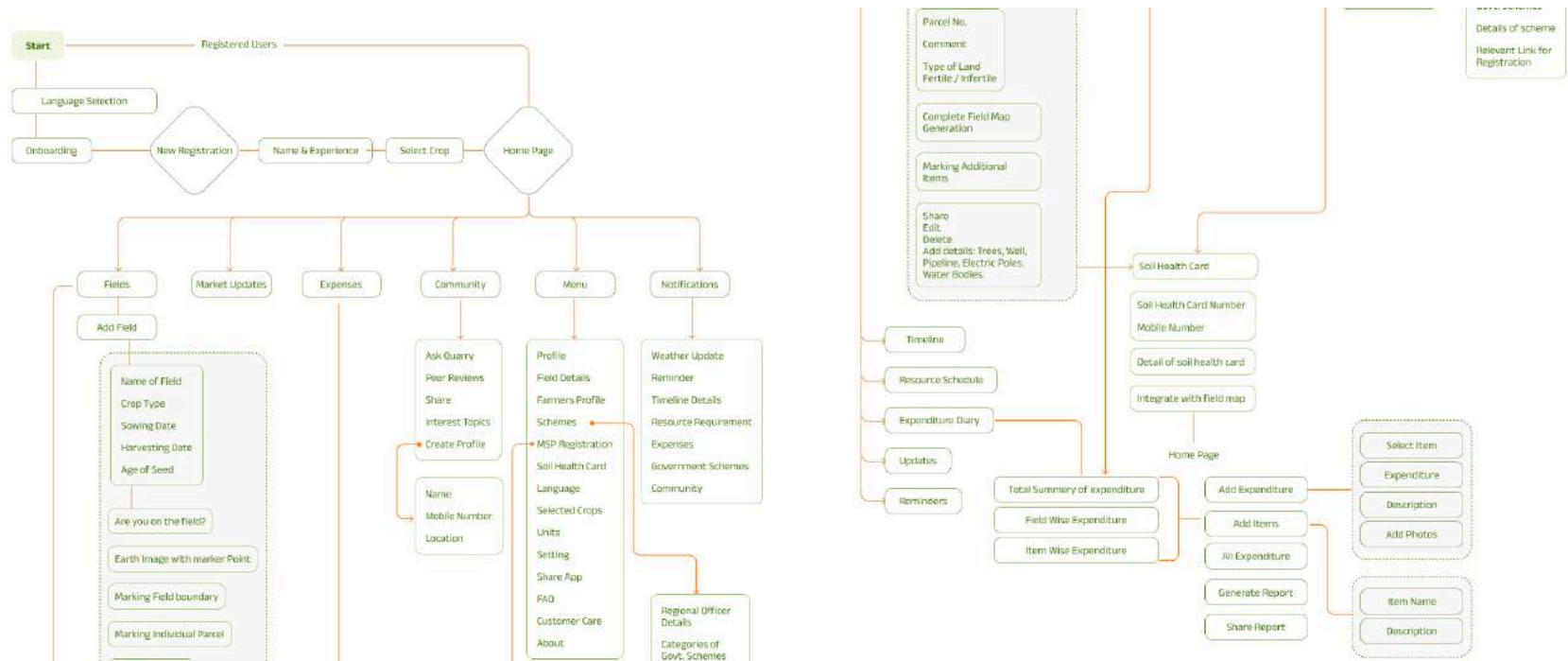


Figure 53. Information Architecture

Visual Identity of Mobile Application

Color - Primary Color

Picking up the color from the context, the village surroundings are filled with various shades of green. Green represents trust, growth, freshness, and positive energy, symbolizing prosperity in the community.



Color - Secondary Color



Typeface

Lato is a geometric sans-serif typeface font known for its readability and clarity on digital platforms. Its clear design imparts a sense of stability and trust to users.

KK

Lato
Google Font

Light
Regular
Semibold

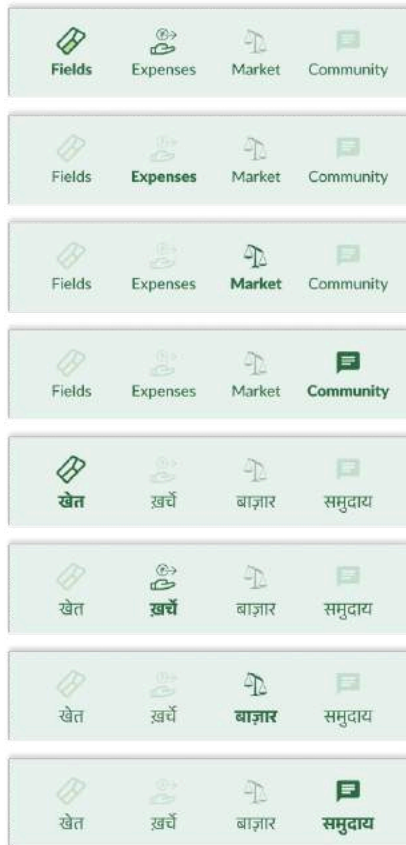
कक

Anek Devanagari
Google Font

किमान
किमान
किमान

Anek is a sans-serif typeface, ensuring optimal readability and clarity in digital contexts. It enhance legibility, making it particularly well-suited for Hindi text.

Elements of Design



Bottom Navigation Bar



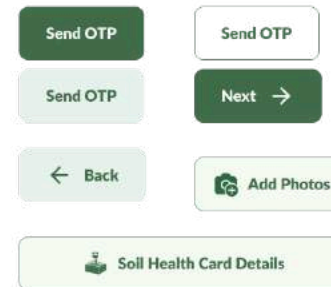
Top Navigation Bar



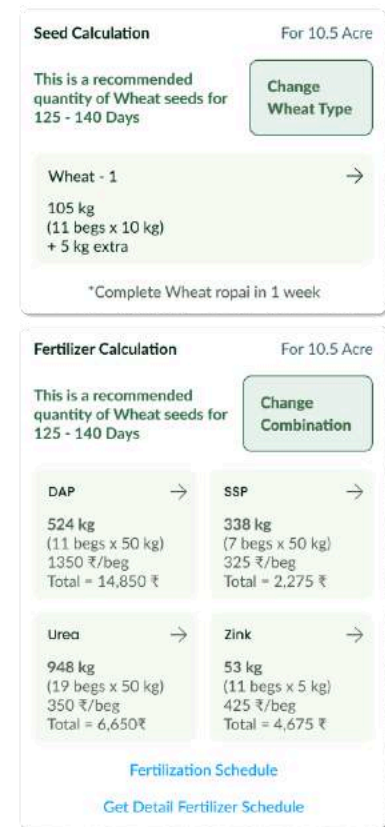
Cards for Parcel Information



Screen Popups



Buttons

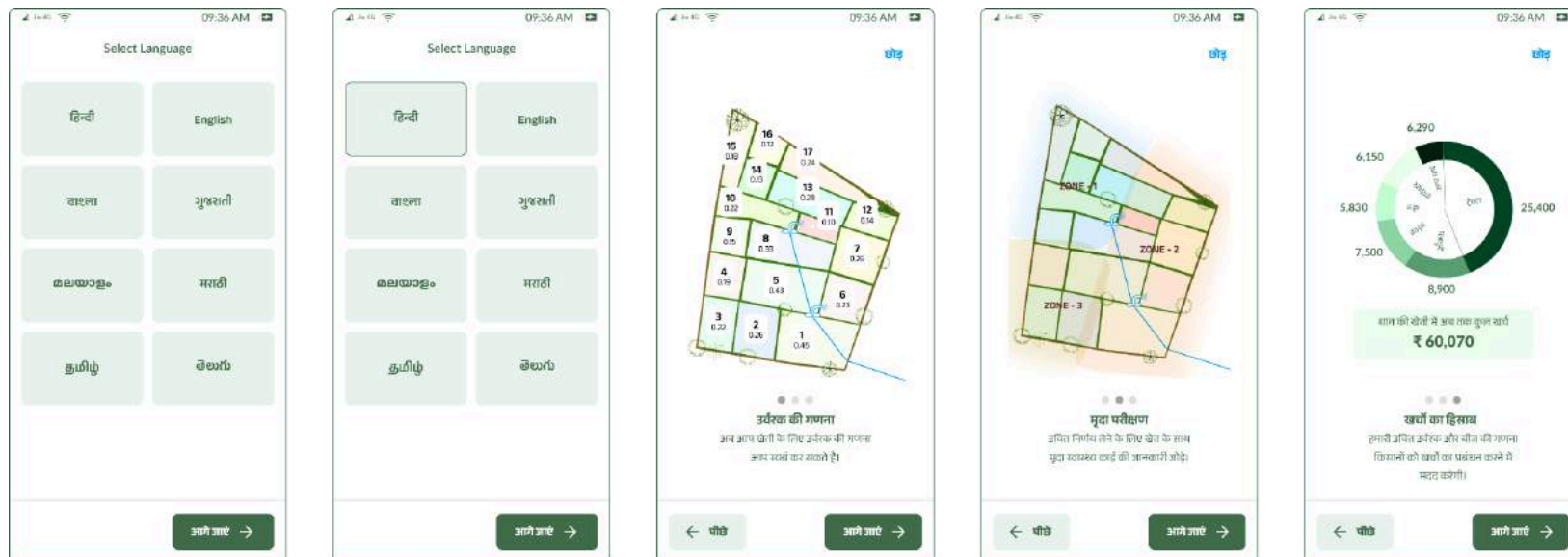


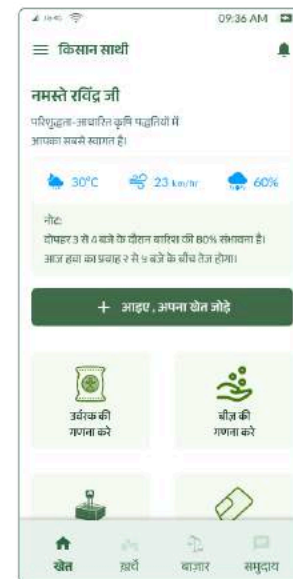
Cards for Resources

Here are the mobile application screens:

Onboarding

The onboarding process is simple and similar to existing applications. It starts with language selection to ensure a better user experience. Next, it highlights the benefits users will receive from using the application. The registration process is straightforward, requiring users to provide their name and farming experience.





Adding Field

Adding field information depends on the field size and shape, as well as the level of detail farmers want to add to the field map. To simplify the process, we have limited each screen to one or two actions. This step-by-step approach helps farmers follow and complete the process easily. Here are the screens attached in sequential order, showing how users will add a field.

The sequence of screens for adding a field is as follows:

- Screen 1:** Field Name: माने कला खेत. Crop Type: गहुँ. Crop Date: 15-03-2024. Crop Duration: ☒ 110 - 125 दिन, ☐ 120 - 135 दिन, ☐ 130 - 145 दिन, ☐ 150 - 170 दिन. Buttons: पीछे, जानकारी जोड़े.
- Screen 2:** Field Name: माने कला खेत. Crop Type: गहुँ. Crop Date: 15-03-2024. Crop Duration: ☒ 110 - 125 दिन, ☐ 120 - 135 दिन, ☐ 130 - 145 दिन, ☐ 150 - 170 दिन. Buttons: पीछे, जानकारी जोड़े.
- Screen 3:** Field Name: माने कला खेत. Crop Type: गहुँ. Crop Date: 15-03-2024. Crop Duration: ☒ 110 - 125 दिन, ☐ 120 - 135 दिन, ☐ 130 - 145 दिन, ☐ 150 - 170 दिन. Buttons: पीछे, जानकारी जोड़े.
- Screen 4:** Field Name: माने कला खेत. Crop Type: गहुँ. Crop Date: 15-03-2024. Crop Duration: ☒ 110 - 125 दिन, ☐ 120 - 135 दिन, ☐ 130 - 145 दिन, ☐ 150 - 170 दिन. Buttons: पीछे, जानकारी जोड़े.
- Screen 5:** Field Name: माने कला खेत. Crop Type: गहुँ. Crop Date: 15-03-2024. Crop Duration: ☒ 110 - 125 दिन, ☐ 120 - 135 दिन, ☐ 130 - 145 दिन, ☐ 150 - 170 दिन. Buttons: पीछे, जानकारी जोड़े.
- Screen 6:** Field Name: माने कला खेत. Crop Type: गहुँ. Crop Date: 15-03-2024. Crop Duration: ☒ 110 - 125 दिन, ☐ 120 - 135 दिन, ☐ 130 - 145 दिन, ☐ 150 - 170 दिन. Buttons: पीछे, जानकारी जोड़े.

09:36 AM

← खेत जोड़े

खेत का नाम *

Nala Wala Khud

Crop Type *

गेहूं - 1

किसान लगाने का समय *

15-03-2025

किसान किसने दिन की है ?

☒ 110 - 125 दिन ☐ 120 - 135 दिन

☐ 130 - 145 दिन ☐ 140 - 155 दिन

☐ 150 - 170 दिन

किसान का प्रकार *

साधारण

गेहूं

समय

पीछे जानकारी जोड़े

09:36 AM

← खेत जोड़े

खेत का नाम *

Nala Wala Khud

Crop Type *

गेहूं - 1

किसान लगाने का समय *

15-03-2025

किसान किसने दिन की है ?

☒ 110 - 125 दिन ☐ 120 - 135 दिन

☐ 130 - 145 दिन ☐ 140 - 155 दिन

☐ 150 - 170 दिन

किसान का प्रकार *

गेहूं - 2

+ फसल

किसान लगाने का समय *

पीछे जानकारी जोड़े

09:36 AM

← खेत जोड़े

खेत का नाम *

Nala Wala Khud

Crop Type *

गेहूं - 1

किसान लगाने का समय *

15-03-2025

किसान किसने दिन की है ?

☒ 110 - 125 दिन ☐ 120 - 135 दिन

☐ 130 - 145 दिन ☐ 140 - 155 दिन

☐ 150 - 170 दिन

Crop Type *

गेहूं - 2

किसान लगाने का समय *

पीछे जानकारी जोड़े

09:36 AM

← खेत जोड़े

खेत का नाम *

☒ रात ☐ हफ्ते ☐ दोपहर ☐ सुबह

10.5 घण्टा

खेत का बरत *

अपने खेत का बरत बताइये ?

पीछे जानकारी जोड़े

09:36 AM

← खेत जोड़े

खेत का नाम *

☒ रात ☐ हफ्ते ☐ दोपहर ☐ सुबह

7.5 घण्टा

खेत का बरत *

अपने खेत का बरत बताइये ?

पीछे जानकारी जोड़े

09:36 AM

← खेत जोड़े

खेत का नाम *

☒ रात ☐ हफ्ते ☐ दोपहर ☐ सुबह

5.5 घण्टा

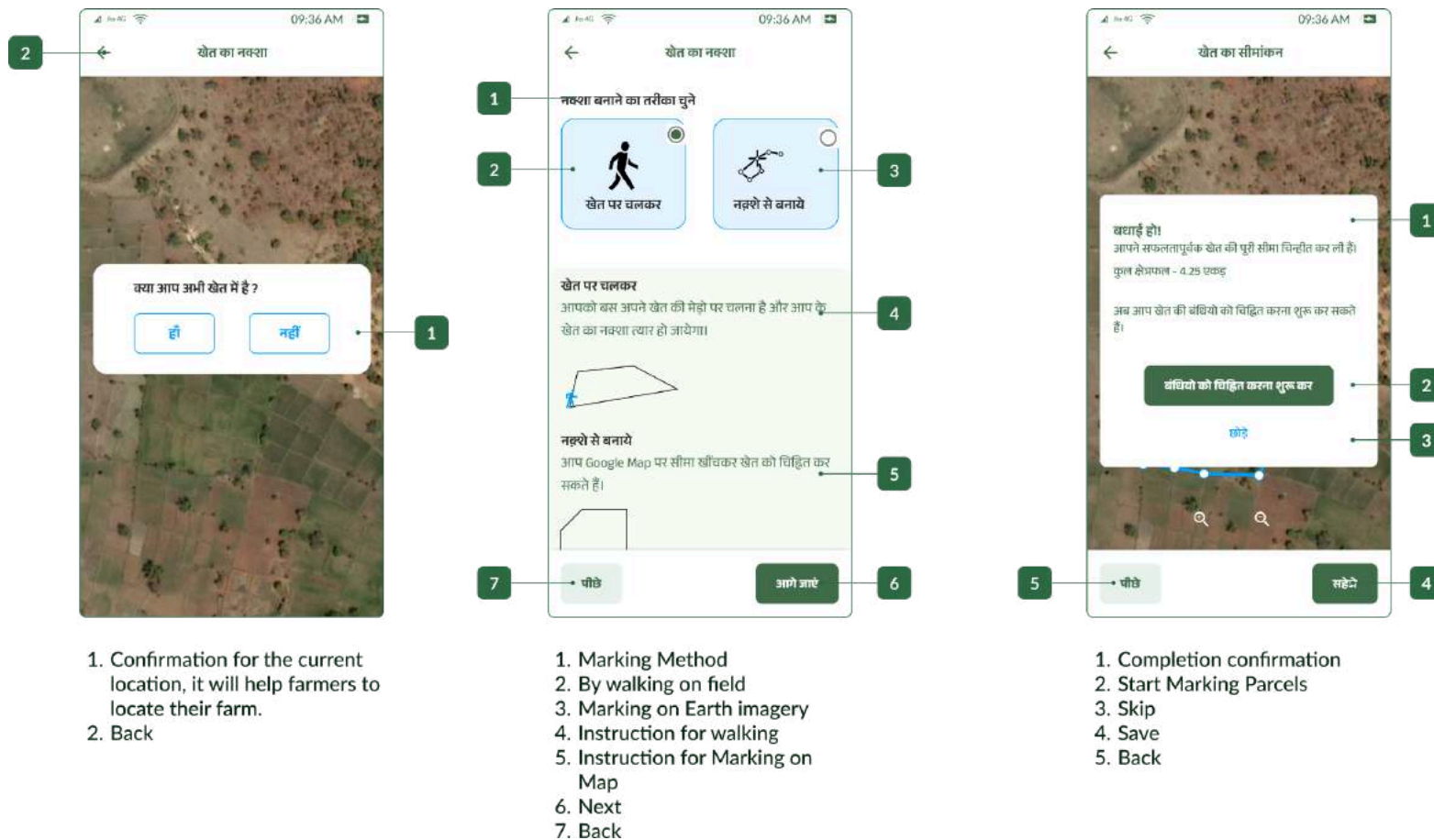
खेत का बरत *

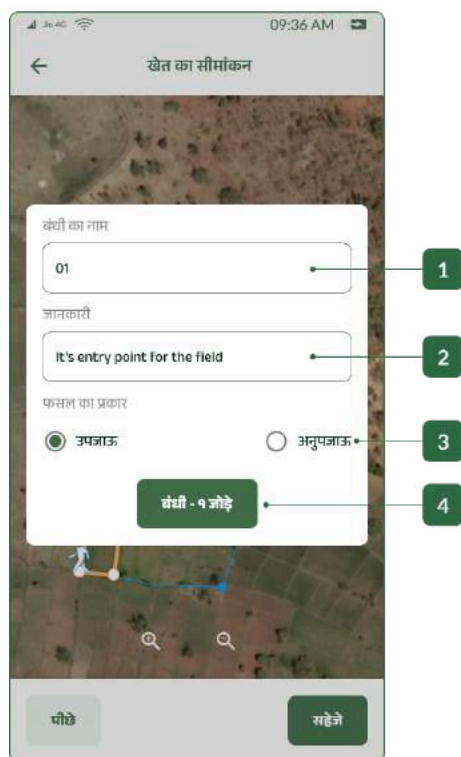
अपने खेत का बरत बताइये ?

पीछे जानकारी जोड़े

Marking Field

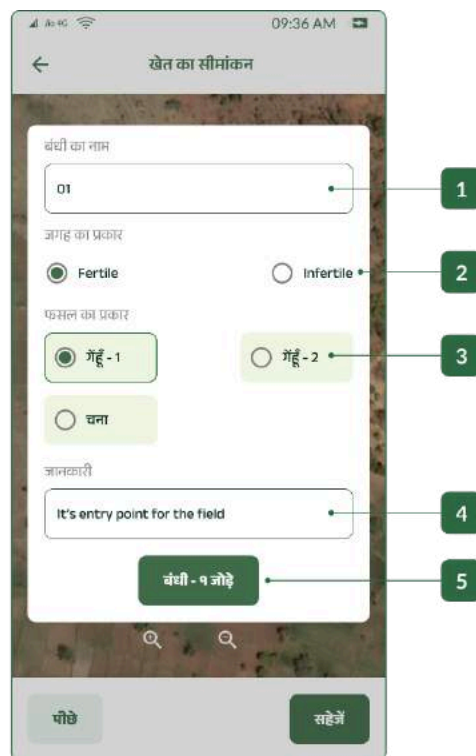
- There are two methods for marking the field: walking along the boundary or marking it on earth imagery. The steps are as follows:
- Add field name and crop details.
- Add field area, either by typing the area directly or by marking the field using the GPS system.
- This design ensures that farmers can easily navigate and complete the task of adding their fields.





When only one type of crop is cropped in farm

1. Name of parcel
2. Description about the parcel
3. Type of land farm (Fertile or infertile)
4. Add parcel to field



When more then one type of crop is cropped in farm

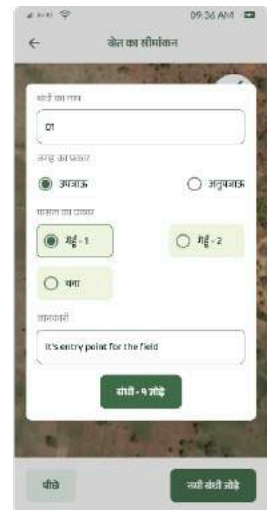
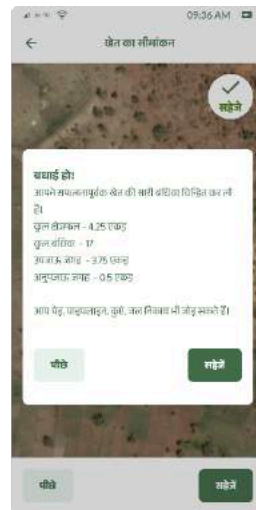
1. Name of parcel
2. Type of land
3. Crop Type
4. Description about the parcel
5. Add Parcel to field



1. Detail about the parcel
2. Edit boundary
3. Save
4. Back
5. Delete

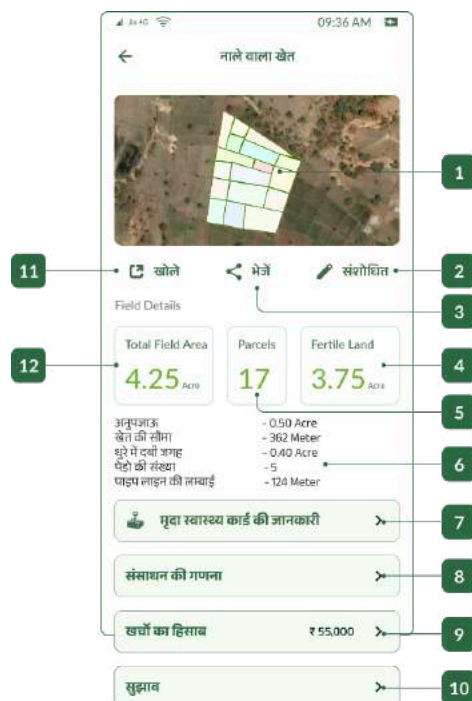
Adding small land parcels with personalized information about each parcel is also possible. Crop types can be assigned to each land parcel.

Below are the screens attached in sequence to add a field map with small land parcels within the field.

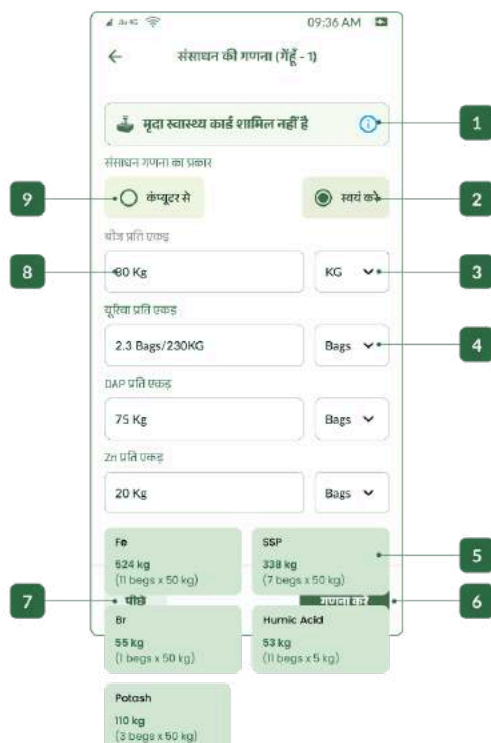


Resource Calculation

Once farmers finish adding a field, they can calculate resources and other details. Here are the screen details showing the features available for resource calculation.



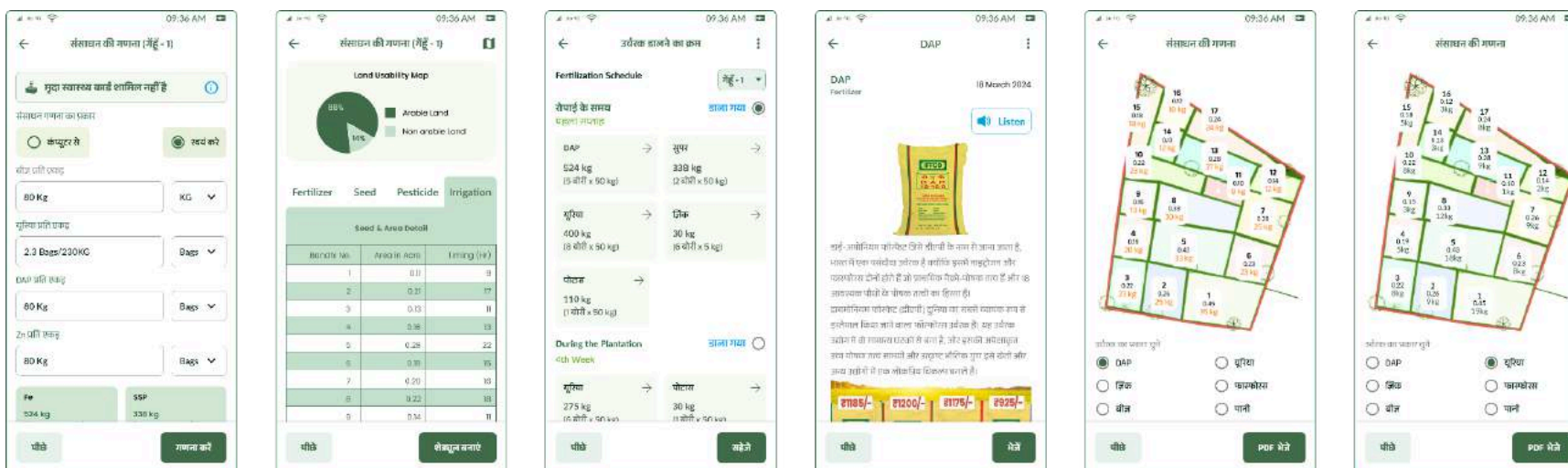
1. Field Map
2. Edit
3. Share
4. Fertile Land
5. Number of Parcel
6. Detail of Field
7. Soil Health Card
8. Resource Calculation
9. Expenditure
10. Suggestions
11. Open Field
12. Total Field Area



1. Soil Health Card Detail
2. Manual
3. Unit
4. Unit
5. Auto calculated Nutrients
6. Calculate
7. Back
8. Quantity
9. Auto Calculate



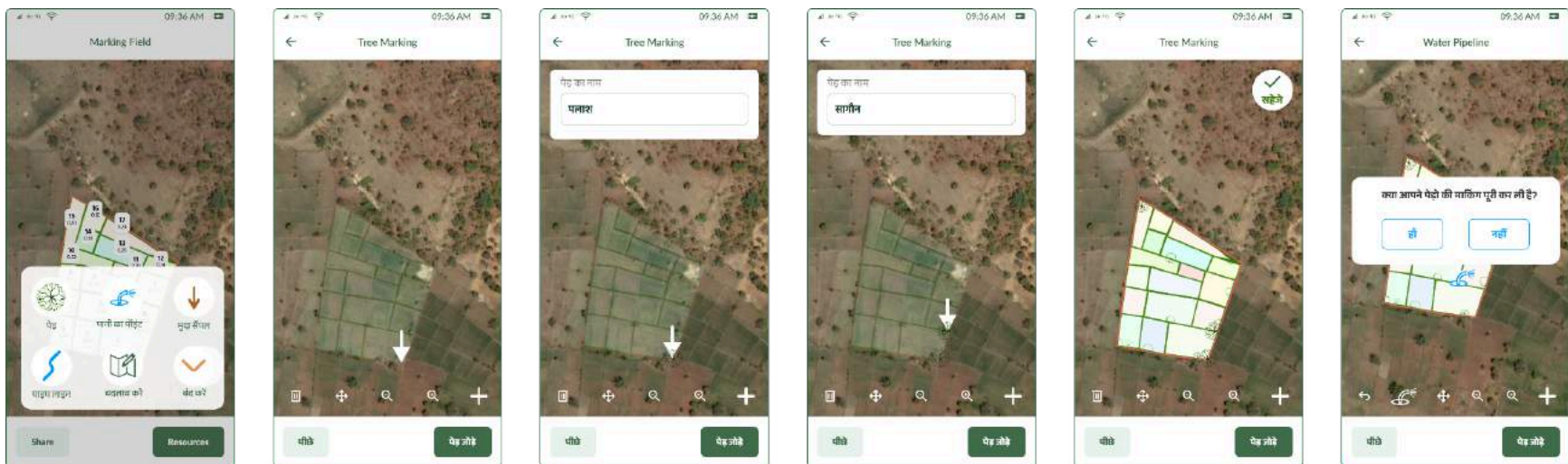
1. See in Map
2. Land Usability
3. Type of Resources
4. List of resource calculation
5. Create Schedule
6. Back



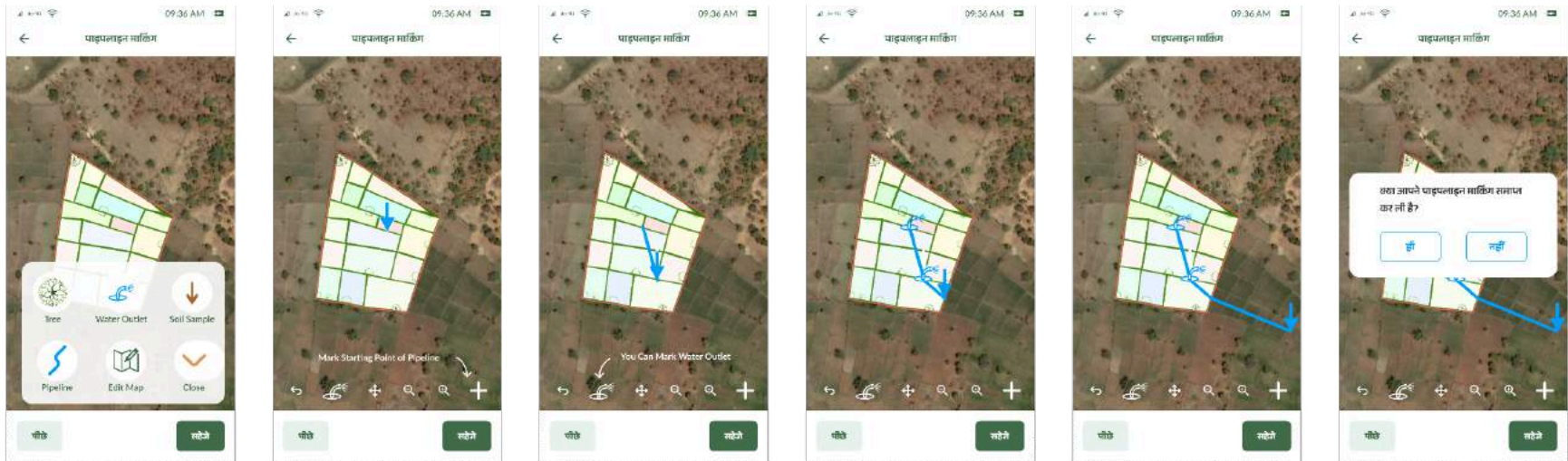
Farmers can calculate resources based on the field map, including each small land parcel. Once the resource calculation is completed, a schedule will be assigned, indicating when and how much fertilizer to apply. Additionally, the application will educate farmers by providing information about each type of fertilizer, including use cases, benefits, and side effects.

Marking Trees and other elements of the field

This process will start when farmers finish marking their field in the mobile application. Here, farmers can mark trees, water pipelines, water outlets, special elements, and soil testing sample collection locations. Farmers have the freedom to give personalized names to each one. Here are the screens presented in sequence for adding a tree on the map.



Marking tree on the field



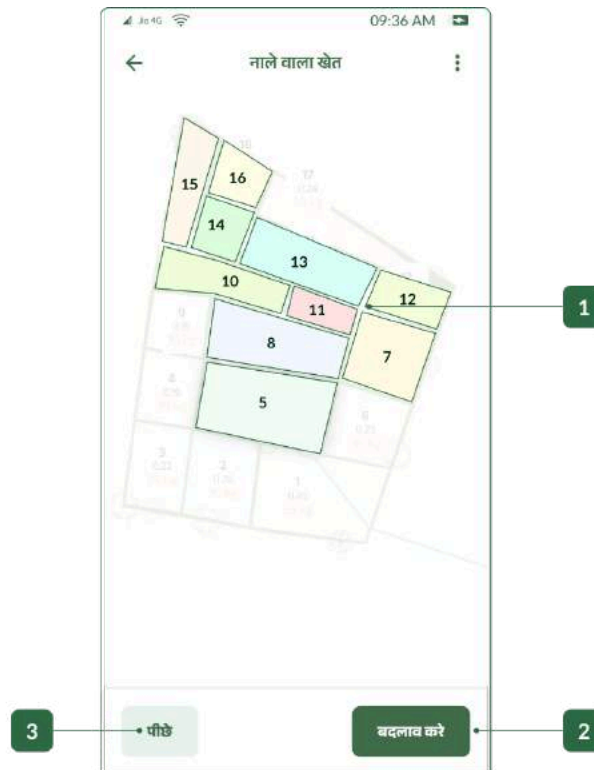
Marking water pipeline on the map

Managing Crop Types on the Field

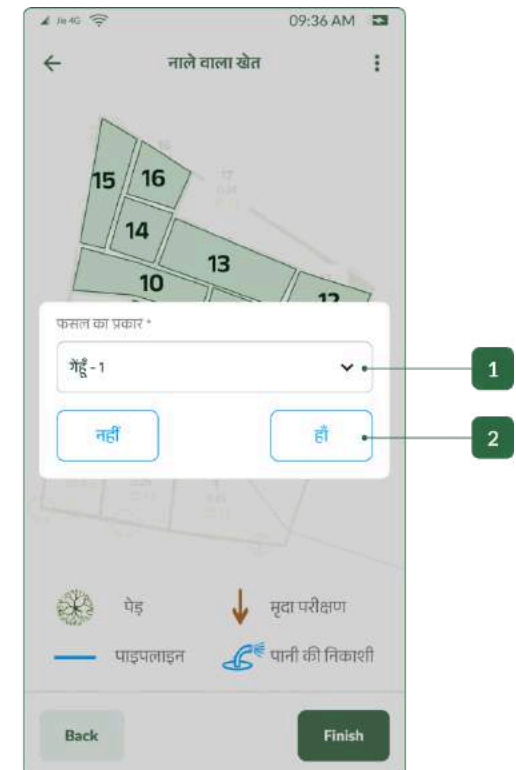
Every year, farmers change the seed. With this flow, users can change the crop area by selecting land parcels and then changing the crop type.



1. Share, Export, Delete and Print
2. Fertilizer, Seed, Area, and Comments
3. More Information
4. Selected Parcel (On Click)
5. Back or Close



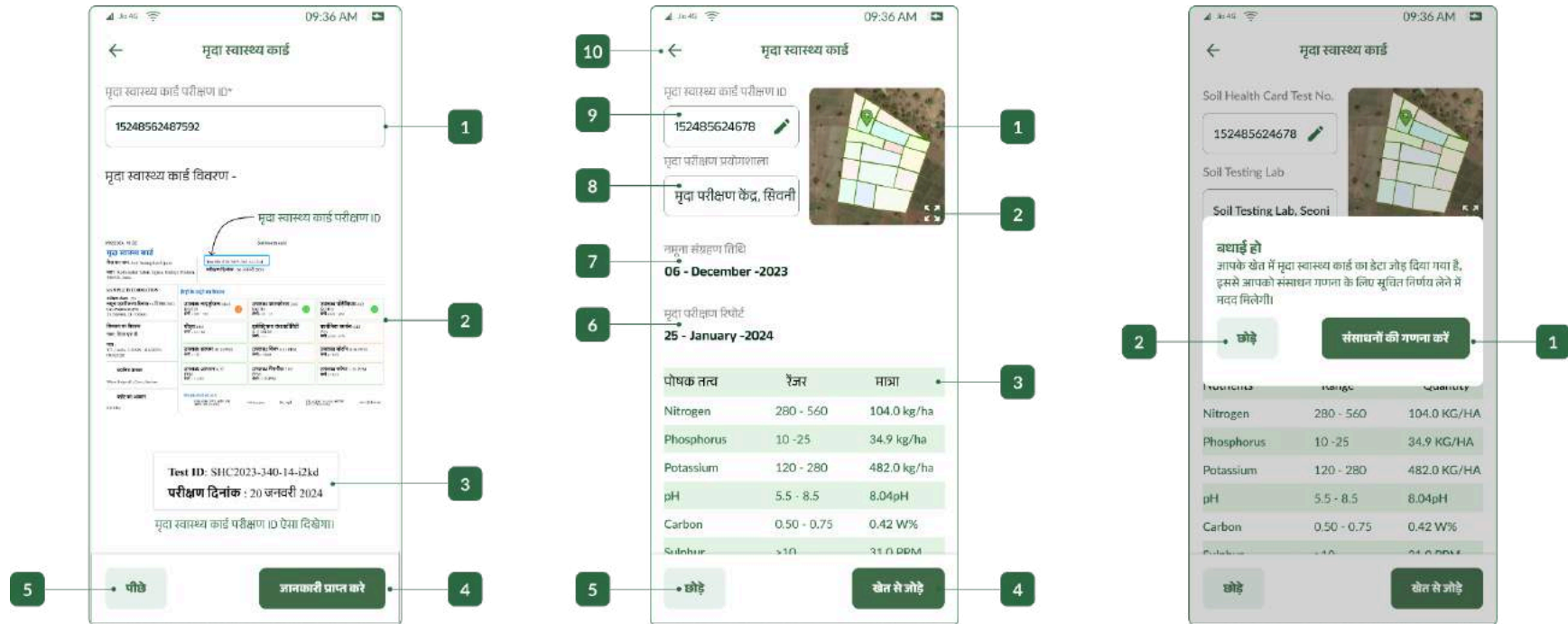
1. Tab and hold to select parcels
2. Edit crop type
3. Back



1. Select Listed Crops
2. Confirmation

Soil Health Card Integration

This process is simple: farmers need to input the soil health card ID, based on which data will be retrieved from the government server. This information will be ready to sync with the field. Once synced, resources will be calculated based on the soil health card information.



1. Soil health card ID
2. Demo of Soil health card
3. Zoomed view ID
4. Fetch Information
5. Skip

1. Map of field - Sample collection location
2. Expend Map
3. Available Nutrients
4. Attach to field
5. Skip

6. Soil testing date
7. Sample Collection Date
8. Soil testing lab
9. Soil health card ID
10. Back

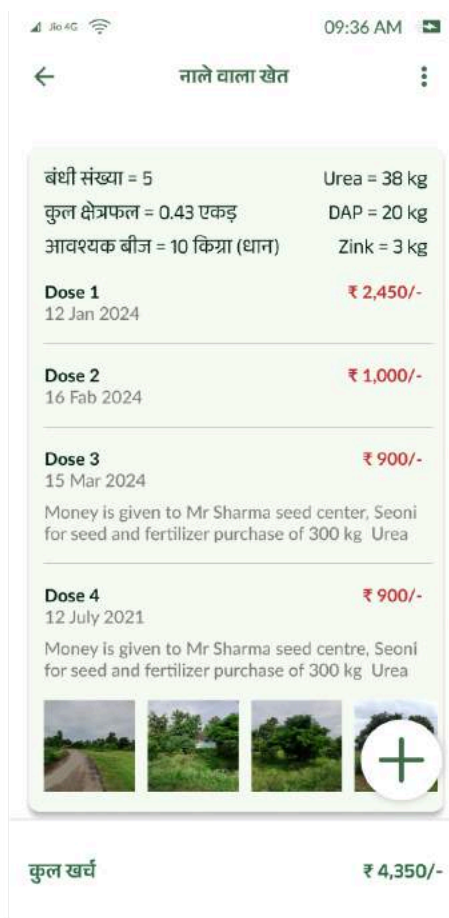
1. Calculate resource based on soil health card data
2. Skip

Home Page After adding Field

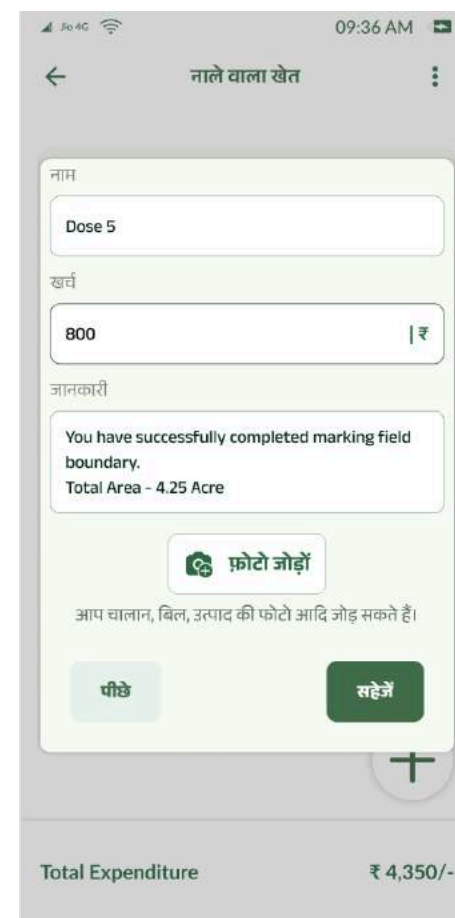




Selection of Parcel



Selection of Parcel

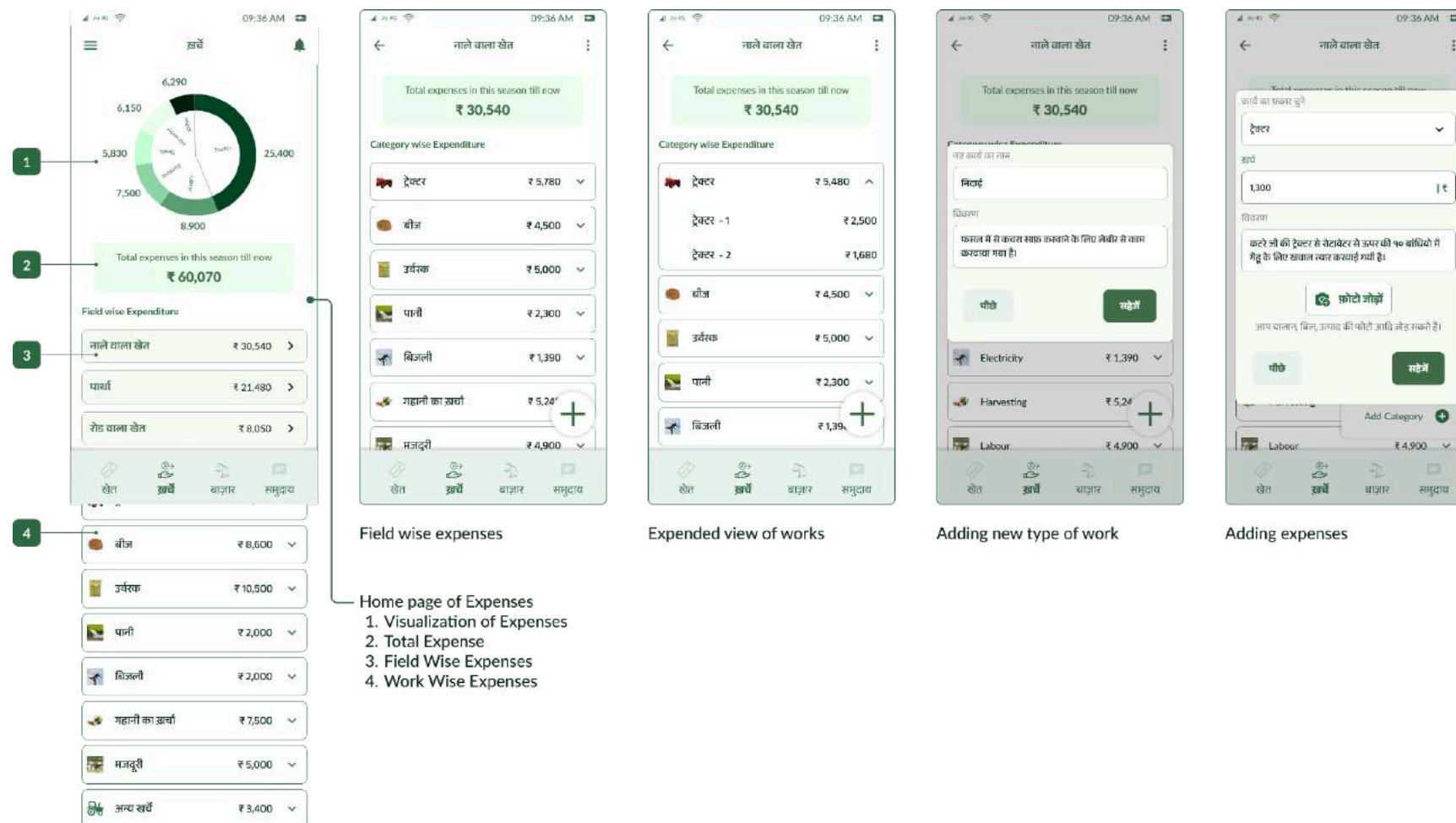


Add next dose of fertilizer

Here, farmers can select any land parcel and view all relevant details about it. They can also add more details about that parcel, including images.

Expense Record Keeping

This is a kind of logbook for farmers to manage all expenses in one place. Here, farmers can see the overall summary of expenses. They also have the option to manage field-based expenses and work-based expenses. In this process, farmers can add new types of work. They need to add expenses manually.



Market Portal



Selecting the Crop



Adding Mandis



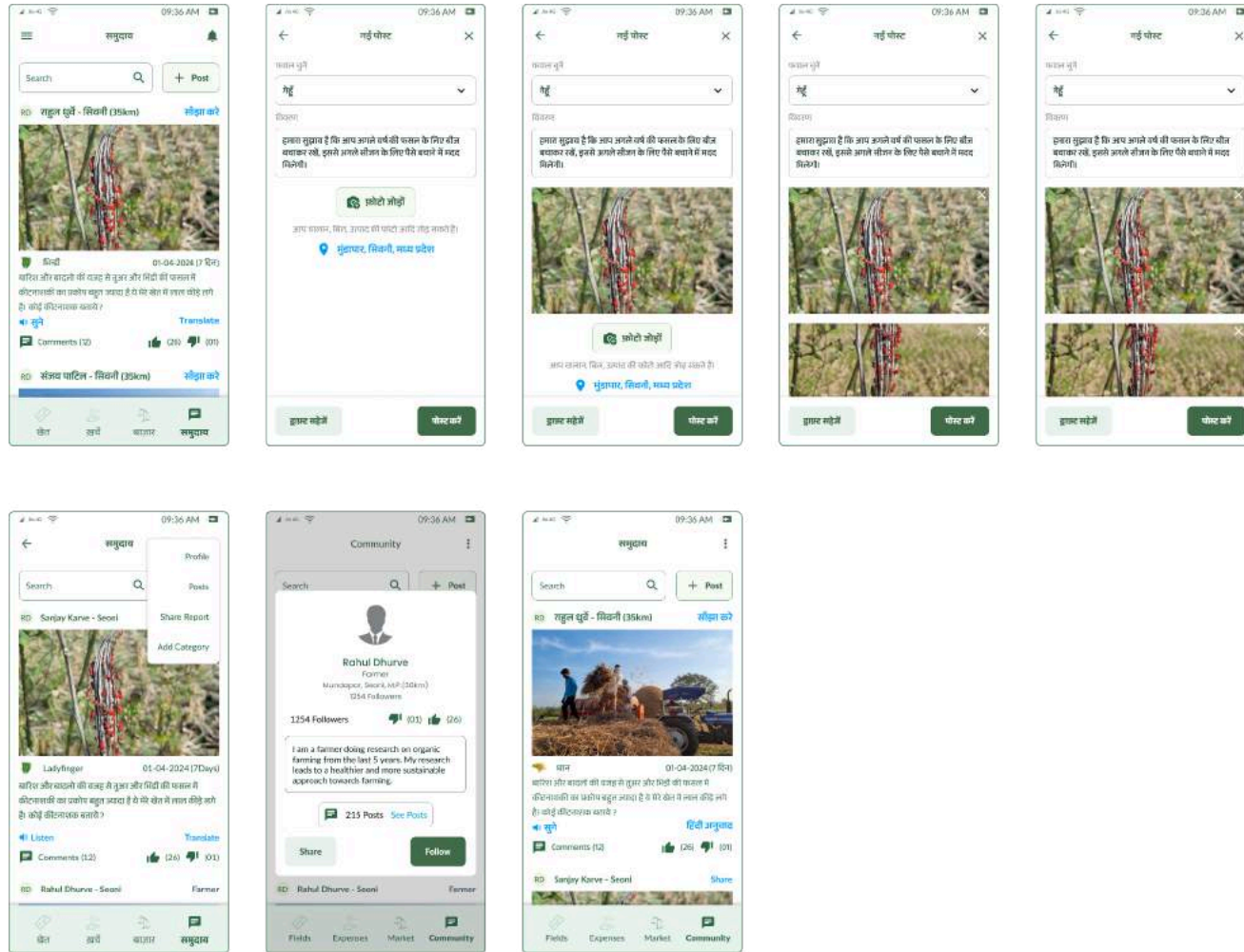
Market Rates of Crop

1. Name
2. Distance
3. Lowest and Highest Rate
4. Premium Rice Price

In the Mandi rate update feature, farmers need to select the type of crop and then choose the Mandis where they would like to sell their crop. Based on this selection, farmers can add the Mandis to their favorites or home screen for quick access.

Community Portal

This portal is inspired by the local news channel Public App, where local news is broadcast and added by the locals themselves. Similarly, in this community portal, farmers can see what others are doing, the problems they are facing, and information about crop health, etc. This information will be shared on the portal. To make it interactive, farmers can comment, like, and share posts.



Design Prototype

Figma Prototype

We have developed the working prototype for mobile application. Please click here to view Prototype

Link:

<https://www.figma.com/proto/Zk8EmyiDdh9DuMnk292Snc/Krishi-Application?page-id=0%3A1&node-id=648-21941&viewport=-2979%2C-21168%2C0.43&t=3lf61nAbL6kvVVx-1&scaling=contain>

Video of Prototype

Reorder video of prototype

Link:

<https://drive.google.com/file/d/1R2JOc6N3x8qIGX6vo88nwPfm9jLcpzWU/view?usp=sharing>



User Testing

Users were asked to provide a suitable time for user testing. First, we introduced the project and the purpose of this study. Once they understood, the mobile application was handed over to a designated mobile device for them to use. They were assigned three tasks to complete. Users could choose how many tasks they wanted to do, and we mentioned that they could withdraw at any time, even if they had agreed to perform the tasks. Once they started, I was available to answer questions, but only at the beginning or end of the functions. During the tasks, I observed user activity, noting task completion or failure. After finishing the tasks, users were asked for feedback.

Tasks:

We have designed three tasks for users to perform.

- The first task is adding a field. In this task, we aim to see if users can add their fields based on their mental model. This is the first step in calculating resources, integrating the soil health card, and keeping a record of expenditures.
- The second task is to test if farmers can mark their land on Google Maps imagery. There are two methods designed for this. One method involves farmers walking along the field boundary to mark points. Once the user finishes marking the outer boundary, they can start marking internal parcels within the field. This parcel marking will provide a more precise area calculation. The other method involves marking the field on earth imagery. In this method, the user does not need to be in the field. Here too, farmers must first mark the outer boundary of the field and then start marking internal partitions.
- The third task is designed to check resource calculation and resource scheduling. In this task, farmers have to calculate resources by following specific steps.

Adding the Field

Home Page
Add Field
Details about the Field
Area Addition
Marking the Field on Map*
Adding Soil Health Card Detail*
Save Field

Finding Field on Map

Home Page
Open Field Detail
Add field Map
Mode of Marking

- By walking
- Marking on Map

Walking on Field Boundary
Walking Along Parcel Boundaries
Save Field

Resource Scheduling

Home Page
Open Field Detail
Resource calculation
Mode of Calculation

- Automatic
- Manual

Adding the quantity of resources
Resource calculation
Scheduling

Experiment Design

The Task Performance Sequence

First step is to ask for a suitable time and place for user testing. Based on their responses, the tasks are scheduled. Once the task starts, we first explain the project and the purpose of the user testing. Then, users are provided with a mobile device to perform the tasks. After the tasks are completed, a discussion and feedback session follows.

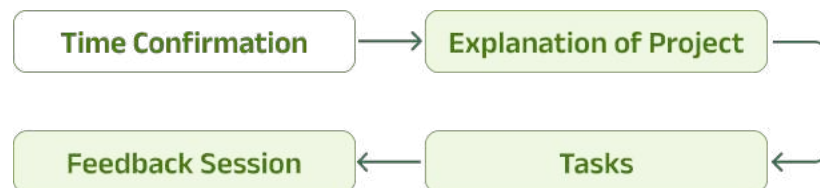


Figure 54. Task Sequence

Experiment Details:

Experiment Duration: 30 minutes - 1 hour

Number of Participants: 12 (08 new farmers, 04 experienced). Additionally, 2 new and 3 experienced farmers dropped out during the experiment but discussed the project.

Experiment Setting: Conducted as per the convenience of the farmers—near the farms, at home, or in shops. A mobile phone and notebook are required for the interview. Participants Selection Criteria: Mobile phone user, has a land area of more than 2 acres, has been engaged in farming activities for at least 1 year, or is knowledgeable about farming.

Observation: Task completion, closely observing finger movement and attention span during the task.



Figure 55. User Testing

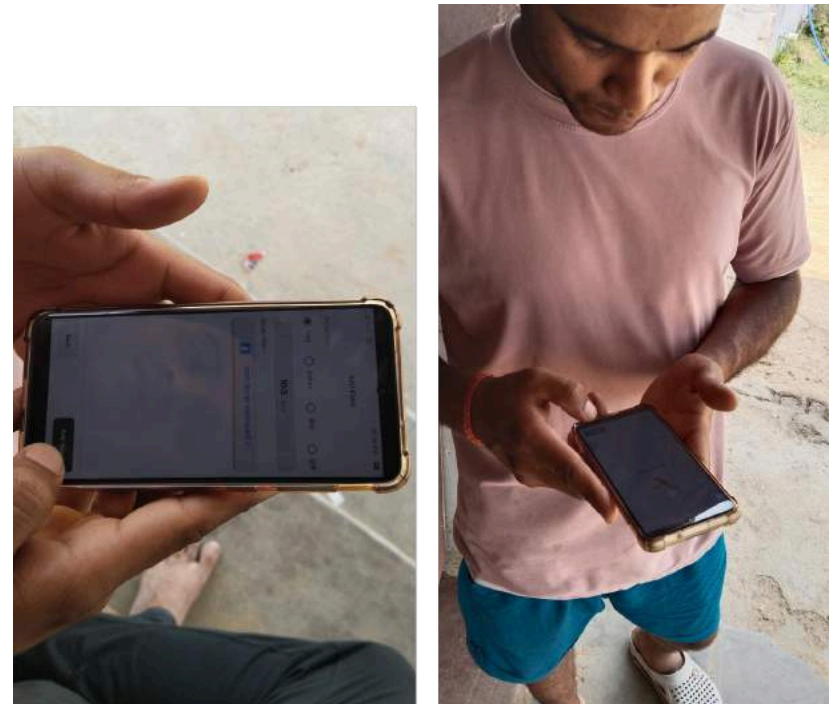


Figure 56. User Testing

Result and Analysis

Out of 18 farmers only 12 farmers showed interest the completing the task. Some farmers were interested in discussing the project.



Figure 85. User Testing

According to the user testing results, 75% of new farmers were able to complete the tasks, while 50% of experienced farmers were able to do so. Among the experienced farmers, fear of performance was noticeable as they appeared conscious during the tasks. However, if someone assisted them, they were able to perform better.

After task completion and during the discussion, users mentioned points that need to be updated in the mobile application's UX and UI. These were mostly related to the information architecture of the application.

- Users found difficulty in adding multiple crops to one farm, as many farmers plant more than one type of seed in a single season, or sometimes one farm will be cropped with different types of crops. Initially, our design mainly focused on landmarking based on the mental model of farmers. To address this, we have introduced the ability to assign crops and descriptions for land parcels.
- First-time users needed guidance in navigating the application because it is not a regular application they use. In the resource calculation process, many farmers faced challenges due to the new calculation methods. Once we explained the process, they were able to complete it. For better understanding, an on-screen information guide needs to be added.
- Experienced farmers faced challenges in the second task, as finding their farm in Google Maps imagery was difficult due to the unfamiliar top-down view. Many farmers struggled to identify their fields, but with guidance, they were able to locate them. This is an area where repeated use of the application can help improve familiarity.
- During the discussion, an alternative to this service was suggested. Instead of marking multiple crops in

one field, farmers suggested that we could mark multiple fields depending on crop type, which is an easier process. However, our suggestion is to mark the field once and change crop-wise divisions as needed. This approach is better because the field area and parcels are permanent, while crop type and cropped area change seasonally.

- During user testing, we understood that some features are currently not useful for the farmers but might become valuable once they start using the application. These features include pipeline marking, tree demarcation, the MSP registration portal, and the community portal. The development and adoption of these features will take time. Additionally, resource calculation will be required 5-6 times during one farming lifecycle.
- Once farmers can mark their fields, they can take a printout to note down details about the field. Based on this, we have proposed a logbook where farmers can keep their field records. This logbook will help farmers maintain a comprehensive record of their fields, aiding in better resource management and planning.

In our qualitative interviews regarding the final design and its implications, farmers demonstrated an understanding of the benefits of this application. Here are some quotes from farmers during the interviews.

“हम तो बाजु वाले काका डालते हैं तभी हम भी डाल देते हैं। अगर ऐसा कुछ आता है तो हमें पता रहेगा की कब खाद डालना है। ”

“When uncle next to our field applies the fertilizer in his field, then we also apply the fertilizer in our field. ”

This means that farmers, especially new farmers, rely heavily on others for making farming-related decisions. This reliance was evident during our primary research interviews. By introducing a more accurate method of calculation and scheduling, we aim to empower farmers to make informed decisions independently. This approach will also highlight that they recognize existing gaps in current farming practices that can be addressed with technology.

“सोडा (Fertilizer) नापते तो नहीं बस बोरी खेत में लेजाकर अंदाजे से फेक देते हैं। वो धमेले से नापते हैं वह भी। और बच गया तो फिर दुबारा से हल्का हल्का फेक देते हैं।”

“Fertilizers are not measured, they just take the sack to the field and throw it away based on instinct. They measure and take with the bucket. And if it remains, then throw it lightly again.”

“खेत में सोडा को सही से बाटने में मदद होगी क्योंकि अभी तो सब अंदाजा चलता है।”

“This will help in distributing the fertilizer properly in the field because right now everything is an estimate.”

“इस से फायदा होगा क्यूकी सभी जगह सोडा बराबर जायेगा अभी क्या होता है कही कही ज्यादा होता है तो फसल पिली पड़ जाती है।”

“This will be beneficial because soda will be supplied equally everywhere, what happens now is that if it is in excess at some places then the crop turns yellow.”

In current practice, farmers use experience-based distribution of resources throughout the field. They take the fertilizer and then decide where and how much to apply. Sometimes this method works well, but it is often based on luck. New farmers find this approach more difficult. However, as farmers suggested, if an application could provide basic measurements of field parcels, it would be helpful to make decisions based on a map.

We presented an example where fertilizers are specified for each parcel and distributed evenly throughout the field. The farmers were surprised by this approach and believed it would simplify their work. They also mentioned that they could instruct someone else to perform this task if necessary.

In current practices, if land area estimation goes wrong, it can directly impact the crops, causing them to turn yellow due to improper nutrient distribution.

“जायदातर तो बांधियो का एरिया ऐसे देखने से अंदाजा लगा लेते हैं, पर वो सही है या नहीं ये नहीं देखे। देखा हमने कोई कोई अपने गांव में मोबाइल से नापते हैं। अगर जैसा इसमें हो रहा है वैसा हमारे खेत के लिए हो जायेगा तो अच्छा रहेगा और भी काम आएगा।”

“Most of the time, they estimate the area of the dams by looking at it like this but do not check whether it is correct or not. We have seen some people in our village measuring it using mobile phones. If what is happening here, the same will happen for our fields. It will be good and will be more useful.”

“मोहित हमारे खेत का भी बना देना, कम से काम पता तो रहे की कौन की बंधी कितनी बड़ी है।”

“Mohit, please make our farm work also, at least we should know how big the land is.”

Users were showing interest in getting such an application for their fields because it allows them to calculate resources and manage them independently. This indicates that farmers are starting to understand and question the current estimation-based practice of farming. They see the value in having more precise and data-driven methods for resource distribution.

"इस में जो जगह उपजाऊ नहीं है उस का पता चल जा रहा है। अभी तो पुरे खेत के लिए सोडा डालते हैं। फिर लगता है की फसल कम हो रही है।"

"In this, the place which is not fertile is being revealed. Right now we pour soda for the entire field. Then it seems that the crop is decreasing."

Right now, people know the area recorded in government records, which only provides the total plot area without subdivisions. As a result, resources are also calculated based on the holistic land area. However, in our application, farmers can reduce the infertile land area by marking specific land parcels. Farmers have realized that certain areas are not fertile, yet they still calculate resources for them. Some farmers are aware of this issue but lack proper guidance on how to use this information effectively.

"ये धंधे वालो के लिए सही नहीं है, क्योंकि जब हार्वेस्टर चलता है तो वो पुरे खेत में ही घूमता है अगर ज्यादा बंधिया होगी तो टाइम भी ज्यादा लगेगा, पर इसमें सिर्फ फसल का एरिया आ रहा है।"

"पर इसमें जो साइल हेल्थ कार्ड के हिसाब से जो सोड़े की मात्रा बता रहा है वो सही है क्योंकि अभी तो पता ही नहीं की साइल हेल्थ कार्ड का क्या करना है।"

"This is not good for business people, because when the harvester runs, it roams in the entire field. If there are more parcels, it will take more time, but only the crop area is covered in it."

"But the amount of soda mentioned as per the soil health card is correct because right now we don't know what to do with the soil health card."

It was interesting to learn that people in the business sector are using this type of technology to measure land area but not for farming practices. Since this application identifies fertile land and eliminates other areas, it will be a concern for them. However, they mentioned that it is beneficial for farming activities because it allows for more accurate resource calculation. The use of the soil health card in farming activities also supports this approach.

In our qualitative interviews, farmers mentioned that this method is new, and at first glance, it seems difficult to meet all the requirements needed to follow this method. However, after explaining it twice, they understood how to use it. Some of the younger farmers are familiar with mobile applications for Google Maps-based area calculation, and they found this method more personalized. Experienced farmers faced challenges in the process of marking their fields. Some of the younger farmers expressed interest in taking this up as a business opportunity to create field maps for other farmers, as this could be beneficial since many farmers are still new to using Android-based mobile devices. Additionally, due to some network issues, making fields on Google Earth images

is more accurate and can be done from anywhere.

Therefore, in a village, one or two people could do this work for others on a commission basis.

Experienced farmers were hesitant to perform the task as it was something new for them. Some of them refused to complete the task. They acknowledged the usefulness of this method but mentioned that they would need guidance throughout the process. During the interviews, the farmers were alone, and their children were not with them. Often, children help their parents with mobile tasks at home.

Similarly, this application requires some experience in using mobile applications.

Project Constraints

Farming is a complex problem, not a linear process. Initially, it seemed straightforward, but it involves a web of many interrelated factors such as weather, soil type, previous year's crop, insect control, and proper nutrients. Additionally, experimenting with farming activities takes time because crop growth is a naturally lengthy process. In this project, we are focusing on a single village with a limited user group. A mobile application has been prototyped for testing, but the actual functionality of marking fields on earth imagery is not yet operational. To address this, we used the Wizard of Oz method, which simulates the application's functionality without having a fully developed mobile application.

The Success of Design

It would be beneficial if farmers could understand the benefits of precision farming and were willing to use it in the next farming season. For now, enabling users to mark their land and make decisions based on that for agriculture, focusing on new farmers, would be advantageous. This approach would empower farmers to leverage technology to optimize their agricultural practices, enhance productivity, and improve their livelihoods. By providing user-friendly tools and resources as per the needs of new farmers, we can facilitate their transition to precision farming and contribute to sustainable agricultural development.

Discussion

The project aims to provide farmers with in-depth information about their farms. Our primary and secondary research indicates that farming is complex and influenced by numerous factors. Agricultural researchers are striving to develop precision-based farming methods. This project seeks to enhance area calculations by using GPS technology, bringing land area measurements closer to reality. Through continuous discussions with farmers, it became evident that land area needs to be reconsidered for the distribution of fertilizers, incorporating soil health card information in resource calculations. This will help farmers make informed decisions about fertilizer use, promoting a sustainable farming approach.

Working with farmers and discussing their livelihood requires precise language. Any unexpected changes can make discussions challenging. Farming is a long and time-consuming activity, and researchers must visit multiple times as farmers' needs change. Initially, farmers focused on fertilizers and seeds; later, they were concerned about electricity, weather, and pesticides. Towards the end, their attention shifted to MSP registration and preparations for the next crop. Designers need to be aware of these changing needs and their impact on research.

While this project focuses on resource calculation based on land area and soil health card data, other factors also affect

resource calculation, such as weather conditions, seed quality, fertilizer type and mix percentages, and variations by company. Future iterations of the project should address these factors to make it more comprehensive, potentially creating a new system for resource calculation. Empirical studies are crucial when working with farmers or in rural areas. Online methods do not provide rich data or accurate insights for drawing conclusions, as we observed in this project.

Conclusion

This project focuses on a small part of overall farming activities. However, our research through the Design Research Seminar (DRS) and primary and secondary research indicates that accurate land area measurement is crucial for effective resource management. This small intervention can significantly benefit farmers. User feedback for the project indicates that it is a useful method for making informed decisions about farming activities. New farmers, lacking experience in resource and area calculation, were particularly interested in our design. Experienced farmers, on the other hand, showed more interest in government services, expenditure management, and expert advice. Therefore, our application proposes solutions to meet both groups' needs. Despite this, experienced farmers faced challenges in marking their fields on the map. This could also be developed into a business model for creating field maps with resource calculations.

The project has initiated discussions among farmers about current land and resource allocation methods, highlighting the need for improved practices and potentially leading to broader changes in farming techniques.

Future Work

This project addresses a small yet significant part of farming activity. Through this project, we aim to help farmers make informed decisions regarding resource and expense management by introducing soil health card integration. Here is a list of potential future scopes:

Comprehensive Farming Records

- Utilize field maps for long-term farming records.
- Identify and address farming challenges through data analysis.

Integration with Modern Agricultural Technology

- Share marked land on Google Earth imagery with agricultural drone systems.
- Enhance precision-based farming through soil health data and advanced weather stations.

Chemical vs. Organic Fertilizer Comparison

- Upload and analyze fertilizer usage data on the portal.
- Compare the impact of chemical fertilizers with organic fertilizers.
- Present potential profit increments from organic fertilizer usage to farmers.

Resource Optimization and Sustainable Farming

- Promote sustainable farming approaches by optimizing resource usage.
- Implement methods to reduce reliance on chemical fertilizers.

Community Portal Development

- Create a social media platform for farmers to share knowledge and experiences.
- Facilitate peer-to-peer learning and support within the farming community.

Expansion to Other Farming Activities

- Extend application functionalities to cover a broader range of farming activities.
- Integrate additional features to support various crops and farming practices.

Integration with Government and Agricultural Services

- Collaborate with government agencies for seamless data sharing and support.
- Connect with agricultural services to provide timely and relevant information to farmers.

Incorporation of Seasonal Requirements

I have been to the field three times throughout this project for study purposes. Initially, farmers were focused on the Minimum Support Price (MSP) and selling their crops to

cooperatives, so their main concern was the MSP. As time progressed and wheat farming was about to start, their requirements shifted to seeds, fertilizers, tractors, etc. During the second visit, their focus was on the weather, as it significantly affects crop growth. In the last visit, their attention was not much on farming but primarily on finding tractors for plowing. So mobile application should change its shape according to need.

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