Czech University of Life Sciences Prague

Faculty of Economics and Management

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Master's Thesis

Analysis of Existing Agriculture Information Systems in Pakistan, Identifying Gaps, and Designing a Web-Based Solution

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Mirza Waqas Safder, M.Sc.

Informatics

Thesis title

Analysis of Existing Agriculture Information Systems in Pakistan, Identifying Gaps, and Designing a Web-Based Solution

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Objectives of thesis

The main objective of the thesis is to analyze the existing agricultural information systems in Pakistan, identify the gaps and design a new web-based solution that takes into account the identified advantages and shortcomings. The partial objectives of the thesis are as follows:
To Analyze three existing information systems In Pakistan;
To Identify Gaps in existing Information Systems ;
To Understand Farmers' Information Needs;
To design a Web-Based Solution;
To Conduct testing and gather user feedback.

Methodology

To achieve the objectives, there is a need to review the literature for similar research work that has been done to analyze existing information systems in Pakistan, identifying barriers and designing a web-based platform for sharing information.

Three existing agriculture information systems will be selected to analyze through a survey. The set of questionnaires will be answered by farmers by this survey. To summarize the response from farmers, the frequencies, percentages, and descriptive statistics analysis will be conducted.

The research involves understanding farmers' needs through analysis.

A web-based information system will be designed using UML and a CMS framework. Testing and a User Acceptability Test (UAT) will be conducted to ensure the system meets requirements and is user-friendly. Based on the synthesis of theoretical and practical findings, the conclusions of the thesis will be formulated.

The proposed extent of the thesis

60 – 80 pages

Keywords

Statistical Analysis, Survey, Unified Modeling Language, Content Management system, User Acceptance Testing, Agriculture information System

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Recommended information sources

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Expected date of thesis defence

2023/24 SS – PEF

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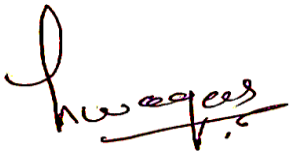
Declaration

I declare that I have worked on my master's thesis titled "Analysis of existing Agriculture information systems in Pakistan, identifying gaps, and designing a web-based solution" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.



In Prague on 17.03.2024

Mirza Waqas Safder

Acknowledgement

I would like to thank you Ing. Petr Benda, Ph.D for valuable guidance, support, and insightful feedback throughout the research process. His expertise, encouragement, and patience have been instrumental in shaping this work.

My heartfelt appreciation extends to my family for their unconditional love, encouragement, and understanding during the course of my studies. Their constant support and belief in my abilities have been a source of strength and motivation.

I would like to extend my gratitude to my friends and colleagues who have offered their assistance and encouragement during challenging times. Their camaraderie and encouragement have made this journey more enjoyable and rewarding.

Finally, I would like to acknowledge the participants of this study, whose contributions have been integral to the research process. Their willingness to share their experiences and insights has enriched this thesis and contributed to its validity.

In conclusion, I am deeply grateful to all those who have played a part in this endeavor. Their support, guidance, and encouragement have been invaluable, and I am truly fortunate to have had their assistance along the way.

Analysis of Existing Agriculture Information Systems in Pakistan, Identifying Gaps, and Designing a Web-Based Solution

Abstract

The 21st century is an era of fourth industrial revolution. This century is dictated by data and technology. Just like any other field, agriculture is no exception. Pakistan has had an agrarian economy since its inception; however, numerous issues related to food and agricultural growth have limited its economic scope. This study aims to analyze the usage of information systems in agriculture while identifying the challenges faced by this industry. To achieve this, three of the most widely-used agricultural websites were selected and statistically analyzed to identify the shortcomings and availability of agriculture information on these platforms.

The subsequent phase involves the designing UML diagrams & High Fidelity Wireframes to ensure the system fullfill the shortcomings which were found in existing information systems. The prototype web-based information solution was designed using CMS framework to address the agricultural queries and reduce the deficiencies that the previous system failed to tackle. To validate the effectiveness and usability of the developed system, Alpha User Acceptance Testing (UAT) was conducted.

If these recommendations and web-based solutions are accurately implemented, Pakistan's economy has the potential to regain strength and stand tall in the global community of nations.

Keywords: Agriculture, Information system, Digital agriculture, Pakistan, CMS, UML web-based solution.

Analýza stávajících zemědělských informačních systémů v Pákistánu, identifikace nedostatků a návrh webového řešení

Abstrakt

21. století je obdobím čtvrté průmyslové revoluce. Toto století je diktováno daty a technologiemi. Jako každý jiný obor ani zemědělství není výjimkou. Pákistán má agrární ekonomiku od svého založení; četné problémy související s růstem potravin a zemědělství však omezily jeho ekonomický rozsah. Tato studie si klade za cíl analyzovat využití informačních systémů v zemědělství a zároveň identifikovat výzvy, kterým toto odvětví čelí. Aby toho bylo dosaženo, byly vybrány a statisticky analyzovány tři nejpoužívanější zemědělské webové stránky, aby se identifikovaly nedostatky a dostupnost zemědělských informací na těchto platformách.

Následná fáze zahrnuje návrh UML diagramů a High Fidelity Wireframes, aby systém naplňoval nedostatky, které byly zjištěny u stávajících informačních systémů. Prototyp webového informačního řešení byl navržen s využitím rámce CMS pro řešení zemědělských dotazů a snížení nedostatků, které předchozí systém nedokázal vyřešit. Pro ověření účinnosti a použitelnosti vyvinutého systému bylo provedeno Alpha User Acceptance Testing (UAT).

Pokud budou tato doporučení a webová řešení přesně implementována, má pákistánská ekonomika potenciál znovu nabýt sílu a obstát v globálním společenství národů.

Klíčová slova: Agriculture, Information system, Digital agriculture, Pakistan, CMS, UML web-based solution, Wordpress, Descriptive statistics.

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1. Introduction

With the advent of modern technology and internet, traditional processes such as businesses, education, banking etc. are being shifted online through digital devices such as mobile phones and laptops. As Nobel Prize-winning economist Robert Solow has aptly remarked “computer age is everywhere, except in productivity statistics”. In the age of globalization, we must wage war on digitalization in order to both survive and maintain our respectable status in the community of nations. Many nations have taken steps to keep data online 24/7 and to digitally transform their economies.

Since its inception, Pakistan has been an agricultural nation. The greatest source of foreign exchange earnings, accounting for half of the employed labour force and 24 percent of the GDP, is agriculture, according to government figures. However, malnutrition and stunted growth remain pervasive, the rural poverty rate is twice as high as the urban rate, and Pakistan has turned into a net importer of food and agricultural products. (Agriculture - Ministry of Finance, 2022)

From the very beginning, farmers have relied on dependable weather patterns. Season after season, raising a healthy crop depends on knowing roughly when it will rain and how hot or cold it might be. True, unexpected events like an unseasonably cold snap or extremely heavy rain have always affected farmers.

However, the agriculture sector in Pakistan is facing numerous challenges that require innovative solutions to enhance productivity and address issues such as climate change, water scarcity, and arable land reduction (Ahmad, R. and Rehman, S., 2023). These challenges have led to a shift in the majority of the population from rural to urban areas, which has had a detrimental impact on the agriculture industry.

The existing agriculture information system in Pakistan needs thorough analysis to identify its shortcomings and propose a web-based solution that can address the gaps. To combat these challenges, Pakistan must adopt innovative technologies and practices that promote climate-smart agriculture. This entails a reorientation of traditional farming practices towards more digitalization and deployment of information system in agricultural practices. A methodological strategy combining online surveys, field surveys, and expert

interviews was used to gather substantial and multifaceted data relevant to the research at hand. The development of a structured questionnaire with twelve painstakingly constructed questions that addressed crucial facets of the current agriculture information system in Pakistan. To ensure a comprehensive viewpoint, this questionnaire was then distributed through email to a varied set of responders, including farmers and people closely related to agriculture.

In addition, field surveys were carried out in Pakistan using local contacts and personal networks in recognition of the value of local insights. These field surveys made it easier to gather contextually rich data, which added priceless qualitative data to the survey results. Furthermore, an interview with the Director General of agriculture was undertaken in order to acquire a thorough grasp of the numerous problems and difficulties facing the agriculture information system. An authoritative viewpoint and insider knowledge of the workings and flaws of the system were provided in this interview. This study aims to give a thorough the analysis of the existing state of the agriculture information system in Pakistan, with a nuanced grasp of its intricacies and potential remedies, by using this diverse data gathering technique.

1. Objectives & Methodology

2.1 Objectives

The main objective of the thesis is to analyze the existing agricultural information systems in Pakistan, identify the gaps and design a new web-based solution that takes into account the identified advantages and shortcomings. The partial objectives of the thesis are as follows:

- To Analyze three existing information systems In Pakistan
- To Identify Gaps in existing Information Systems
- To Understand Farmers' Information Needs
- To design a Web-Based Solution
- To Conduct testing and gather user feedback

2.2 Methodology

The methodology is the study focus on analysis and synthesis of technical information resources related to specific issues. The primary research based on relevent literature review focused on agriculture information systems, it’s importance & role in agriculture sector. The second part of research is to conduct a survey through google survey forms which comprises on 15 questionnaires in order to get the information, impacts on agriculture farmers and finding gaps about 3-existing agriculture information systems in Pakistan.

The third part of research based on descriptive statistical analysis using the software SPSS (Statistical Package for the Social Sciences). The descriptive statistics, Cross tabulation Infrantional statistics (Anova) tests were conducted to analyse the data. The UML diagrams and High Fidelity wireframes constructed to build an prototype web-based information system. The proposed web-based agriculture information system designed using CMS framework Wordpress. The Alpha UAT testing was conducted to check the functionalites & gather user feedback.

2. Literature Review

This chapter discusses the important literature consulted for the effective completion of the research. It also provides definitions of important terms to comprehend the title. In this way it acts as the theoretical foundation of thesis.

3.1 Conceptualizing key terms

3.1.1 Information

A collection of facts or data that offer knowledge or insight into a certain topic or circumstance might be generically characterized as information. It can be communicated through a variety of channels, including print, digital, spoken, and a variety of other formats, including text, photographs, videos, sounds, and more.

Information is fundamentally a tool for comprehending the world around us and a means of communication. Making educated decisions, processing and analyzing data, and imparting information to others are all made possible. We would be unable to study, produce, or invent without information, and our comprehension of the world would be constrained. (Haag et al., 1998)

Information is more readily available and abundant than ever in the modern digital era. The way we interact, access, and share information has changed as a result of the internet, social media, and other digital technologies, opening up new possibilities for creativity, collaboration, and learning.

3.1.2 Information system

In order to assist decision-making, coordination, control, analysis, and visualization, information systems (IS) are networks of interconnected parts that collect, store, process, and distribute information. Major broad categories that can be used to classify IS are:

1. Information management system (IMS)
2. Transaction processing system (TPS)
3. Decision support system (DSS)
4. Executive Information Systems (EIS)
5. Expert Systems

6. Artificial Intelligence Systems (AI), and
7. Geographic Information Systems (GIS)

The focus of this study is on information management systems.

Information management system (IMS): A sort of software or technology called an information management system (IMS) is used to manage and store data and information inside of an organization. It aids businesses in controlling information flow, enhancing data accuracy, and guaranteeing data security. (Haag et al., 1998). Depending on their functions and intended purposes, information management systems can take many different shapes. Information management systems can be found in several common configurations.

Document management system: Electronic documents and photographs can be stored, managed, and tracked using a document management system (DMS).

Knowledge Management System (KMS): A system that controls the organization's knowledge and information assets and facilitates effective knowledge exchange and collaboration.

Content management system (CMS): The production, revision, and dissemination of digital information are all managed by a system.

Customer relationship management system (CRM): A system for managing interactions and connections between a business and its clients.

Enterprise resource planning system (ERP): It refers to a category of software that businesses employ to handle daily tasks including accounting, purchasing, project management, risk management, and compliance, as well as supply chain management.

3.2 Information and communication technology in agriculture

Through enhanced information and communication processes, ICT in Agriculture, also known as Digital Agriculture (d-Agriculture), aims to boost agricultural and rural development. ICT has been used in this context as an umbrella phrase that refers to all information and communication technologies, including devices, networks, mobiles,

services, and applications. These technologies range from cutting-edge Internet-era technologies and sensors to other traditional aids like landlines, televisions, radios, and satellites.

As new ICT applications are continually tapped into in the agriculture industry, d-Agriculture's scope continues to expand. It entails the idea, design, development, evaluation, and use of novel ICT applications in the countryside, primarily concentrating on agriculture. The fundamental components of d-Agriculture include the maintenance of rules, regulations, procedures, and tools; the development of institutional and human capacities; and the support of policy.

A subclass of digital agriculture, mobile agriculture (m-Agriculture) uses mobile technologies to support participants in the agriculture value chain. Voice, data, network, and connectivity technologies are among the subcategories of mobile technology, which includes a wide range of devices.

The following are some of the most important and common elements of the agriculture value chain: (Claudia et al., 2016)

Input providers: Suppliers of raw supplies including seeds, fertiliser, and insecticides.

Farmers: producers or smallholders, who are in charge of overseeing the production of the agricultural commodity.

Associations and cooperatives: forming groupings of numerous smallholder farmers to bargain for higher prices with customers and provide extension services.

Buyers: acquiring the agricultural product and, on occasion, handling the processing, packaging, and marketing of the finished goods.

Consumers: devouring the finished goods.

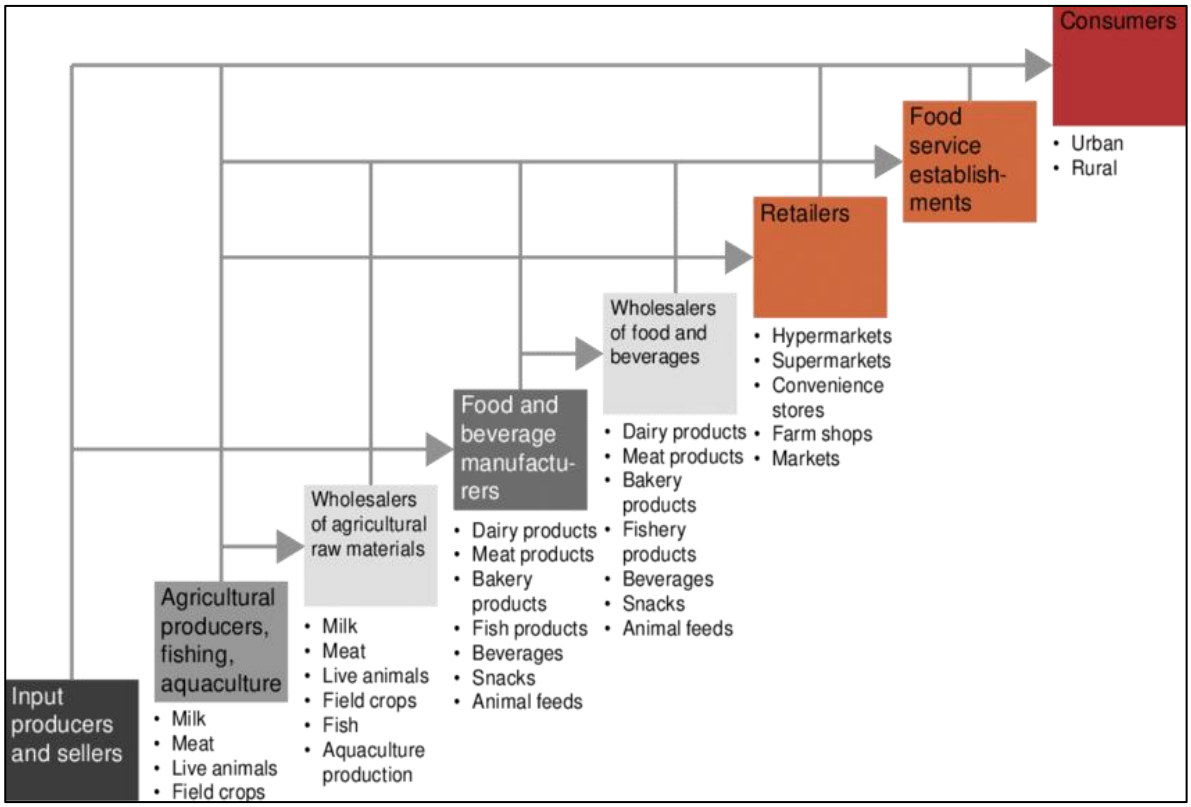

Figure 1: Components of agriculture value chain (Source: Viira et al., 2017)

Where an actor can play multiple roles, the accurate representation of the agricultural value chain is frequently more complicated. For instance, when the farmers they engage with lack a consistent supply of inputs, the purchasers shift to input providers. Additionally, it frequently occurs that buyers additionally provide financing for these inputs. The role of intermediaries has been rather ambiguous; they buy at the farm from individual smallholders and sell in bulk to the more reputable buying corporations, but while doing so, they frequently take a sizable cut of the profit and give cash-strapped farmers poor prices.

Mobile technology and portable wireless devices have sparked the development of cutting-edge services and applications that are utilised in both developed and developing nations' agricultural value chains. The implementation of m-Agriculture applications typically occurs farther up the value chain, such as with processors or consumers, in developed markets where mechanisation is more advanced and the agricultural labour force is substantially lower than that of many developing countries. Mobile technology is

more frequently used to provide services for farmers and traders in developing nations where a sizable section of the labour population is working in agriculture.

3.3 Previous studies supplementing the topic under discussion

The paper discusses the challenges faced by agriculture in Pakistan, such as lack of connectivity and delayed information to farmers, and the potential of information and communication technologies (ICTs) to improve agricultural productivity and sustainability. The authors emphasize the importance of empowering farmers with the right information at the right time and place through modern communication tools. The paper discusses various methods used in Pakistan for the dissemination of agricultural information and knowledge among the farming community, including modern information and communication tools such as decision support systems, kiosks, and SMS. (Khalid et al., 2021)

The researchers focuses on how farmers in the Pakistani district of Muzaffargarh utilise their mobile phones to acquire agricultural information. Data from the two tehsils (cities/sub-districts) of Muzaffargarh were gathered using a multistage sampling technique, resulting in a sample size of 180 farmers. The data were analysed using computer software called SPSS. Results showed that 91.2% of the farmers reported owning a smartphone. According to further statistics, 87.20% of farmers consulted with advisors from the private sector to learn about agriculture. (Khan et al., 2019)

In this paper, Three areas of farmers' preparedness research is being done on the intended mobile phone information and trade system (MAITS): (a) farmers' willingness to use the trade system & newly developed mobile phone information system; and (b) significant factors influencing farmers' use of Systems for mobile decision support. The farmers' ability to connect with the mobile corporate networks is included in at (c). The investigation of them used a qualitative research methodology. The analysis found that farmers' willingness to adopt new mobile phone information systems necessitates the highest level of optimism and inventiveness as well as a number of the restraining variables that affect the ready condition. (Shaukat et al., 2014)

In this paper, researchers chose 160 households at random from four districts in Pakistan's Punjab province. Data were gathered utilizing an interviewing technique and a validated, expert-reviewed questionnaire. According to the findings, the majority of farmers (47.5%), followed by farmers who rated this source second (31.9%), and farmers who ranked it third (33.7%), listed neighbours, friends, and relatives as their primary sources of knowledge. In contrast, a very small percentage of farmers (10%) identified agricultural extension personnel as their top source of knowledge. (Yaseen et al., 2016)

The paper analyzes the use and effectiveness of mobile-based farm advisory services (mFAS) in Pakistan, particularly in the Muzaffargarh district. The study explores the content provided, utilizing a Likert scale and bivariate Probit regression to analyze farmers' experiences and the regression. Researchers discovered that although 70% of respondents were mFAS subscribers, there was a large discrepancy between farmers' access to information and how they really used it. ivrWeather forecast was the most utilized information, while market updates were the least utilized. (Khan et al., 2020)

The paper evaluates the sustainability of agriculture production systems in Pakistan using emergy accounting method and various indicators. The study analyzes the inputs and outputs of agriculture production systems in four provinces of Pakistan and provides insights for policy makers and producers to create sustainable agricultural production systems. It uses the emergy accounting method to analyze the sustainability of agriculture production systems in Pakistan. Various indicators are used to evaluate the inputs and outputs of agriculture production systems in four provinces of Pakistan. (Shah et al., 2021)
The research aimed to identify the agricultural information needs of rural farmers in Khyber Pakhtunkhwa, Pakistan, and to provide a solution to access this information. The study found that the use of Information and Communication Technology (ICT) can enhance production and improve the livelihood of small-scale farmers in rural Pakistan. (Awan et al., 2019)

The paper provides an overview of the issue and proposes a solution to address the problem. It discusses the current status of farming practices and ICT interventions in Pakistan's agriculture sector. It highlights the need for an ICT solution to address the outdated farming practices and lack of technology in various farming stages, which are the

major reasons behind the decline in crop production. The paper proposes guidelines for an ICT solution that will be easily accepted by local and small-scale farmers. (Sidra et al., 2020)

The paper presents the development and evaluation of an interactive voice response (IVR) system for the agricultural community of Punjab, Pakistan. The results demonstrate that an IVR system is a feasible means of delivering agro-information. The system distributes agro-information, including weather forecasts, pesticide and fertilizer information, and so on. An assessment of the IVR system's usage revealed that it is a feasible means of providing agro-information. (Riaz et al., 2017)

This study identifies the core agricultural information needs of farmers in central Punjab and develops a touch application to deliver information such as weather forecast, pesticides, and fertilizer information. The results show that the application is a viable option to deliver agro-information. (Ali et al., 2016)

The paper discusses the importance of agriculture in achieving sustainable development goals and the need for unrestricted access to spatial data for evidence-based policy-making. It focuses on the case of Pakistan and explores the types of spatial datasets required to address the challenges faced by the agriculture sector in the country.(Ali et al., 2021)

By examining the elements impeding the interaction between the system actors (extension, research, and farmer), the paper aims to identify the limiting factors within the agricultural extension system in the Balochistan province of Pakistan. It suggests using these links to effectively bridge the gap between potential and actual farm productivity. (Mengal et al., 2019)

3.4 ICT based technology in Agriculture: methodologies that are guiding stars.

ICT is a new technology with a significant role to play in the development of the agricultural sector. The most promising is agriculture and important profession and is required to preserve life on Planet Earth. The plans for farmers to improve their

agricultural practises using ICT technology are being implemented through government policies and programmes to ensure inclusion and prevent digital gaps.

In order to process various forms of agricultural data on an individual basis across several domains using cloud technology, a QoS-aware system was created. The suggested system gathers data from several users using a specified device, as illustrated in Figure 2, and automatically provides the data needed by users. By creating a scheduler that can readily change resource planning in accordance with requirements, the suggested method could be improved. (Jeong et al., 2013)

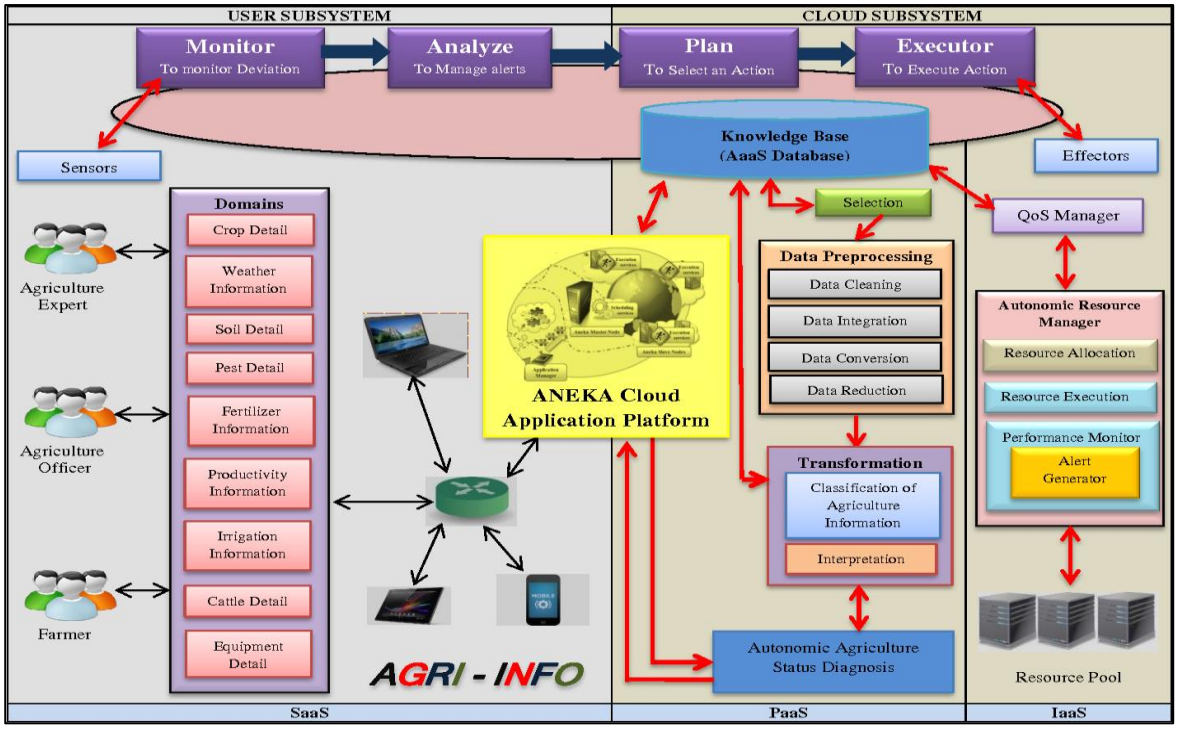

Figure 2: Qos aware Agri-info framework (source: Jeong et al., 2013)

Information and Communication Technology (ICT) has the power to boost production efficiency, create a welcoming political environment, and give information on prices, agricultural inputs, access to national and worldwide markets. (Lemma et al., 2017) Smart farming involves several important areas, including improving the quality of life for farmers and managing soil, water, seeds, fertilizers, pests, crops, and post-harvesting. Better information and alternatives to a range of technologies, such as computer simulation, remote sensing, analyzing soil quality, predicting crop yields, and determining

wind speed and direction, are made possible by technology for farmers. Figure 3 illustrates a general data-driven management system for smart agriculture. (Saiz-Rubio et al., 2020)

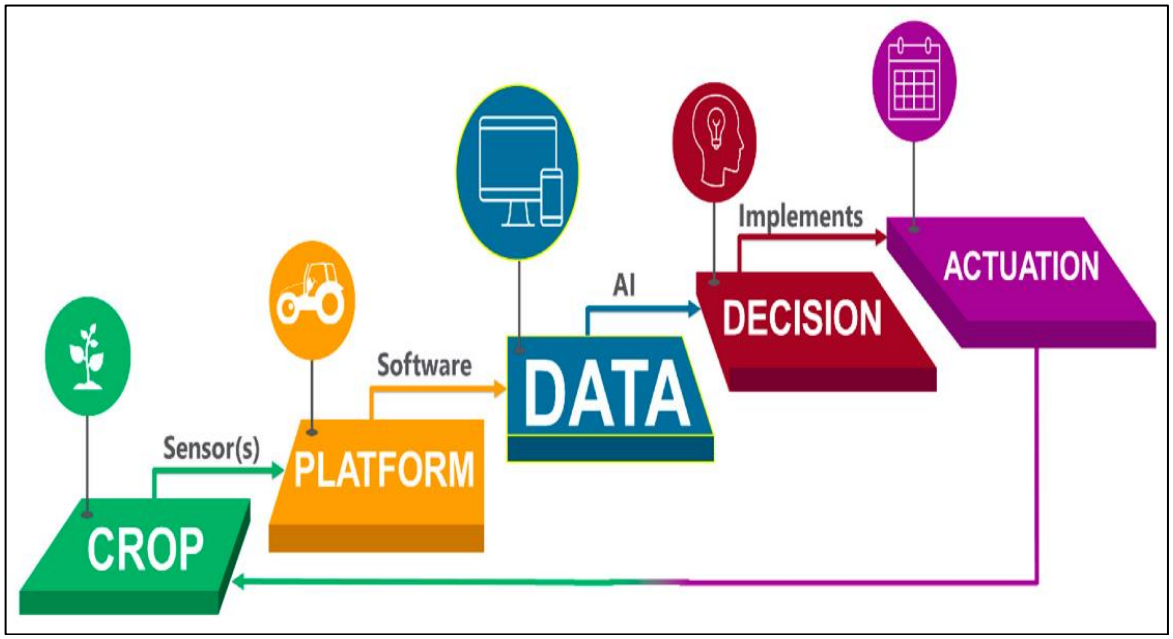

Figure 3: Management system for smart agriculture (source: Saiz-Rubio et al., 2020)

The intended results have not yet been attained despite Pakistan's implementation of numerous measures to solve the different issues the national and federal governments in the agricultural sector face.

3.4.1 Cloud Computing (CC) In Agriculture

Smart agriculture of specialized crops is an area where cloud computing is especially helpful in assisting decision-making. Sensor and other data sources with high throughput must be supported by decision support systems. Real-time data processing is made possible by CC's scalability. As demonstrated in Figure 4, CC enables the prompt provisioning of resources by making timely decisions, even when the demand for decision support varies throughout high and low seasons. (Lemma et al., 2017)

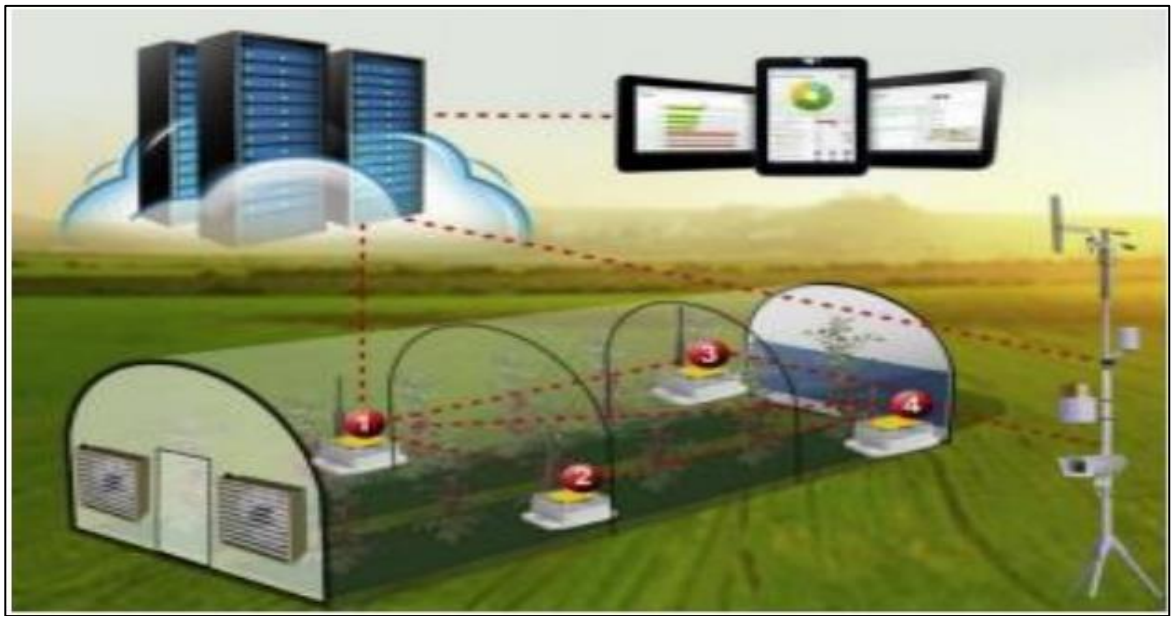

Figure 4: Cloud computing in agriculture (source: Lemma et al., 2017)

3.4.2 Big Data in Agriculture

A large investment in data processing and storage infrastructure is required for agricultural big data applications that need to function in near real-time, such as animal diseases, crop pest monitoring, and weather forecasts. Therefore, the term "big data analysis" is used to characterise cutting-edge techniques created to help farmers and related organisations derive economic value from a large variety of data, high-speed collecting, and analysis. Numerous industries, including online banking, insurance, customer understanding, and personalization, have effectively embraced big data analysis.

Although big data analysis is popular and appears to be useful in many domains, its application in agriculture dates back only a few years, as stakeholders began to realize its potential benefits. Big data analysis can be used to give farmers suggestions that will enhance crop yields globally by around $20 billion. By comprehending complex agricultural ecosystems, new digital technology can better comprehend and address the growing issues of agricultural production. Such Technologies are able to continuously monitor the physical environment and generate vast amounts of data with exponential growth. These technologies generate enormous amounts of data, or "big data," including data from sensors in fields, continuous physical environment assessment and tracking, and crops. (Akal et al., 2019).

3.4.3 Smart Agriculture Technology

IoT, or the Internet of Things, is used in smart agriculture to connect devices or nodes to networks for communication and information sharing. The Internet of Things (IoT) has the potential to create billions of connected, intelligent items. These intelligent items have the ability to gather environmental data and connect online with other systems. IoT applications for irrigation, crop cultivation, harvesting and post-harvest, crop storage, processings, & transportations are integral to the life of agricultural products. For agricultural applications, a variety of speciality sensors are utilised, including soil moisture sensors, humidity sensors, leaf moisture sensors, solar emission sensors, infrared light sensors, and rain gauges as illustrated in figure 5. (Sui et al., 2019)

Figure 5: Smart Agriculture Technology (source: Sui et al., 2019)

3.4.4 Soil and Water Sensors

The soil and water sensor is the component that will have the most direct impact. These sensors are inexpensive and long-lasting. Even complete farms are easy to distribute throughout the globe and have a number of advantages. The majority of soil moisture sensors are made to calculate the volumetric water content of the soil using the dielectric constant of the soil. As a result, the water content can be predicted using the dielectric constant calculation. Instead of relying on a set schedule, the sensors' ability to detect nitrogen and humidity can be utilised to decide when to fertilise and water. In addition to

allowing you to save money by using the resources more effectively, this also prevents erosion, conserves water, and lowers the amount of fertiliser in nearby lakes and rivers, assisting businesses in becoming more eco-friendly. (Sui et al., 2019)

3.4.5 Weather Stations

The most widely used smart farming devices are weather stations, which integrate different sensors to collect scattered data and upload it to the cloud. With the help of the measurements provided, it is possible to map the local climate, choose the best crops, and take the required steps to increase their productivity. Dependence on neighborhood meteorologists is not a smart idea because computerised weather modelling has improved. Farmers can access some internet weather services that are specifically focused on agriculture using integrated farming technology, specialised PDAs, and mobile apps that function on practically all consumer smartphones. This method enables farmers to pay close enough attention to frost, hail, and other bad weather conditions to take protective measures to protect their crops or atleast alleviate damages. (Estévez et al., 2011)

3.4.6 Advanced Crop Management devices

The Internet of Things (IoT) is a commonly utilised technology in agriculture that includes a special crops management features. They should be placed in the agriculture field, together with weather stations, to collect information related to the crops being grown. Information on farm precipitation, temperature fluctuations, and crop quality & leaf water capacity, can all be easily gathered to help farmers make more informed decisions.

3.4.7 Satellite Imaging

Images can be clipped in real time because remote satellite photography is more sophisticated. This image has a resolution of more than five metres, making it more than merely a bird's-eye perspective. Using crop pictures, farmers can examine crops as if they weren't there. Even weekly image reviews might help you save money and effort. The information is also integrated with sensors for soil, water, and crops, enabling farmers to receive alerts with the appropriate satellite imagery anytime a crucial threshold is crossed. Online web applications and geographic information systems (GIS) software can help farmers forecast crops and manage their production by using multi-spectral imagery

captured by satellites, fixed-wing aircraft, or unmanned aerial vehicles (UAVs) and processed to Normalized Difference vegetation index (NDVI) (Hank et al., 2019).

3.4.8 Pervasive Automation

Extensive automation, which lessens farmer workload, is a term that is frequently used in the world of agricultural technology. Robotics such as the real time kinematic (RTK) navigation system, which as much as possible optimises the fertilisation and seeding routes, or autonomous vehicles controlled remotely via ultraprecision and terminals. Most farm equipment has already adopted these technologies, resulting in the agricultural reality of connected and plug-and-play tractors, combines, and other farm equipment. (Ferrández-Pastor et al., 2017)

3.4.9 Minichromosomal Technology

Mini chromosomes are tiny, genetically inert entities that exist inside of cells and can store data. Plants can have dozens or hundreds of additional traits added by agricultural geneticists utilising a micro chromosome. The most intriguing aspect of the minichromosomal approach is that the plant's original chromosome remains unchanged, despite the fact that some of these traits, like the utilisation of nitrogen and drought tolerance, can be highly challenging. Consumers should expect quicker regulatory approvals and a greater range of acceptability as a result. (Yu et al., 2016).

3.4.10 Radio Frequency Identification (RFID) Technology

Animal identification in livestock was frequently accomplished using radio frequency identification, or RFID. Producing plant-based foods is another aspect of agriculture; using RFID can help with the production of things like wheat, maize, and grain. The groundwork for traceability was created by the soil and water sensors. Infrastructure construction in the sector is only getting started. This sensor offers data that may be relevant to agricultural output. Though it may sound like science fiction, we live in a world where the bag of potatoes has a barcode that can be scanned with a smartphone and we have access to information on the land that generated it. The farm is unlikely to be able to market on its own, and devoted customers keep an eye on the food goods available for purchase. (Williams et al., 2019)

3.4.11 Vertical Farming

In the 1950s and beyond, vertical farming was already a science fantasy concept. In the next ten years, it will no longer just be a scientific possibility but also a commercially viable one. Vertical farming technology is a component of urban agriculture and a method of food production that has a number of advantages. The capacity to grow in an urban setting is therefore the most obvious, leading to the quicker and cheaper availability of fresher food. However, vertical farming is not only applicable to urban settings, as was previously thought. It may be utilised by farmers in every region to more effectively utilise the land that is available and to produce crops that are often impossible in that region. Over the ensuing decades, agricultural technology would become increasingly computerised. (Kalantari et al., 2020)

Figure 6: Vertical farming demonstration (source: Kalantari et al., 2020)

3.4.12 Agricultural Food Supply Chain

Transfer from the level of agricultural production to the final consumer. The majority of the time, it is characterised by the deployment of numerous small media. These supply chains in the agriculture and food industry also cover consumer and postproduction operations. Agricultural supply networks are an example of inefficiency along the supply chain, which impacts all participants from farmers to consumers. Furthermore, running supply chain costs which represent "two-thirds" of the final product cost and 7% of worldwide commercial value are predicted to be covered by document expenses alone.

The problems with supply chains are as follows: limited information on product traceability; high rates of manual labor and paperwork; missing or inconsistent data that results in a lack of transparency and a lack of interoperability. Measures to cut costs and avoid delays are addressed by the World Trade Organization (WTO) trade promotion agreement. (Upadhyay et al., 2019)

3.4.13 Block-chain Technology

Block-chain is a system for storing information that makes it challenging or impossible to alter, cheat, or hack a system. A blockchain is essentially an electronic collection of transactions that are replicated and distributed among the whole network of computers involved in the blockchain.

It can be challenging to transport food between continents and may be necessary to use a supply chain. With so many people involved in this supply chain and so many connections, human error is more likely to occur. Block-chain technology has the potential to improve the efficiency, security, and transparency of the food supply chain in agriculture. The promise of complete supply chain visibility allows you to track your products from source (or origin) to final destination. A block-chain solution can increase pricing and lower transaction costs by eliminating middlemen, which will address accumulating issues. (Sripathi et al., 2019)

Figure 7 demonstrates the main advantages of implementing blockchain-based solutions in the supply chain.

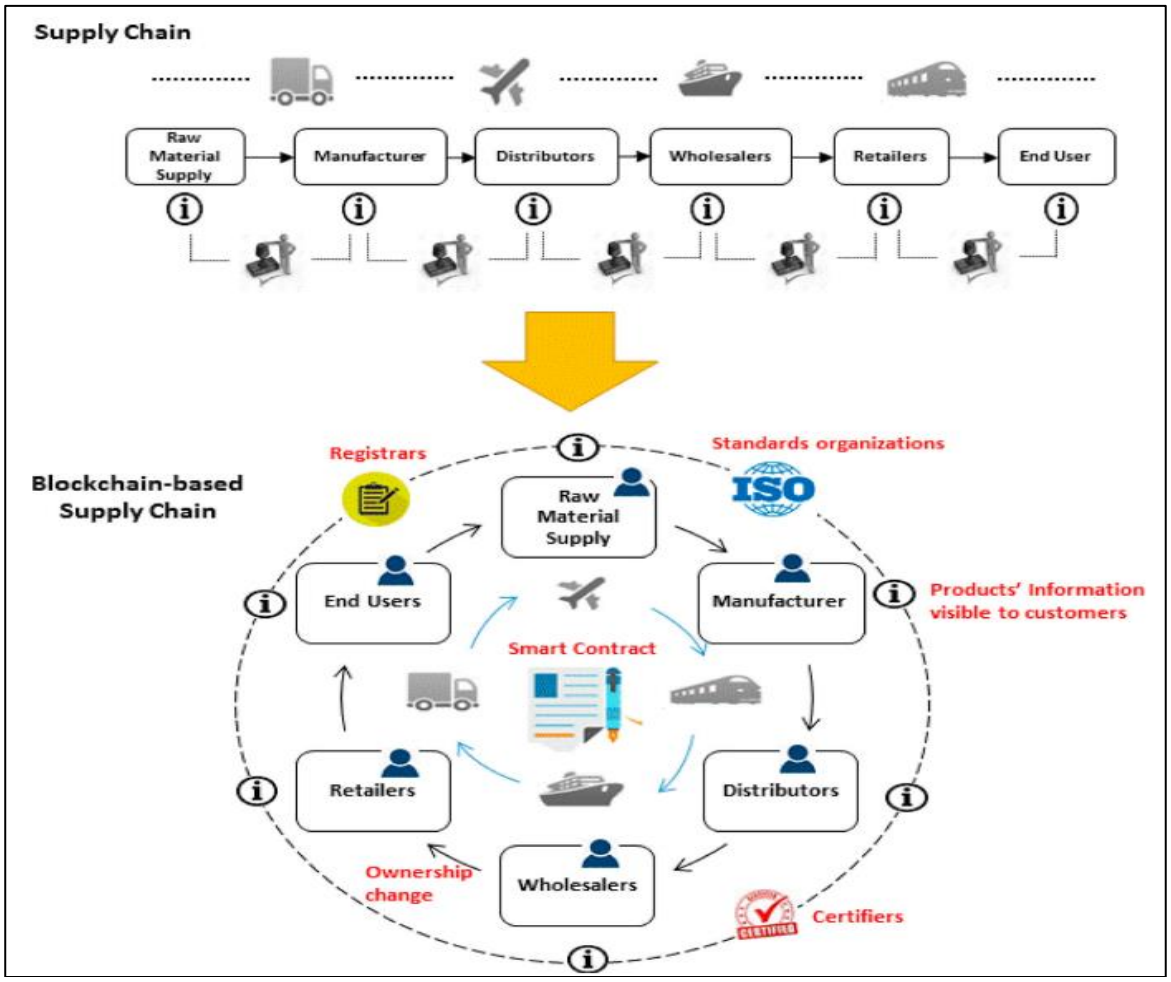

Figure 7: Blockchain based supply chain (source: Sripathi et al., 2019)

The blockchain technology has the potential to produce significant efficiency gains for each actor in the supply chain by storing invariant records that are transparent and digitally accessible to all users. By tracing origins and assuring product validity, the blockchain offers a platform for traceability throughout the agricultural supply chain. The ability to track the goods and keep a record of its movements makes it possible to take legal action against anyone who misrepresents the product's validity, which makes it simpler to enforce regulations. Blockchain makes guarantee that the process and the product are always connected. The comparison of today and tomorrow supply chain management are shown in Figures 8 and 9 proportionally. (Sripathi et al., 2019)

Figure 8: Today supply chain management (Sripathi et al., 2019)

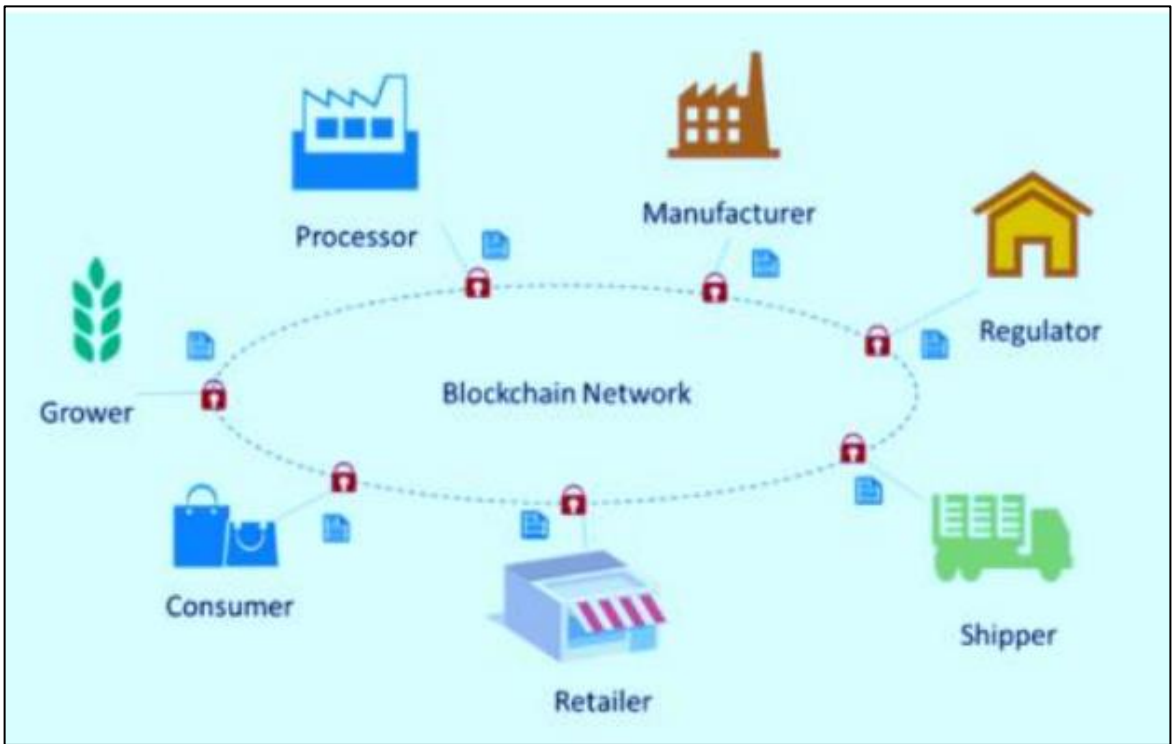

Figure 9: Tomorrow supply chain management (Sripathi et al., 2019)

3.5 Open issues and Challenges

Despite the massive scale and variety of agriculture in Pakistan, farmers confront stagnant yields and low profitability. Some of the most important agricultural bottleneck regions in Pakistan can be greatly resolved thanks to the influence of ICTs.
The following thematic categories list some of the major issues Pakistan is now facing.

3.5.1 Ecosystem issues

Lack of a cohesive, Enabling ecosystem: The absence of an environment that supports all players and produces overall gains is one of the sector's main problems. The current state of the agriculture sector calls for a shift in perspective in both policy formation and implementation. The advantages of capacity building and the potential of public-private partnerships are not completely utilised by the governmental approach. In order to support the public sector in the execution and scalability of various initiatives, the private companies have not been able to fully contribute their core expertise and agility. The technological partners have not been successful in advancing more intelligent methods of connecting with the farmers.

Development of ecosystems occurs with the involvement of several stakeholders. The groundwork has been laid for Pakistan to establish warehouse and collateral management businesses in the next years. These possibilities will contribute to improved market access, pricing transparency, and product standardisation.

One of the main factors preventing the sector's growth is policymaking (the disparity in supply and demand side as indicated by distorted growth between different provinces). The majority of the time, the Policy does not consider the importance of public-private partnerships or the role of the private sector. Additionally, the policy places little attention on crop diversification and mostly concentrates on a single crop type, which leads to skewed sector growth (for example, the local wheat procurement price is higher than the global price due to the policy's focus).

Lack of ICT involvement and digitalization: There aren't enough self-sustaining, scalable initiatives being made to digitise many aspects of agriculture. The importance of innovation financing and incubation services provided by private organisations and

multilateral organisations needs to be emphasised further. The best way to address the problems associated with low productivity and inefficiency is to invest in R&D and put forth creative ideas. As a result of the increasing involvement of educated rural youth in agriculture today, this is a simple task**.**

3.5.2 Operational issues

Lack of effiecient farm practices: High value agriculture and effective farming methods are underemphasized. The emphasis on increasing the farmer's profitability/yield and altering how the farmer is seen by different stakeholders (such as the government) is weak. Focus on R&D to increase productivity and yield is lacking. Farmers face a serious challenge with water management, which is now supply-driven, because access to water is the first issue, followed by inefficient water usage (on average, 35% of water is wasted). Flood irrigation is still used, which not only produces waste but is inappropriate for most types of crops.

Inefficiency and distortion in post-harvest treatment and distribution: Farmers use the prices this year to estimate their productivity for the following year, which leads to a glut. Farmers ultimately transport their extra produce to the wholesale market because fixed merchants are already present in the market. The lack of cold chain facilities makes it difficult to secure the produce for export.

Failure to ensure scalability of projects: When pilot programmes under public-private partnerships do not succeed, scalability becomes a problem. PPPs play a significant role in this scenario, where the government establishes the framework through legislation and regulations, the private sector takes the lead through technological innovation, and donor organisations can provide co-financing and technical expertise.

Lack of connected databases and linked systems: There is a need for a non-profit collecting centre where farmers may bring their goods, find markets, acquire knowledge, and eventually link to over 1000 businesses to the remote farms. In Pakistan, this is something that might someday be put into practise. A lack of interconnected systems prevents the use of farmer profiles (through BISP/NRSP access) for identification, input on

the soil fertility levels of owned land, and delivery of climate data. This has not happened since different databases (such as NADRA, GSM/telecom firms, banks, etc.) lack connected systems that would offer a comprehensive picture and tailored solutions for the farmers. There is currently a knowledge gap since farmers cannot yet be recognised via digital means, which results in missing out on lucrative market opportunities.

3.5.3 Access issues:

Inadequate access to inputs and marketplaces: The lack of adequate grading, testing, and packing causes Pakistan to lose money when selling to export markets even while the produce is of international market quality. It's also important to take into consideration other difficulties including storage, shipping, maintaining standardised outputs, and selling those outputs to related markets. As transparent and effective marketplaces would provide fair playing fields for all players, the issue of power distortion caused by middlemen (referred to as the "aarthi") also needs to be addressed.

Insufficient access to credit and financing: When it comes to receiving financial aid, a farmer exhibits specific behaviours that indicate he is more focused on responsibility when cash is involved and may not be as concerned when credit is involved. Government must ensure quality and ongoing support as a partner because subsidies may not be sufficient on their own.

Lack of awareness and digital literacy: Farmers lack access to technology and content that is tailored to their region, making it difficult to interact with them face-to-face while also getting their input via virtual channels. Experts must inform the public about technologies like mobile wallets since technology and its use are crucial. When it comes to focusing on the role of marginalised segments, such women farmers, there is a tremendous disparity. Additionally, testing procedures and extension services, where the private sector can play a part, need to be improved. Finding the farmers' touchpoints and giving them guidance are important considerations.

3.6 An overview of digital agricultural system of Pakistan

Even though Pakistan has a mostly agrarian economy, which accounts for about half of the labour population and a quarter of the GDP, it lags behind the rest of the globe

in terms of per-acre yield. Between Pakistan and its neighbors, especially India, there is a yield disparity of about 40%; however, when compared to the industrialized world, this gap is 100% larger. (Ali et al., 2016)

In Pakistan's productive Punjab province, a digital effort has been established to empower farmers with digital agriculture solutions and to build smart communities. In Pakistan, this project is a first-of-its-kind community network for digital agriculture. At Chak 26-SP in the Pakpattan district of Punjab, a "Digital Dera" (technology-enabled community) has been established, providing more than 1,500 farmers from all across the rural belt with the opportunity to learn about the most recent agricultural technology and services in order to assist them discover answers to farming difficulties. (ISAAA 2021)

As a lab for agriculture and food security innovation, Digital Dera seeks to serve as a resource for AgriTech businesses and investors from across the nation to visit and test their innovations and products in a real-world agricultural setting. It has high-speed Internet and will support small farmers' capacity-building efforts most recently with local language awareness training. Through the strength of Internet connectivity and access to the digital knowledge economy, it seeks to empower local farmers. (ISAAA 2021)

The 18th Amendment to the Pakistani Constitution was a significant development since it gave provinces more authority over particular topics and issues rather than the central government. The National Assembly of Pakistan passed an amendment in 2010 requiring the establishment of local government systems in each province. The provinces could also create and carry out their own sector-specific strategies and programs. The political, administrative, and financial authority was thereafter transferred to the elected officials of the provinces. (Digital Pakistan 2018)

As a result of the 18th Constitutional Amendment, which was passed in June 2011, the provinces now have a number of new duties in relation to agriculture. In terms of legislating, regulating, and formulating policies, the provinces were granted autonomy and given the option of adopting new laws and regulations or adhering to those already in place at the federal level. Additionally, provinces now have the power to negotiate with donors directly and get loans from international lending institutions like the World Bank (WB)

and the Asian Development Bank (ADB). To enable the provinces to discuss, settle on, and coordinate a variety of topics, including enacting rules and regulations pertaining to, for example, marketing and trade, a Council of Common Interests (CCI) was also established. (Digital Pakistan 2018)

The state of agriculture in Pakistan continues to be dire despite enormous government attention, several programmes, and various initiatives aimed at strengthening the industry. The Hunger Index, which gauges food insecurity and malnutrition, is a crucial sign of this problem. Pakistan typically performs low on this index, which is a reflection of the country's population's ongoing issues with poor nutrition and limited access to food. High levels of food insecurity are a direct result of difficulties in the agricultural sector, such as the inability of small-scale farmers to obtain resources, ineffective distribution networks, and the effects of climate change, such as unpredictable rainfall patterns and protracted droughts. Millions of Pakistanis struggle to acquire enough and wholesome food as a result of these issues, which collectively reduce agricultural production and worsen food insecurity.

Further highlighting the severity of the agricultural crisis is Pakistan's Food Security Index. Despite its best efforts, the government is unable to keep up with the demand for affordable, healthy food among its population. Significant post-harvest losses in agricultural products are caused by inadequate infrastructure, which includes a lack of suitable storage facilities and transportation networks. These losses increase food poverty by raising prices and limiting market availability in addition to reducing farmers' revenues. Furthermore, Pakistan's alarmingly high percentage of undernourished children shows that a sizeable portion of the population, particularly youngsters, lacks the nutrients needed for normal growth and development. This is shown in table 1 given below:

3.7 Problem Statement

There is an urgent need for an effective and comprehensive information system that can enable prompt access to critical data, knowledge, and resources for farmers and stakeholders in the context of Pakistan's key agricultural sector. The country's current agriculture information systems, nevertheless, have flaws and restrictions that limit their

usefulness. These constraints include problems with data availability, usability, coverage, and integration, which taken together prevent the industry's expansion and resilience.

This study intends to address the crucial issue of locating the gaps and weaknesses in Pakistan's current agriculture information systems and then makes a suggestion for the creation of a web-based solution. In order to close these gaps and develop a strong, user-friendly platform that can provide farmers, researchers, policymakers, and other stakeholders with timely and accurate information, this solution aims to close the identified gaps. This will ultimately promote sustainable agricultural practises and promote socioeconomic development in the agricultural sector.

3.8 Methods of data collection

The practice of gathering information from multiple sources in order to build a dataset that can be analyzed and utilized to make decisions or draw conclusions is known as data collection. There are various ways to gather data, and the method used will depend on the kind of data being collected, the study objective, and the resources at hand. (De Leeuw et al., 2008)

These are discussed below:

i. Surveys
ii. Interviews
iii. Observations
iv. Experiments
v. Case studies
vi. Secondary Data

We will discuss only those methods that we have used in our research to collect data.

3.7.1 Surveys:

Asking a group of people or an organization a series of questions is a common way to collect data through surveys. Surveys can be carried out in person, on the phone, by email, or on websites. Surveys are frequently used to collect quantitative data, including preferences, views, and demographic data. Open-ended responses to surveys are one type

of qualitative data that can be gathered. Customer satisfaction surveys, political polls, and employee engagement surveys are a few examples of surveys. (De Leeuw et al., 2008)

3.7.2 Interviews:

One-on-one conversations between a researcher and a participant make up interviews, a way of gathering data. Interviews can be conducted in person, over the phone, or by video conferencing, and they can be structured, semi-structured, or unstructured. Interviews are frequently used to collect qualitative data, including firsthand accounts of experiences, convictions, and opinions. Job interviews, focus group interviews, and ethnographic interviews are a few examples of interviews. (De Leeuw et al., 2008)

3.7.3 E-mail surveying:

Email surveys are a type of data collection technique that involves sending surveys or questionnaires to a target audience. They are an easy and straightforward approach to get consumer feedback. These surveys were e-mailed to different farmers and agriculturists based in Pakistan. The main aim of these questions were to analyze the issues that current agriculture information system is facing. (De Leeuw et al., 2008)

Fifteen questions along with a wide range of answers were sent to identify the issues. A sample of survey is given in appendix section.

4. Practical Part

This chapter discusses the method and techniques that are used to collect data. A sample of survey is also attached in which fifteen questions related to agriculture information system asked and sent through social media platforms like Facebook and WhatsApp helped gather opinions from many people and other people who were related to agriculture sector.

4.1 Hypothesis

On the basis of research questions following hypothesis are drawn:

Question number one is the analysis of current system and is done on the basis of existing literature and reports. However question number two and three are more important and for these null and alternative hypothesis are given below.

Question number two hypothesis are:

H0 (Null Hypothesis): There are no significant gaps in existing agriculture information system that reduces its efficiency.

H1 (Alternative Hypothesis): There are significant gaps in existing agriculture information system that reduces its efficiency.

Question number three hypothesis are:

H0 (Null Hypothesis): The new web-based solution is not effective and user-friendly than the previous systems.

H1 (Alternative Hypothesis): The new web-based solution is effective and user-friendly than the previous systems.

4.2 Limitations in Data Collection

This research has faced following challenges in the collection of data:

1. Data was collected either through e-mails or other modes rather than in-person encounters and no field visits were possible in Pakistan since the author was in Czech Republic.
2. Language barrier was another major hurdle in collection of data. Mostly farmers speak and understand local language.
3. Financial restrictions have also barred author’s ability in collecting data.

4. Due to the time constraints it was impossible to meet every representative or policy maker in the department of agriculture and only marketing wing was made possible.

4.3 Sampling Method

As illustrated earlier, the study is conducted through the surveys and through some mathematical approach by collecting the concerned data. This chapter illustrates the proper calculations of the data compiled on the basis of results obtained through surveys and is shown in the form of pie charts. The 328 responses were collected. The sample population includes both males and females. The demographics and other factors are shown below.
The response of each question in the form of percentage is shown below in the form of pie charts.

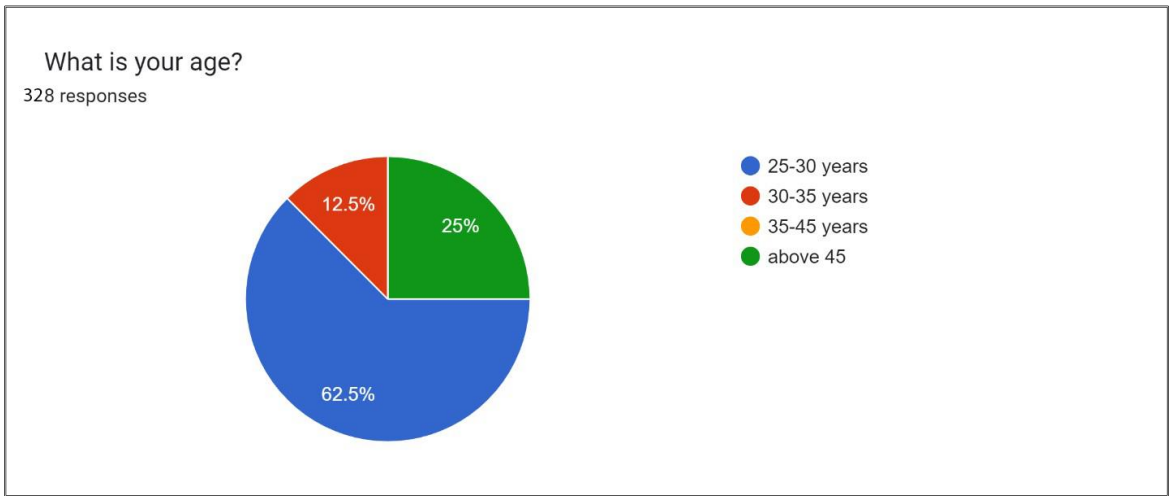

Figure 10: Graphical representation of respondents age in percentage (Source author)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
1.Age	328	25	90	38.33	18.390
Valid N (listwise)	328				

Table 1: Respondents age (Source: Author)

The table above shows descriptive statistics of age of farmers in Pakistan which is the first question Question number 1 comes under the demographic section. It was asked that what is the age of the person who is filling the survey form. Then they were given a range of options from which they mark their specific answer. The options include 25-35 years, 30-35 years, 35-45 years and above 45 years. The results show that 25% of the respondents

fall in the option of above 45 years, 12.5% fall in the range of 30-35 years and 62.5% fall in the age bracket of 25-30 years. This is due to the fact that Pakistan has a large proportion of young people and it is the second country globally with higher number of young people.

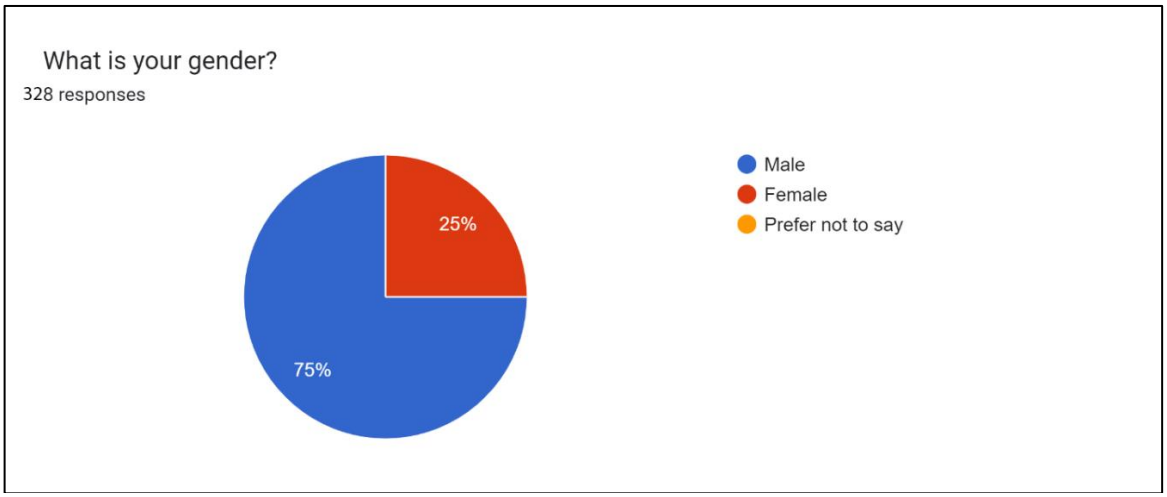

Figure 11:Describe proportion of respondent's gender in percentage (Source: Author)

Question number 2 also comes under the demographic section. It was asked that what is the gender of the person who is filling the survey form. Then they were given a range of options from which they mark their specific answer. The options included either male, female or prefer not to say. However, the results show that 75% of the respondents marked as male and 25 % marked themselves as female.

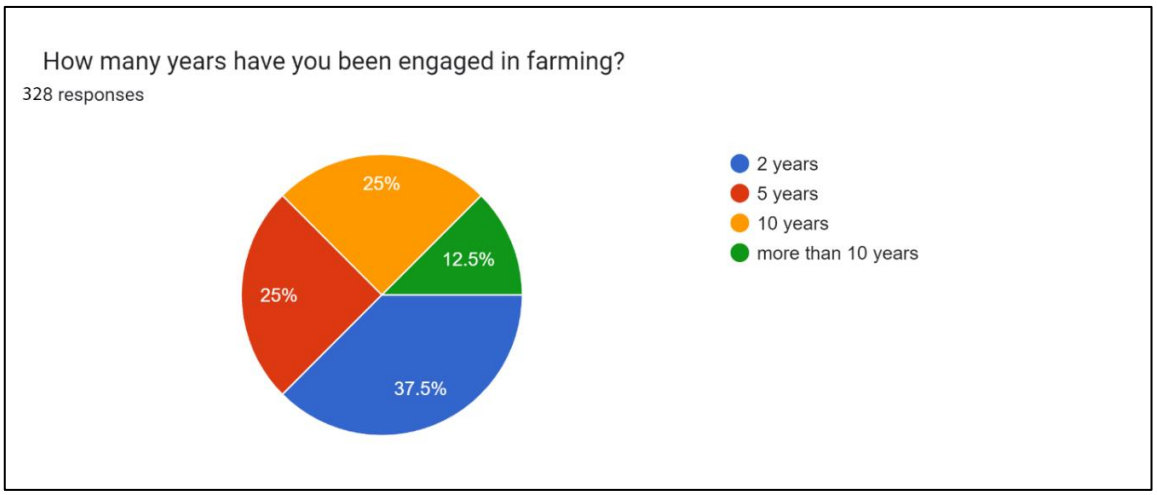

Figure 12: Graphical representation of respondents farming experience (Source: Author)

Question number 3 also comes under the demographic section. It was asked that for how many years that person has been engaged in farming. Then they were given a range of options from which they mark their specific answer. The options included 2 years, 5 years, 10 years and more than 10 years. 25% of the respondents marked 2 years, another 25 % of the respondents marked 5 years 12.5 % marked more than 10 years and 37.5 % marked that they are associated with farming for around 2 years. This means that a third of the respondents were new to farming but in Pakistan every new generation is attached with farming from a very young age.

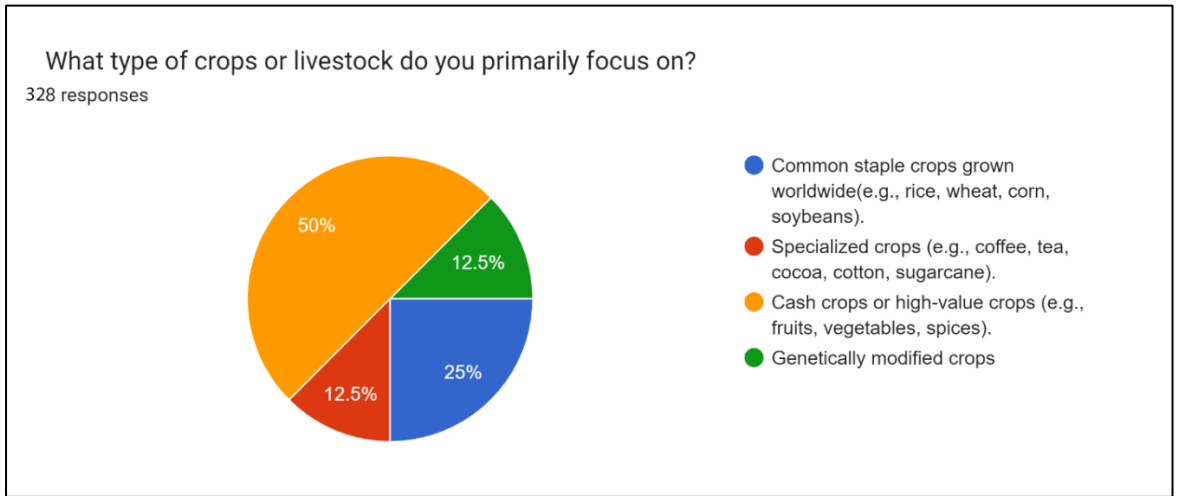

Figure 13: Describe proportion of various crops cultivated by farmers (Source: Author)

Question number 4 is related to the types of crops that respondents deal with. It was asked that what type of crops or livestock does the person who is filling the survey form primarily focuses on. Then they were given a range of options from which they mark their specific answer. The options include Common staple crops grown worldwide (e.g., rice, wheat, corn, soybeans), Specialized crops (e.g., coffee, tea, cocoa, cotton, sugarcane), Cash crops or high-value crops (e.g., fruits, vegetables, spices) and genetically modified crops. Half of the respondents marked their focus on cash crops, followed by 25 % for common staple crops and 12.5 % for both specialized crops and genetically modified crops.

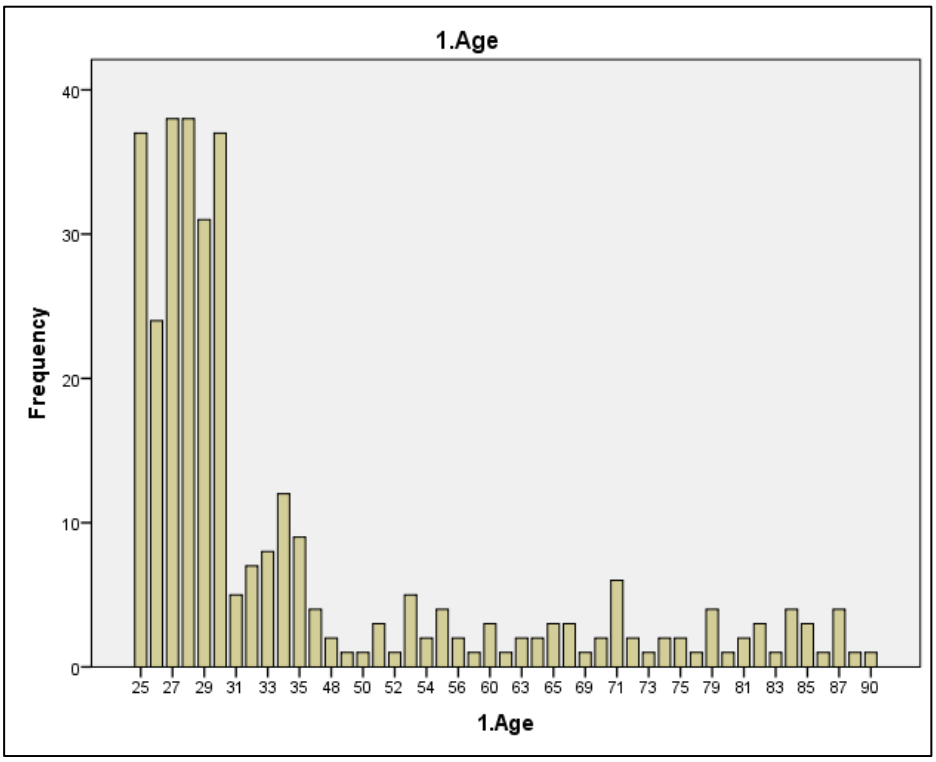

Figure 14: Frequency bar Graph for Age (Source: Author)

The bar graph in Figure 14 above shows that most of the people who farm are between the age ranges of 25 years to 30 years old.

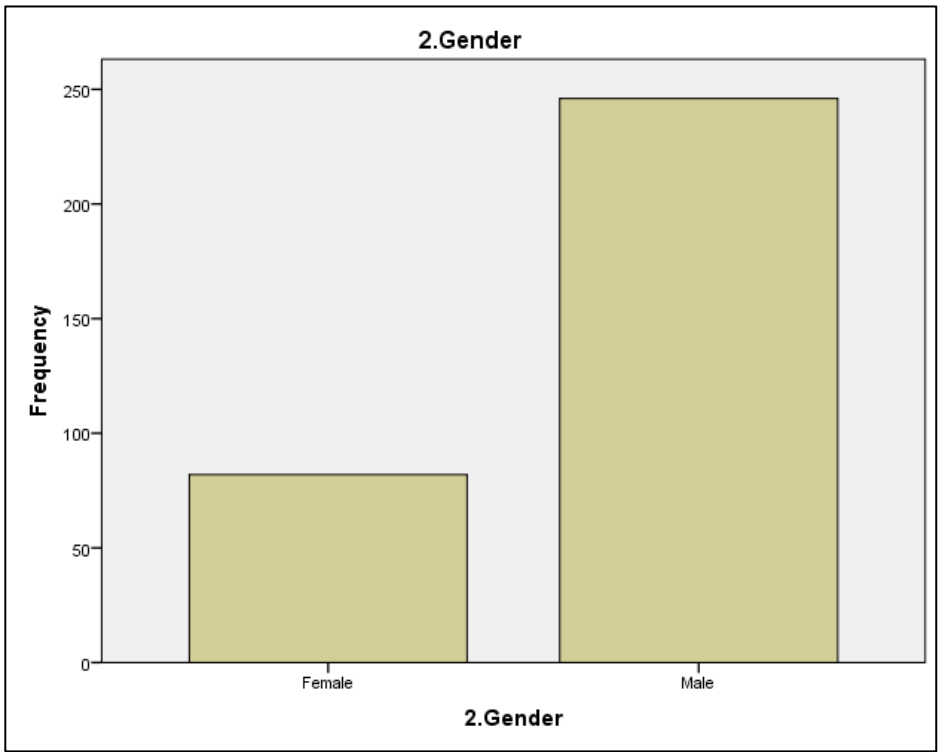

Figure 15: Frequency bar graph for gender (Source: Author).

The graph in Figure 15 above indicates that most people who farm are of Male gender which accounts for 75% of the total sample size. 25% of the people who farm are females, which is the least.

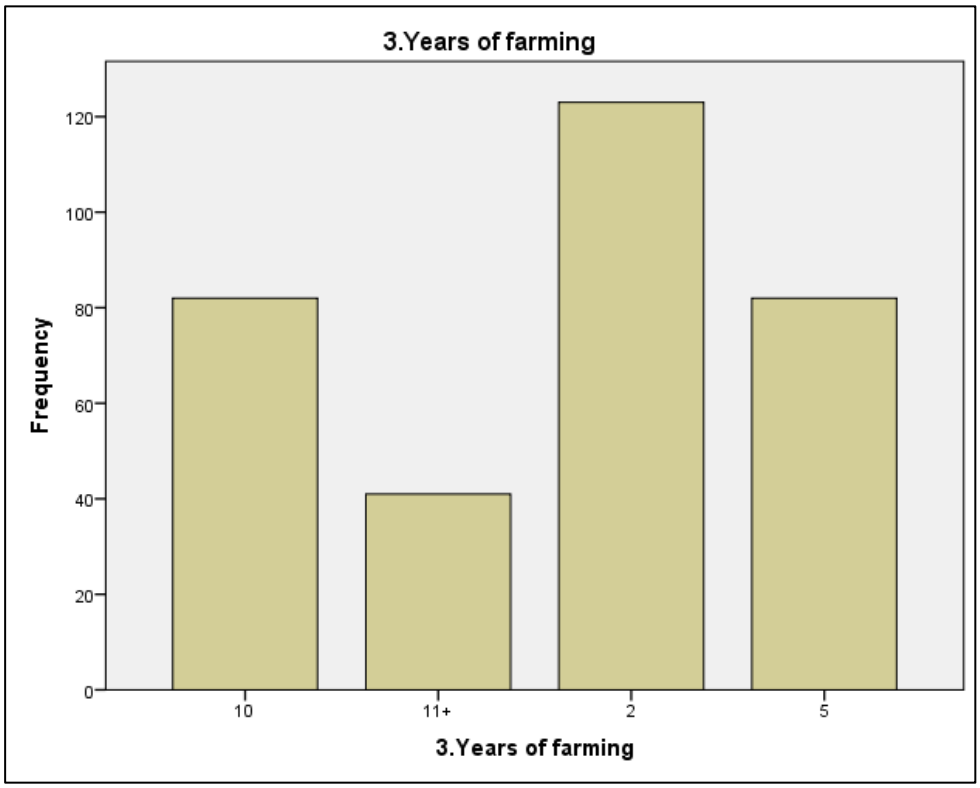

Figure 16: Frequency bar graph showing the number of years of farming (Source: Author)

The graph in Figure 16 shows that many farmers have been farming for 2 years, making up 37.5% of all farmers. The next largest group has been farming for 5 years, accounting for 25% of farmers, followed by those farming for 10 years, also at 25%. The smallest group of farmers, 12.5%, has been farming for more than 10 years.

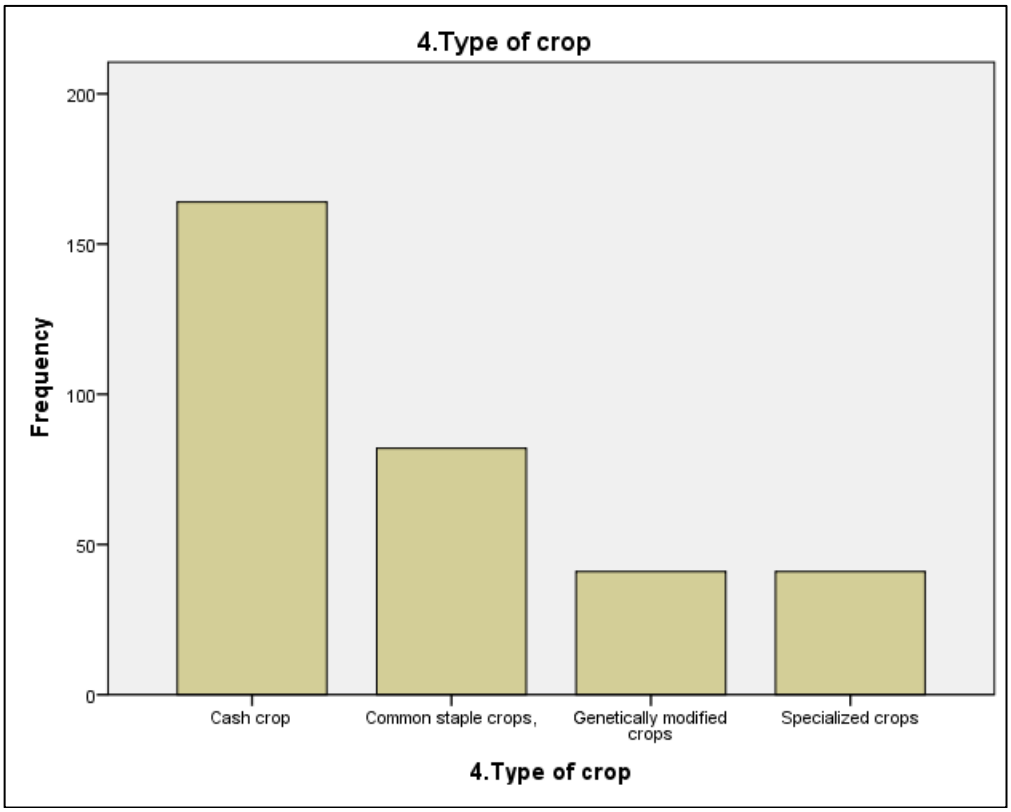

Figure 17: Frequency bar graph showing the type of crop or livestock that is of focus (Source: Author).

Figure 17 shows that half of the crops farmers focus on are cash crops, followed by a quarter focusing on common staple crops. Another 12.5% of farmers focus on genetically modified crops, and the remaining 12.5% focus on specialized crops.

2.Gender * 3.Years of farming * 4.Type of crop Crosstabulation

Count

4.Type of crop			3.Years of farming				Total
			10	11+	2	5	
Cash crop	2.Gender	Female	11	0	10	16	37
		Male	24	3	44	56	127
	Total		35	3	54	72	164
Common staple crops,	2.Gender	Female	6	7	4	2	19
		Male	37	11	10	5	63
	Total		43	18	14	7	82
Genetically modified crops	2.Gender	Female		1	11	1	13
		Male		6	20	2	28
	Total			7	31	3	41
Specialized crops	2.Gender	Female	2	4	7		13
		Male	2	9	17		28
	Total		4	13	24		41
Total	2.Gender	Female	19	12	32	19	82
		Male	63	29	91	63	246
	Total		82	41	123	82	328

Table 2: Cross tabulation for Gender, Years of farming and Type of crops on focus. (Source: Author)

Cash Crops: In Table two, it's shown that 164 farmers primarily focus on cash crops, making up 50% of all farmers. Among them, 37 are female and 127 are male. Specifically, 35 farmers who have been farming for 10 years focus on cash crops, including 11 females and 24 males. Additionally, 3 farmers farming for more than 10 years focus on cash crops, all of whom are male. Moreover, 54 farmers farming for 2 years focus on cash crops, with 10 females and 44 males. Furthermore, 72 farmers farming for 5 years focus on cash crops, including 16 females and 56 males.

Common Staple Crops: 82 farmers (25% of all farmers) primarily focus on common staple crops. Among them, 19 are female and 63 are male. Specifically: 43 farmers who have been farming for 10 years focus on common staple crops, including 6 females and 37 males.18 farmers farming for more than 10 years focus on common staple crops, including 7 females and 11 males. 14 farmers farming for 2 years focus on common staple crops,

including 4 females and 10 males.7 farmers farming for 5 years focus on common staple crops, including 2 females and 5 males.

Genetically Modified Crops: 41 farmers (12.5% of all farmers) primarily focus on genetically modified crops. Among them, 13 are female and 28 are male. Specifically: Farmers farming for more than 10 years focus on genetically modified crops, including 1 female and 6 males. 31 farmers farming for 2 years focus on genetically modified crops, including 11 females and 20 males.3 farmers farming for 5 years focus on genetically modified crops, including 1 female and 2 males.

Specialized Crops: 41 farmers (12.5% of all farmers) primarily focus on specialized crops. Among them, 13 are female and 28 are male. Specifically: 4 farmers who have been farming for 10 years focus on specialized crops, including 2 females and 2 males.13 farmers farming for more than 10 years focus on specialized crops, including 4 females and 9 males.24 farmers farming for 2 years focus on specialized crops, including 7 females and 17 males.

Overall, this summary provides insights into the distribution of farmers based on their focus on different types of crops, their gender, and the duration of their farming experience.

Descriptive Statistics on Awareness of the Information Systems:

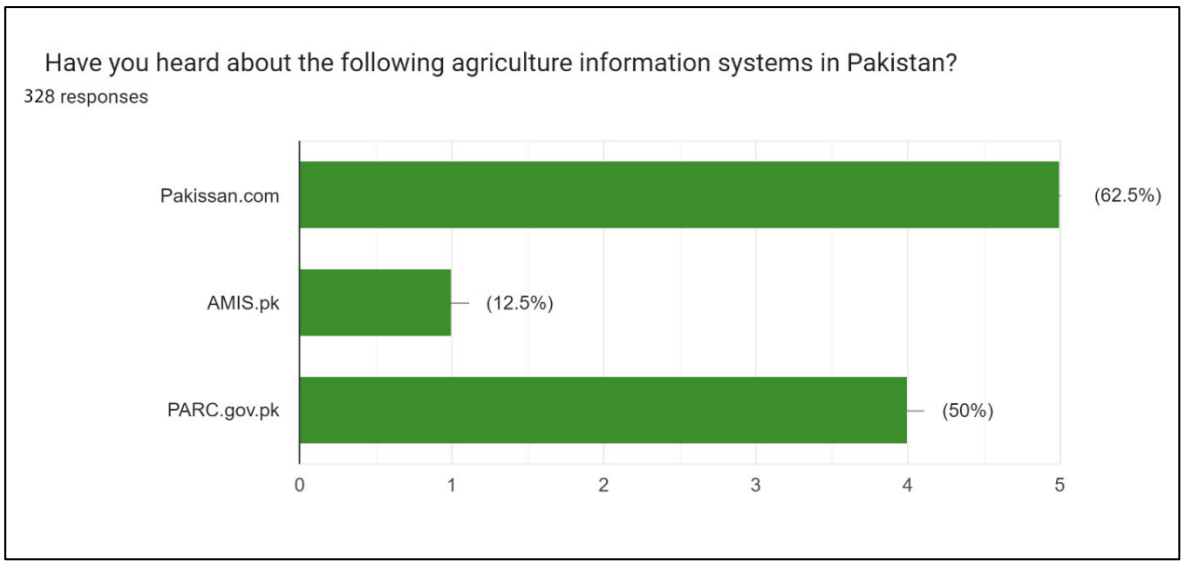

Figure 18: Graphical representation of Information system's awareness among respondents (Source: Author).

Question number 5 is related to familiarity with agricultural websites. It was asked that if they have heard about the websites that are mentioned in the survey form. Then they were given a range of options from which they mark their specific answer. The options include the name of websites i.e Pakissan.com, AMIS.pk and PARC.gov. Out of these three options half of the respondents marked PARC.gov as the most heard website. 62.5% of the respondents marked Pakissan.com and 12.5% marked AMIS. PARC is the most famous website in Pakistan after Pakissan and everyone who is associated with agriculture knows about one or two out of these three websites. Moreover, respondents were allowed to select multiple answers in this question that's why the overall percentage has gone above hundred.

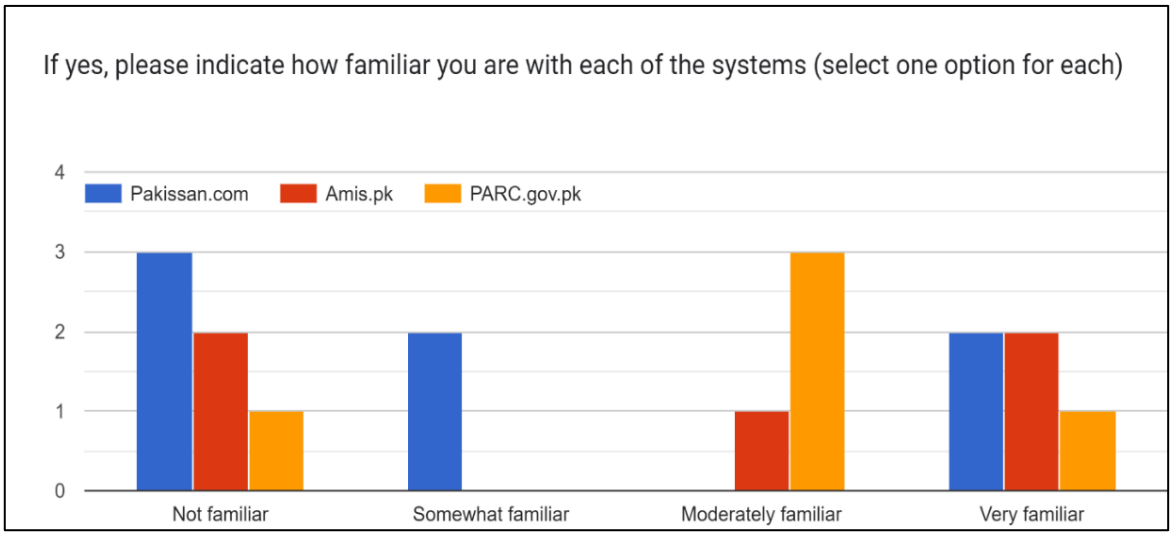

Figure 19: Level of familiarity with the existing information systems (Source: Author)

Question number 6 is related to the degree of familiarity with agricultural websites. It was asked that if they have heard about the websites that are mentioned in the survey then what is the degree of their familiarity with each website. Then they were given a range of options from which they mark their specific answer. The options include not familiar, somewhat familiar, moderately familiar and very familiar. Pakissan.com came up with least number of followers while others have moderate number of audience and followers. The blue bar in the figure represents Pakissan.com.

Report

1.Age

5.Information system	Mean	N	Std. Deviation	Minimum	Maximum
AMIS.pk	38.87	40	18.444	25	89
Pakissan.com	38.36	205	18.281	25	90
PARC.gov	37.99	83	18.849	25	87
Total	38.33	328	18.390	25	90

Table 3: Relationship between age and Information management system for Agriculture in Pakistan (Source: Author)

The sample had more farmers who heard about Pakissan.com (n = 205) than PARC.gov (n = 83) and AMIS.pk (n = 40). The mean ages of farmers who are aware of Agricultural Information Systems are consistent across all three systems, suggesting similar age distributions among users. The standard deviation values indicate the extent to which ages vary from these mean values, reflecting the dispersion of ages within each

system. Notably, the oldest farmer, aged 90, is aware of Pakissan.com, highlighting its reach across diverse age groups within the farming community.

Descriptive Statistics on usage of Information Systems

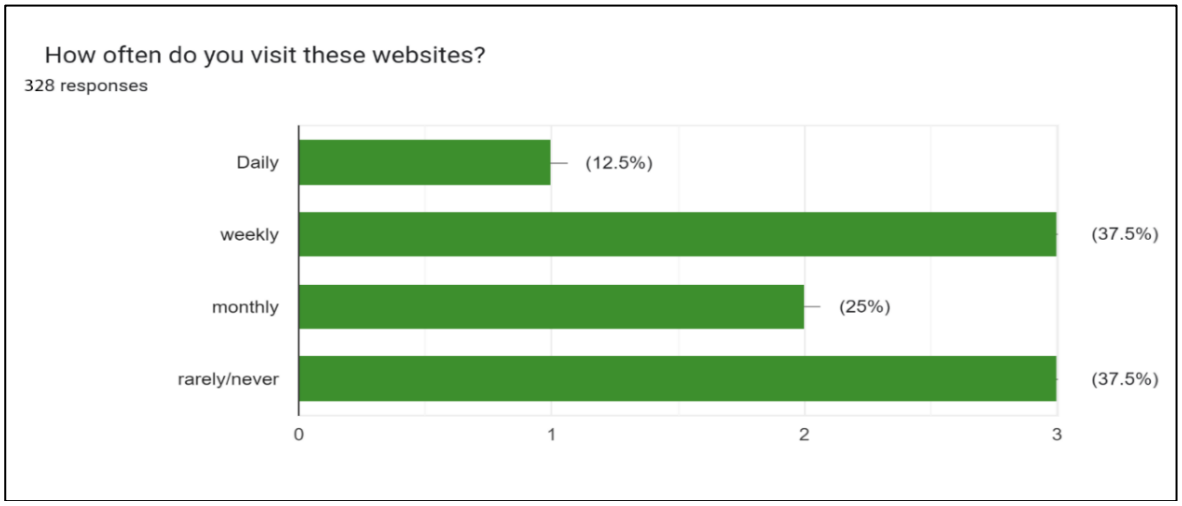

Figure 20: Graphical representation of Information systems usage by respondents (Source: Author)

Question number 7 is related to the frequency of usage of these websites. It was asked that how often you visit these websites. Then they were given a range of options from which they mark their specific answer. The options include daily, weekly, monthly and rarely. 12.5 % of the respondents marked daily, 37.5 % of the respondents marked weekly another 37.5 % marked rarely and 25 % marked monthly.

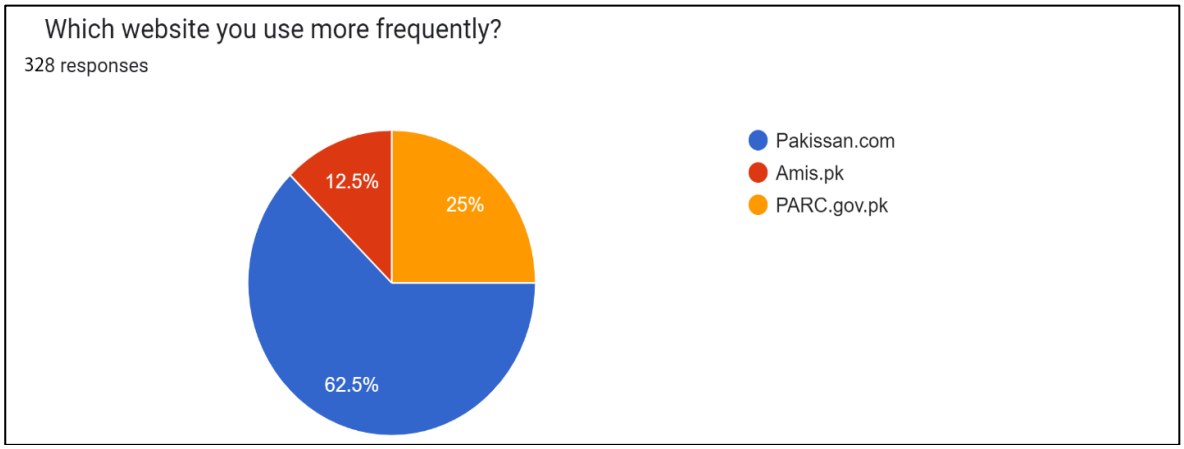

Figure 21: Graphical representation of frequent used website by respondents (Source: Author)

Question number 8 is related to the frequently used website. It was asked that which website you use more frequently. Then they were given a range of options from

which they mark their specific answer. The options include name of websites i.e Pakissan.com, Amis.pk and PARC.gov.pk. 62.5 % of respondents marked Pakissan.com, 12.5 % marked Amis.pk and 25 % marked PARC.gov.pk. from this it can be deduced that the most used website is Pakissan.com and it is also true that the users will find most errors in that website that they use more often which in this case is Pakissan.com.

1.Age * 7.How often do you visit the website

1.Age

7.How often do you visit the website	Mean	N	Std. Deviation	Minimum	Maximum
Daily	39.88	41	21.031	25	90
Monthly	40.07	82	19.929	25	87
Rarely	34.35	82	14.684	25	87
Weekly	39.29	123	18.445	25	89
Total	38.33	328	18.390	25	90

Table 4: Comparison of How often do you visit the website with Age of farmers (Source: Author).

42 farmers who went to the website every day had an average age of 39.88. 82 farmers visited the website monthly, with an average age of 40.07. 123 farmers visited the agricultural websites weekly, and their average age was 39.29. Meanwhile, 82 farmers who rarely visited the website had an average age of 34.35. The standard deviation helps to understand how much the ages of these farmers differ from the average age.

1.Age * 8.Frequently used website

1.Age

8.Frequently used website	Mean	N	Std. Deviation	Minimum	Maximum
AMIS.pk	37.71	41	17.586	25	85
Pakissan.com	38.19	205	18.604	25	89
PARC.gov.pk	38.99	82	18.446	25	90
Total	38.33	328	18.390	25	90

Table 5: Comparison of frequently used website with Age of farmers (Source: Author)

Pakissan.com is visited by farmers more often than PARK.gov.pk, while AMIS.pk is the least visited website among them. On average, farmers who visited AMIS.pk are around 37.71 years old, those who visited Pakissan.com are about 38.19 years old, and those who visited PARK.gov.pk are approximately 38.99 years old.

7.How often do you visit the website * 8.Frequently used website Crosstabulation

Count

		8.Frequently used website			
		AMIS.pk	Pakissan.com	PARC.gov.pk	Total
7.How often do you visit the website	Daily	4	24	13	41
	Monthly	15	49	18	82
	Rarely	7	56	19	82
	Weekly	15	76	32	123
Total		41	205	82	328

Table 6: Cross tabulation showing the relationship between how often the website is visited and frequently used website (Source: Author)

Website content and Usefulness:

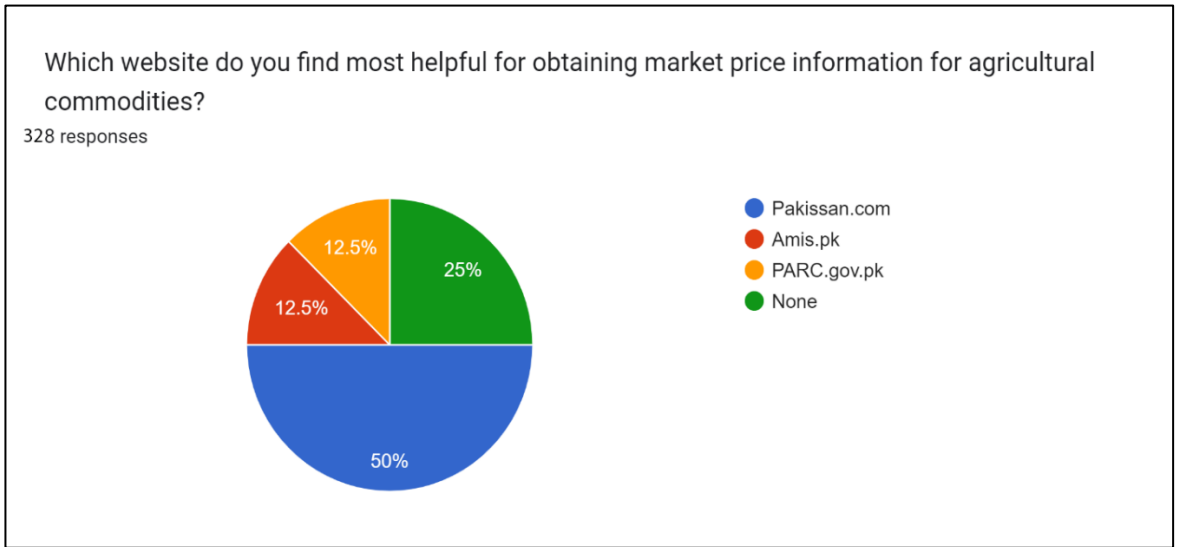

Figure 22: Perceived Importance of Agricultural Product Pricing Websites (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AMIS.pk	41	12.5	12.5	12.5
	None	82	25.0	25.0	37.5
	Pakissan.com	164	50.0	50.0	87.5
	PARC.gov.pk	41	12.5	12.5	100.0
	Total	328	100.0	100.0	

Table 7: Comparison of websites in terms of product pricing (Source: Author)

Question number 9 is related to the usefulness of the content that these websites display. It was asked that which website you find most helpful for obtaining market price information for agricultural commodities. Then they were given a range of options from

which they mark their specific answer. The options include name of websites i.e. Pakissan.com, Amis.pk and PARC.gov.pk and none of these. Half of the respondents marked Pakissan.com content as useful in their dealings, Amis.pk and PARC.gov.pk both got 12.5 % ratings while 25 % of the respondents also shared that none of these websites is useful.

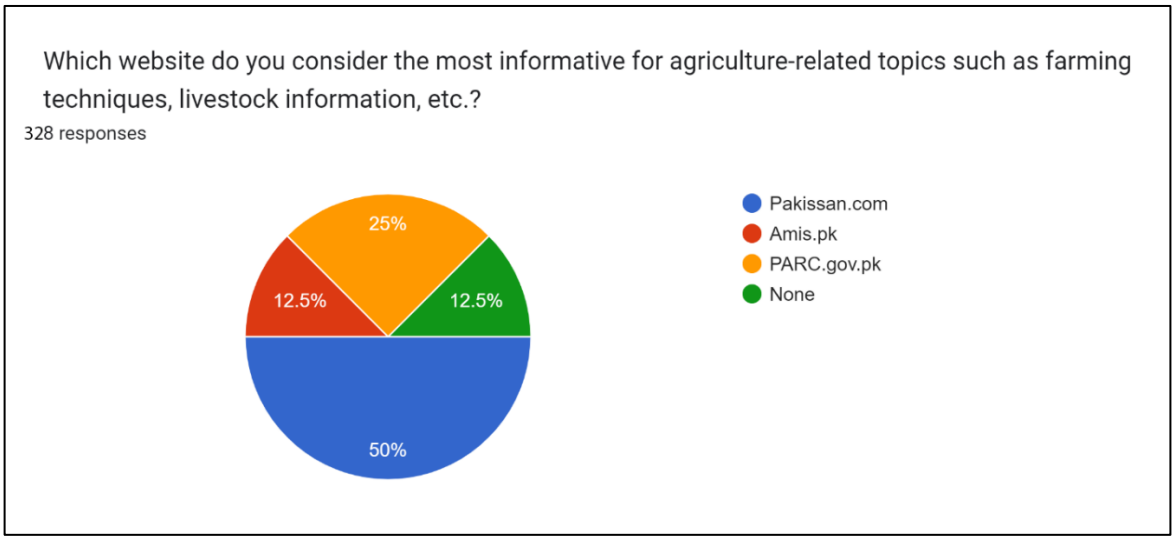

Figure 23: Comparative Analysis of Existing Agricultural Information Websites (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AMIS.pk	41	12.5	12.5	12.5
	None	41	12.5	12.5	25.0
	Pakissan.com	164	50.0	50.0	75.0
	PARC.gov.pk	82	25.0	25.0	100.0
	Total	328	100.0	100.0	

Table 8: Comparison of websites in terms of Agriculture information (Source: Author)

Question number 10 is related to the most informative website related to agriculture topics. It was asked that which website you consider the most informative for agriculture-related topics such as farming techniques, livestock information, etc. Then they were given a range of options from which they mark their specific answer. The options include name of websites i.e. Pakissan.com, Amis.pk and PARC.gov.pk and none of these. Half of the respondents marked pakissan.com content as useful and informative, while 25 % marked PARC.gov.pk and 12.5 % marled Amis.pk content as informative and 12.5 % of the respondents marked none of the websites as informative. These 12.5% were also asked another question that if there is any other website or platform that is helpful to them that

they want to share. But due to e-mail surveying this question was left unanswered. This question is shown in the sample survey form in appendix section.

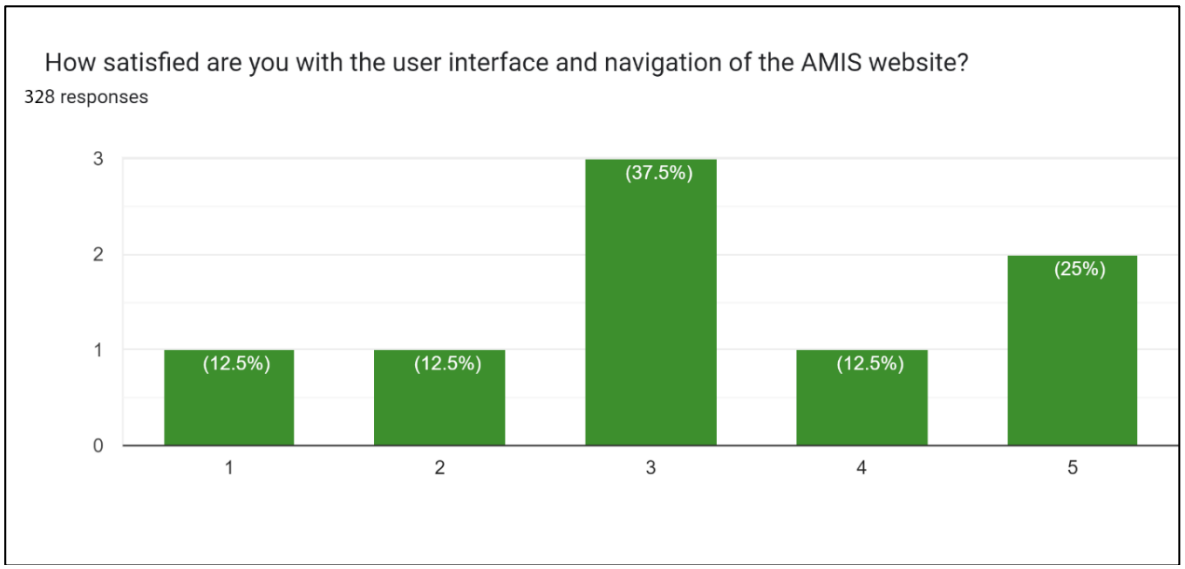

Figure 24: Respondents' Satisfaction Levels with UI & Navigation of AMIS (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dissatifisfied	41	12.5	12.5	12.5
	Neutral	123	37.5	37.5	50.0
	Satisfied	41	12.5	12.5	62.5
	Very dissatified	41	12.5	12.5	75.0
	Very Satisfied	82	25.0	25.0	100.0
	Total	328	100.0	100.0	

Table 9: Satisfaction level in terms of User interface & Navigation of AMIS (Source: Author)

Question number 11 is related to the level of satisfaction with Amis.pk website. It was asked that how satisfied are you with the user interface and navigation of the AMIS website. Then they were given a range of options from which they mark their specific answer. The options include level of satisfaction from 1 to 5, 1 being the least satisfied and 5 being the most satisfied. 12.5 % of the respondents marked level 1, 2 and 4. However, level 5 i.e. most satisfied got 25 % rating and level 3 that is moderately satisfied got 37.5 response.

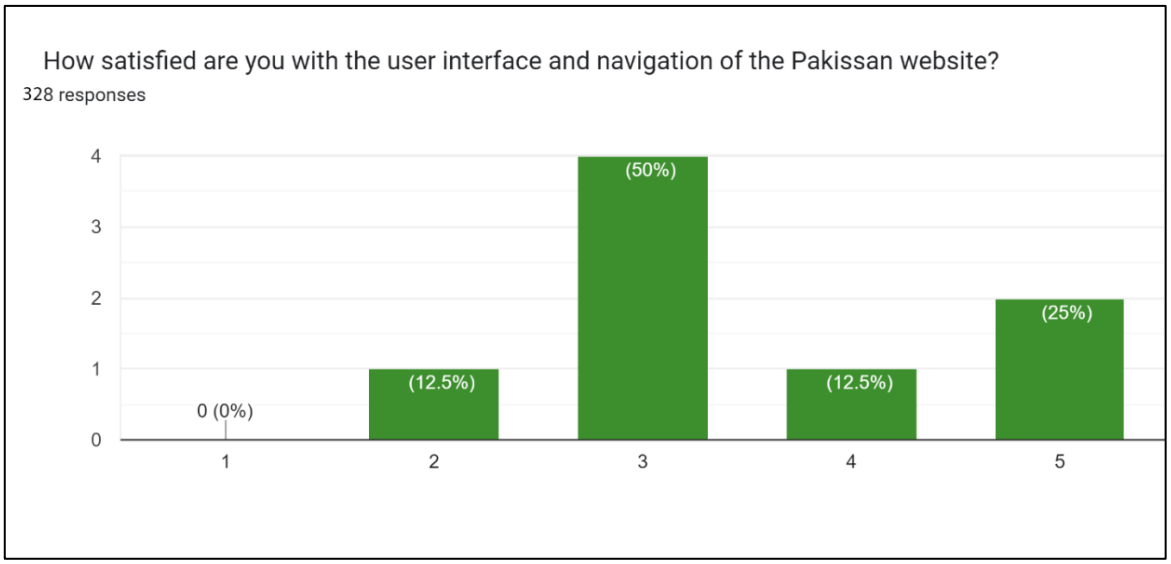

Figure 25: Respondents' Satisfaction Levels with UI and Navigation of Pakissan website (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dissatifisfied	41	12.5	12.5	12.5
	Neutral	164	50.0	50.0	62.5
	Satisfied	41	12.5	12.5	75.0
	Very Satisfied	82	25.0	25.0	100.0
	Total	328	100.0	100.0	

Table 10: Satisfaction level with UI & Navigation of Pakissan (Source: Author)

Question number 12 is related to the level of satisfaction with Pakissan website. It was asked that how satisfied are you with the user interface and navigation of the Pakissan website. Then they were given a range of options from which they mark their specific answer. The options include level of satisfaction from 1 to 5, 1 being the least satisfied and 5 being the most satisfied. 12.5 % of the respondents marked level 4. However, level 5 i.e. most satisfied got 25 % rating and level 3 that is moderately satisfied got 50% response and level 2 got 12.5% response. Level 1 got no responses due to the high level of usage of Pakissan website.

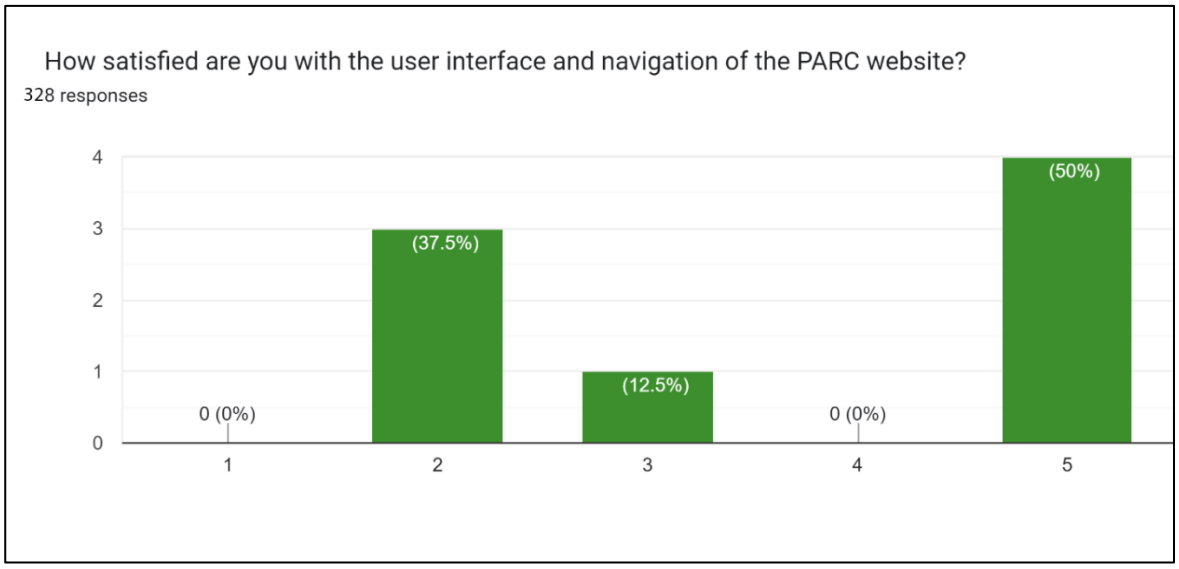

Figure 26: Respondents' Satisfaction Levels with UI and Navigation of PARC website (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dissatifisfied	123	37.5	37.5	37.5
	Neutral	41	12.5	12.5	50.0
	Very Satisfied	164	50.0	50.0	100.0
	Total	328	100.0	100.0	

Table 11: Satisfaction level with UI & Navigation of PARC website (Source: Author)

Question number 13 is related to the level of satisfaction with PARC website. It was asked that how satisfied are you with the user interface and navigation of the PARC website. Then they were given a range of options from which they mark their specific answer. The options include level of satisfaction from 1 to 5, 1 being the least satisfied and 5 being the most satisfied. 12.5 % of the respondents marked level 3. However, level 5 i.e. most satisfied got 50 % rating and level 2 that is less satisfied got 37.5 response. Level 1 and 4 got no responses.

		Count
13.PARC website satisfaction	Dissatifisfied	123
	Neutral	41
	Very Satisfied	164
12.Pakissan website satisfaction	Dissatifisfied	41
	Neutral	164
	Satisfied	41
	Very Satisfied	82
11.AMIS website satisfaction	Dissatifisfied	41
	Neutral	123
	Satisfied	41
	Very dissatified	41
	Very Satisfied	82
9.Most informative for market price info	AMIS.pk	41
	None	82
	Pakissan.com	164
	PARC.gov.pk	41
10.Most informative for agriculture related topic	AMIS.pk	41
	None	41
	Pakissan.com	164
	PARC.gov.pk	82

Table 12: Table showing website satisfaction (Source: Author)

1.Age * 11.AMIS website satisfaction

1.Age

11.AMIS website satisfaction	Mean	N	Std. Deviation
Dissatifisfied	40.10	41	19.165
Neutral	39.56	123	19.630
Satisfied	34.37	41	14.657
Very dissatified	37.05	41	17.638
Very Satisfied	38.21	82	18.198
Total	38.33	328	18.390

Table 13: Means of AMIS website satisfaction (Source: Author)

ANOVA

1.Age

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1027.302	4	256.825	.757	.554
Within Groups	109566.793	323	339.216		
Total	110594.095	327			

Table 14: ONEWAY @1. Age BY @11. AMIS website satisfaction (Source: Author)

In Table 9 above, the value of F is 0.757, which reaches significance with a p-value of .0.554 (which is greater than the .05 alpha level). This means there is no statistically significant difference between the means of the different levels of AMIS website satisfaction variable. This is also shown in Table 8 above.

ANOVA

1.Age

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	180.905	3	60.302	.177	.912
Within Groups	110413.189	324	340.781		
Total	110594.095	327			

Table 15: ONEWAY @1. Age BY @12. Pakissan website satisfaction (Source: Author)

1.Age * 12.Pakissan website satisfaction

1.Age

12.Pakissan website satisfaction	Mean	N	Std. Deviation
Dissatifisfied	37.63	41	19.158
Neutral	38.81	164	18.633
Satisfied	39.20	41	19.129
Very Satisfied	37.27	82	17.394
Total	38.33	328	18.390

Table 16: Means of Pakissan website satisfaction. (Source: Author)

In Table 10 above, the value of F is 0.177, which reaches significance with a p-value of .0.912 (which is greater than the .05 alpha level). This means there is no statistically significant difference between the means of the different levels of Pakissan website satisfaction variable. This is also shown in Table 11 above.

ANOVA

1.Age

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	354.060	2	177.030	.522	.594
Within Groups	110240.035	325	339.200		
Total	110594.095	327			

Table 17: One Way @1. Age BY @13. PARC website satisfaction (Source: Author)

1.Age * 13.PARC website satisfaction

1.Age

13.PARC website satisfaction	Mean	N	Std. Deviation
Dissatifisfied	37.26	123	17.894
Neutral	40.56	41	20.858
Very Satisfied	38.57	164	18.163
Total	38.33	328	18.390

Table 18: Means of PARC website satisfaction (Source: Author).

In Table 12 above, the value of F is 0.522, which reaches significance with a p-value of .0.594 (which is greater than the .05 alpha level). This means there is no statistically significant difference between the means of the different levels of PARC website satisfaction variable. This is also shown in Table 8 above.

Impact on Farming Practices

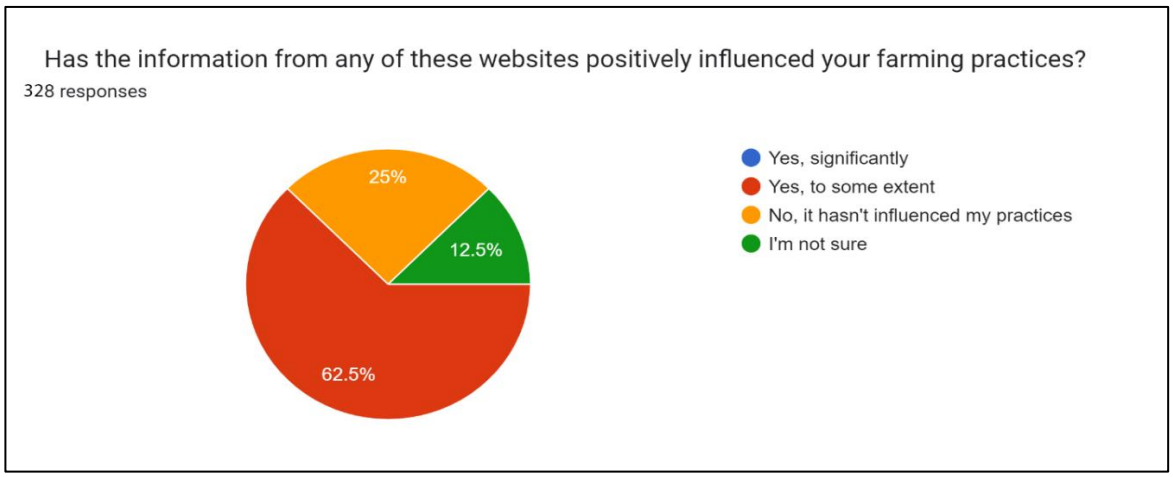

Figure 27: Graphical Representation of Impacts on farming practices (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I'm not sure	41	12.5	12.5	12.5
	No, It hasn't influenced my practices	82	25.0	25.0	37.5
	Yes to some extent	205	62.5	62.5	100.0
	Total	328	100.0	100.0	

Table 19: Impacts of websites on farming practices (Source: Author)

Question number 14 is related to the influence on farming practices through the information of these websites. It was asked that has the information from any of the websites that is Pakissan.com, Amis.pk and PARC.gov.pk influenced your farming practices. Then they were given a range of options from which they mark their specific answer. The options include yes significantly, yes to some extent, no it has not influenced my practices and I am not sure.

The results indicate that 62.5% of the respondents have chosen the option “yes, to some extent” and 25% chose no it has not influenced my practices and 12.5% chose that I am not sure. These data clearly indicate that there need to be develop a website that can impact farming practices of the famers who are unable to get help from the previously designed websites.

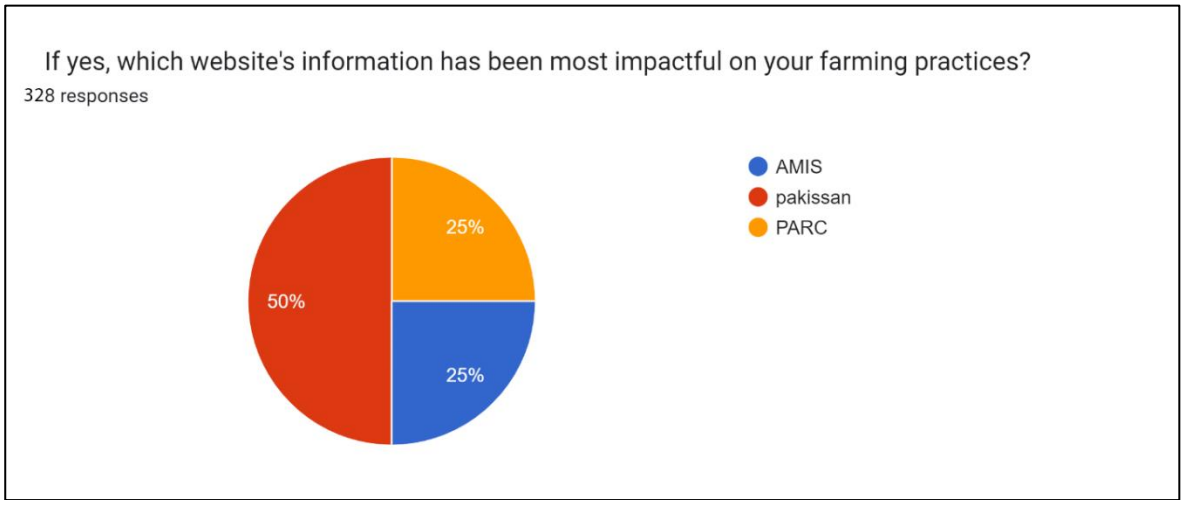

Figure 28: Graphical representation of impactful website on farming practices (Source: Author)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AMIS.pk	82	25.0	25.0	25.0
	Pakissan.com	164	50.0	50.0	75.0
	PARC.gov.pk	82	25.0	25.0	100.0
	Total	328	100.0	100.0	

Table 20: Most impactful website on Farming practices (Source: Author)

Question number 15 is related to the website that has most influence on farming practices. It was asked that name the website that has most impact on your farming practices. Then they were given a range of options from which they mark their specific answer. The options include the name of websites i.e. Pakissan.com, Amis.pk and PARC.gov.pk. Half of the respondents chose Pakissan.com, and 25% chose AMIS and another 25% chose PARC.

		14.Influence of the information in website on your farming practices			
		I'm not sure	No, It hasn't influenced my practices	Yes to some extent	Total
		Count	Count	Count	Count
15.If yes, which website has been most impactful on your farming practices?	AMIS.pk	0	41	41	82
	Pakissan.com	0	0	164	164
	PARC.gov.pk	41	41	0	82
	Total	41	82	205	328

Table 21: Cross tabulation showing the impact of websites on farming practices (Source: Author).

Out of the 41 farmers who found PARC.gov.pk impactful in their farming practices, none were entirely certain if the information from the website had influenced their practices. Conversely, 82 farmers stated that the information in the websites did not impact their farming practices, with 41 of them specifically referring to AMIS.pk and the other 41 to PARC.gov.pk. However, a significant number of farmers, totaling 205, acknowledged that the information from the websites had some level of influence on their farming practices. Among them, 164 farmers credited Pakissan.com for its impact, while 41 farmers recognized the influence of AMIS.pk.

4.5 Unified Modelling Language (UML) Diagrams

4.5.1 Use case diagram:

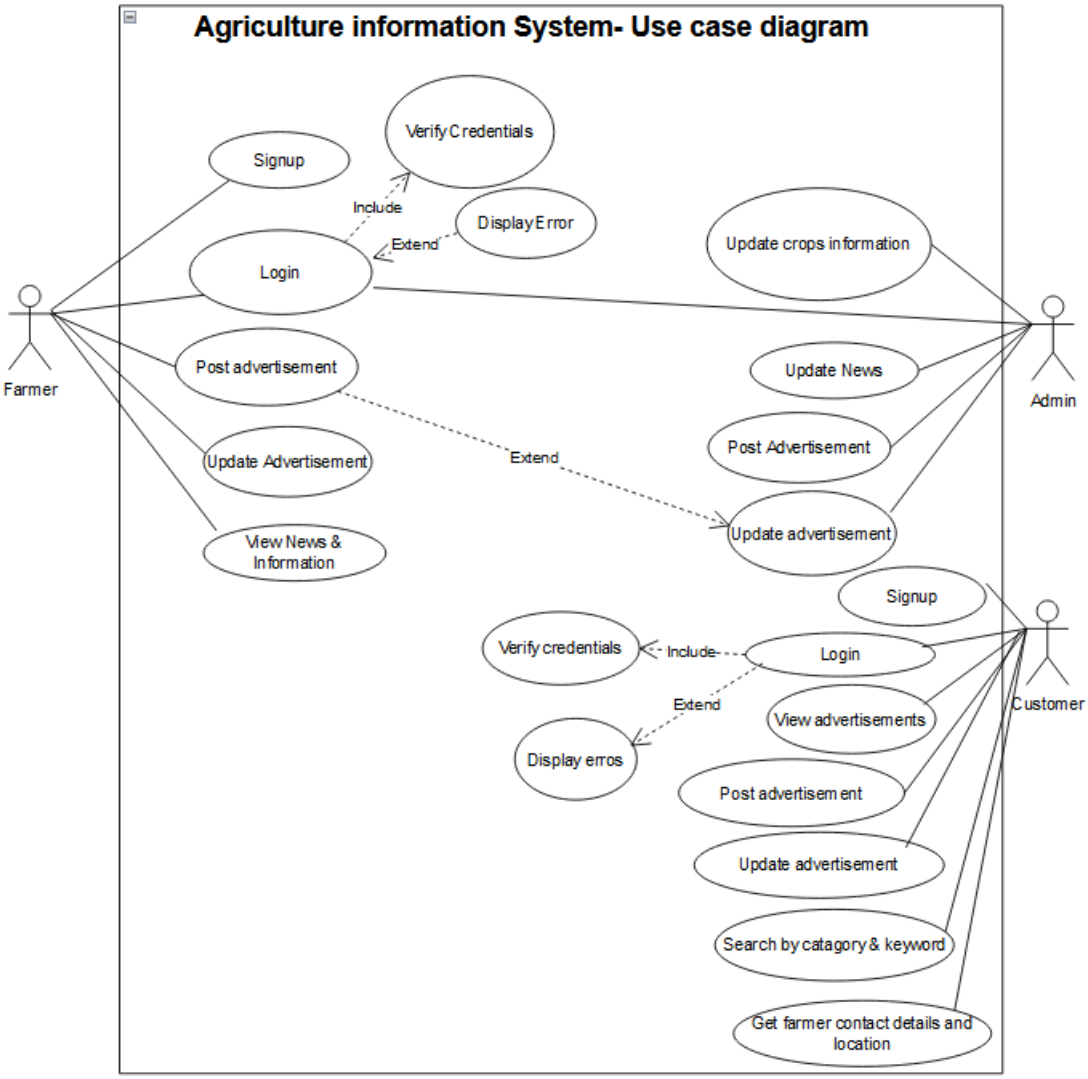

Figure 29: Use case diagram (Source: Author)

In the use case diagram, three primary actors interact with the Agricultural Information System (AIS): Customers, admins, and farmers. Each actor possesses distinct functionalities and roles within the system. The farmers interactions with the system are multifaceted, encompassing various tasks aimed at promoting their products and staying informed about relevant agricultural developments. Firstly, farmers have the capability to register on the platform, providing essential details to create their accounts. Upon successful registration, they can log in to access their personalized dashboard and interact with the system. One of the key functionalities available to farmers is the ability to post

advertisements, where they can showcase their agricultural products, and offerings to potential buyers. Moreover, farmers retain the privilege to update their advertisements as needed, ensuring that their listings remain current and accurate. In addition to advertising their products, farmers can also access news and information related to crops, agricultural practices, market trends, and government policies. This feature empowers farmers with valuable insights and knowledge, enabling them to make informed decisions about their farming activities.

Admins serve as the overseers and moderators of the AIS, wielding administrative privileges to manage and maintain the system. Their primary responsibility revolves around updating news and information pertinent to crops, agriculture, and related domains. By staying abreast of the latest developments in the agricultural sector, admins facilitate knowledge-sharing and enhance the overall user experience on the platform. The admin update news, advertisements and post advertisements.

The customers have the ability to browse and view advertisements posted by farmers. This feature allows customers to explore a variety of agricultural products and services, ranging from crops and livestock to equipment and tools. Moreover, customers can submit their own advertisements, promoting their offerings or requirements within the agricultural community. Additionally, customers can edit their advertisements as necessary. Furthermore, customers have the option to obtain the locations and contact information of farmers, facilitating direct communication and potential transactions. This feature fosters transparency and trust within the agricultural marketplace, empowering customers to engage with farmers on a personal level.

4.5.2 Activity diagram for login process

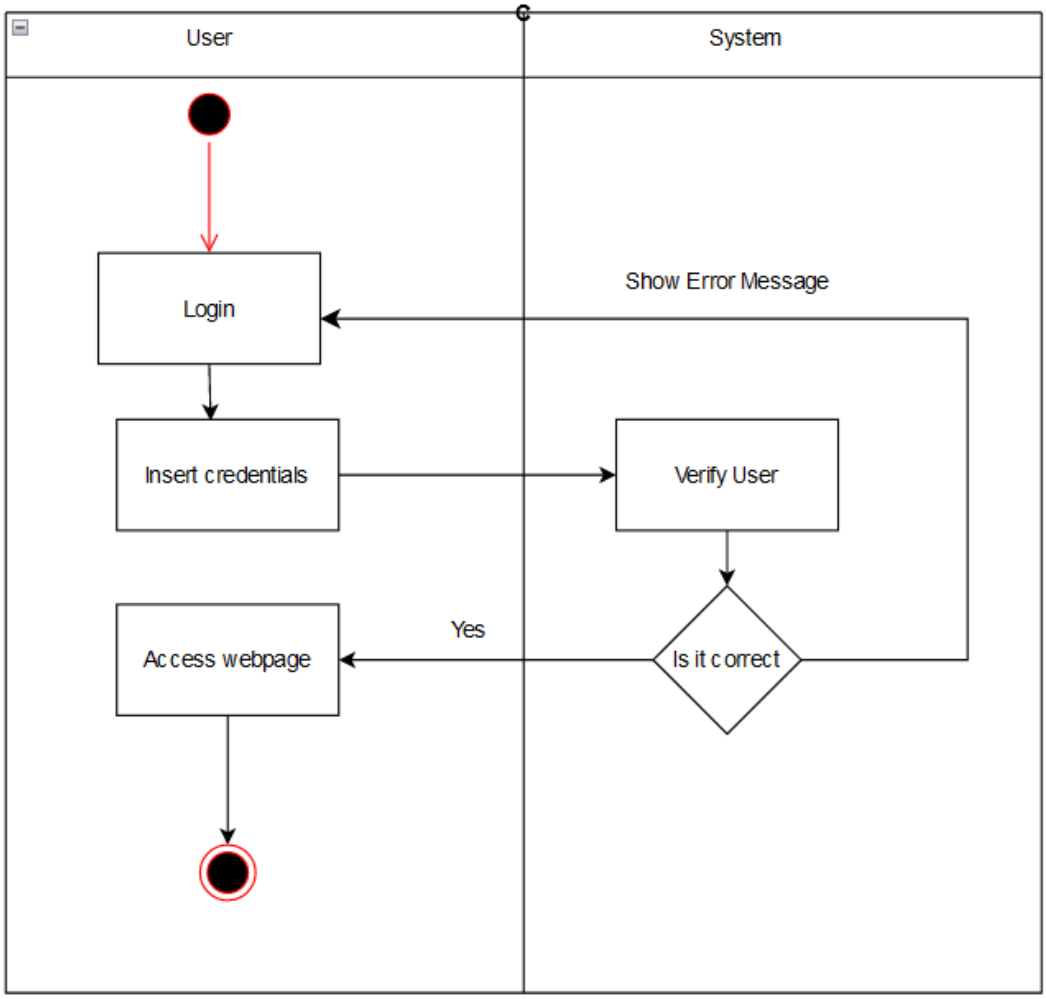

Figure 30: Activity diagram for login (Source: Author)

Each of the stages involved in the user login process are depicted in the UML activity diagram. The process starts in the user section when the user tries to log in. The user then enters their login information, which consists of a username and password. After that, the "Verify User" activity is used by the system section to verify the user's credentials. The system determines if the credentials entered match the approved data at the "Is it correct?" decision step. The user is given access to the webpage if the system finds that the credentials are valid, as shown by the successful result. On the other hand, the negative path takes precedence and an error message appears if the credentials are found to be wrong. The activity diagram's representation of the login process is improved by the addition of red circles, which operate as graphical markers to indicate the start and end of the user's actions.

4.5.3 Activity diagram for Marketplace

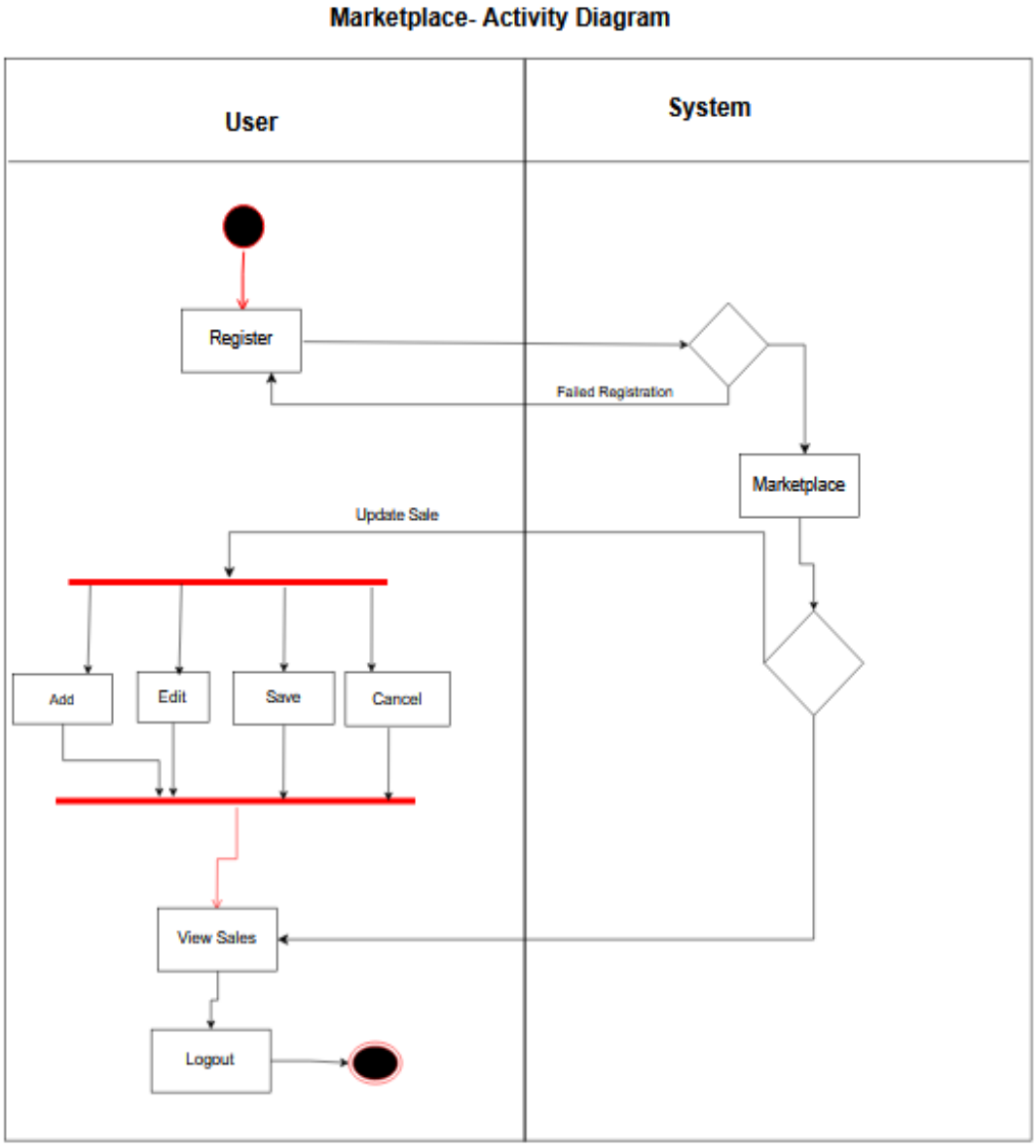

Figure 31: Activity diagram for Marketplace (Source: Author)

User and System are the two main sections of the UML activity diagram for the marketplace system, which show the order in which users interact with the underlying system. User registration is the first step in the procedure under the User area. If the attempt at registration be unsuccessful, the procedure ends; if successful, the user is granted access to a variety of sales-related functions. These actions include examining sales, adding new information about sales, altering details about already-existing sales,

saving changes made to sales, stopping actions linked to sales that are now in progress, and finally signing out to end the session.

In addition, if user registration fails in the System phase, the entire procedure ends at that point. On the other hand, if the registration process is successful, the user proceeds to the Marketplace area, indicating that they have succeeded into the marketplace system's operating phase. In order to provide a thorough picture of how users navigate and interact with the platform for managing sales inside the marketplace, arrows are used in the diagram to serve as a visual guide.

4.6 High Fidelity Wireframes for Proposed Prototype System

4.6.1 High Fidelity Wireframe for Registration

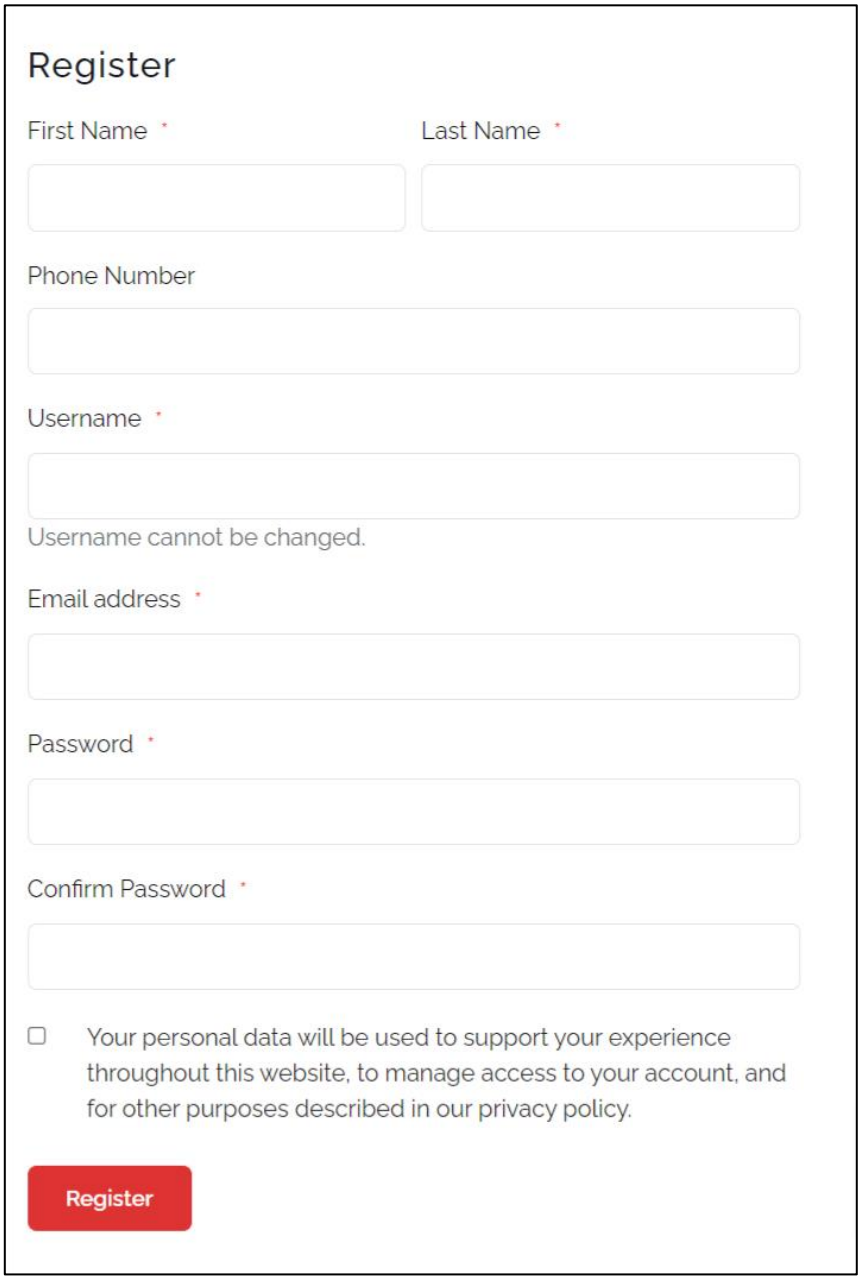

Figure 32: High Fidelity Wireframe for Registration (Source: Author)

4.6.2 High Fidelity Wireframe for Login

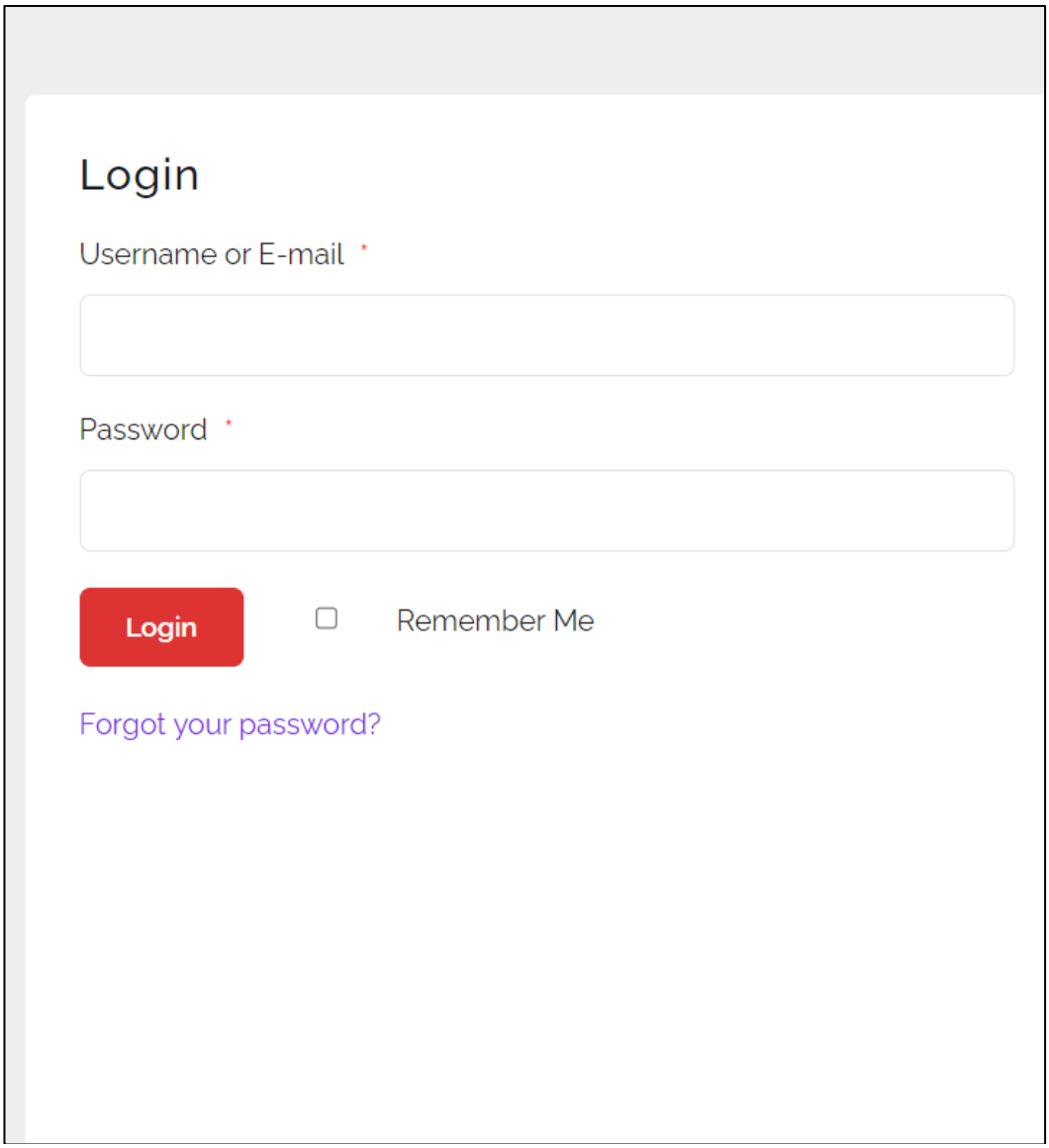

Figure 33: High Fidelity Wireframe for Login (Source: Author)

4.6.3 High Fidelity Wireframe for Landing Page

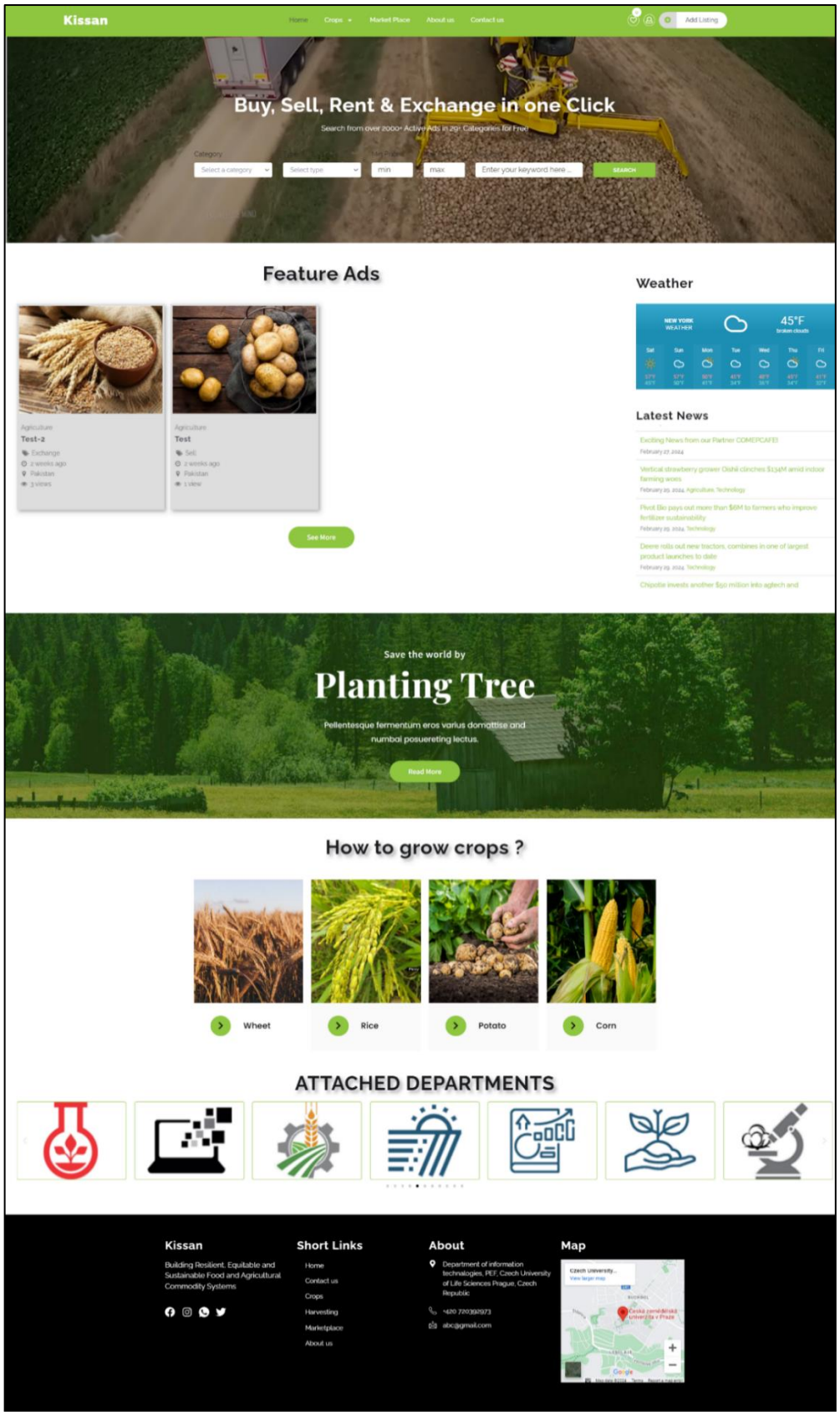

Figure 34: High Fidelity Wireframe for Homepage (Source: Author)

4.6.4 High Fidelity Wireframe for Crops

Figure 35: High Fidelity Wireframe for Crops Production Technology (Source: Author)

4.6.5 High Fidelity Wireframe for Marketplace

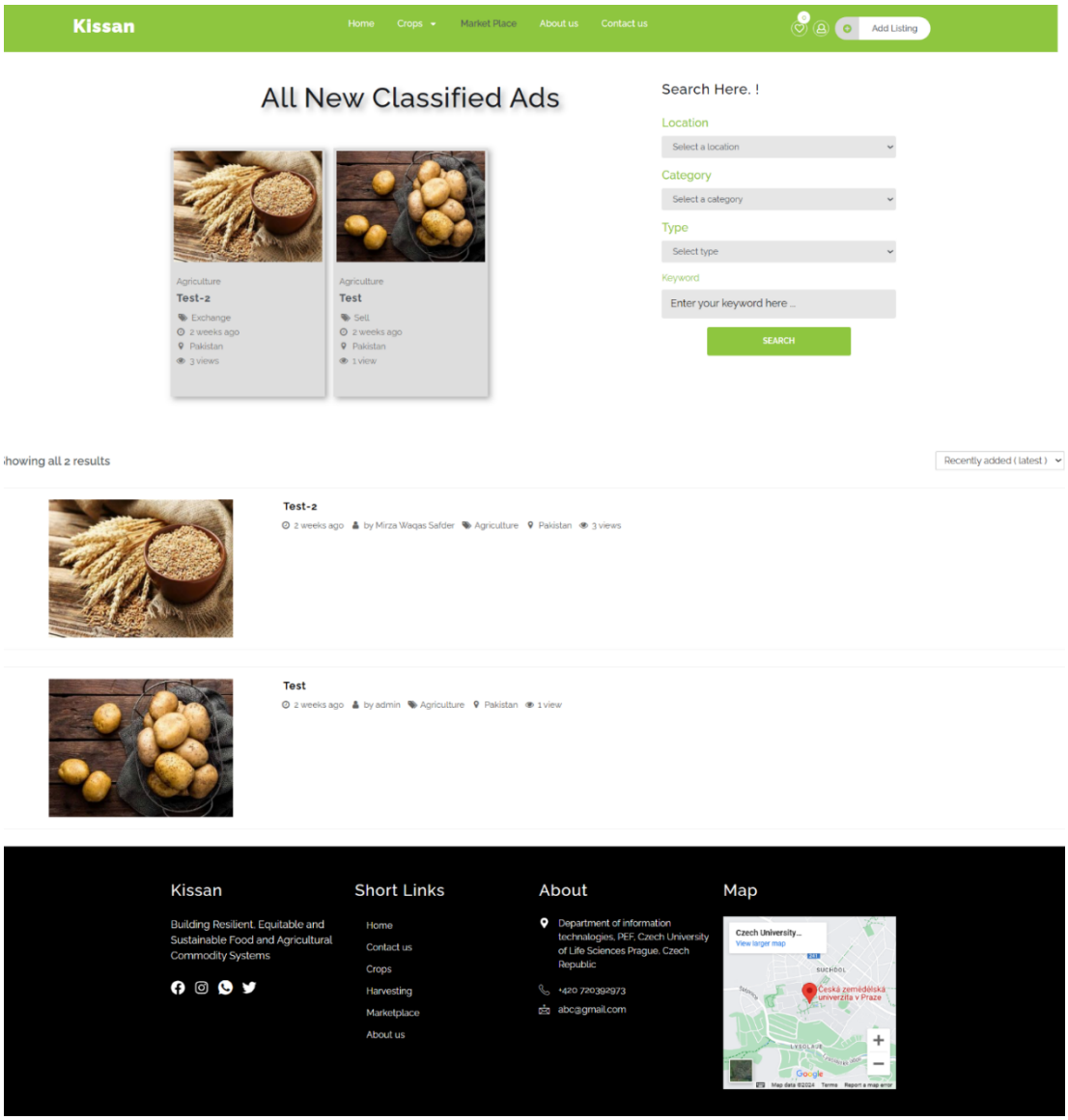

Figure 36: High Fidelity Wireframe for Marketplace (Source: Author)

4.6.6 High Fidelity Wireframe for Advertisement (Listing) Submission Form

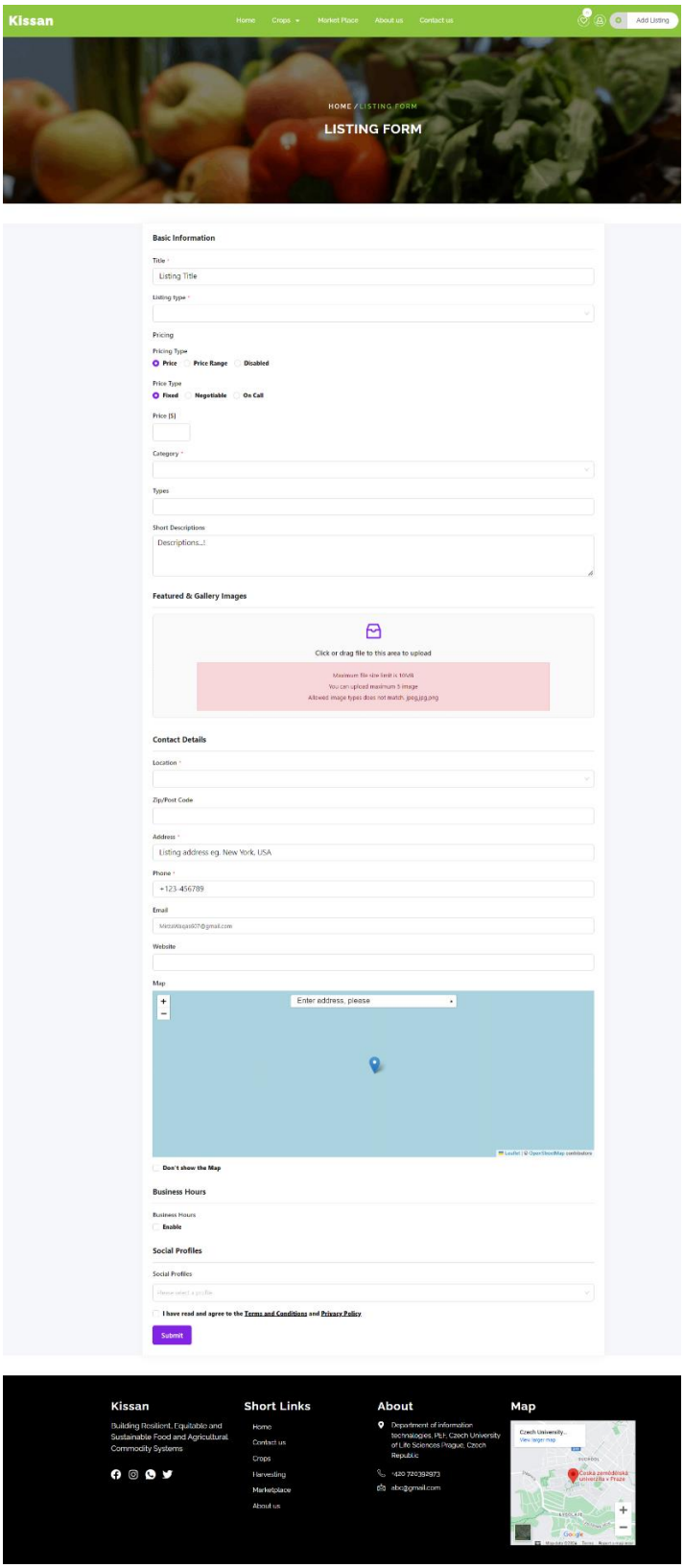

Figure 37: High Fidelity wireframe for posting advertisement (Source: Author).

4.6.7 High Fidelity Wireframe for about us

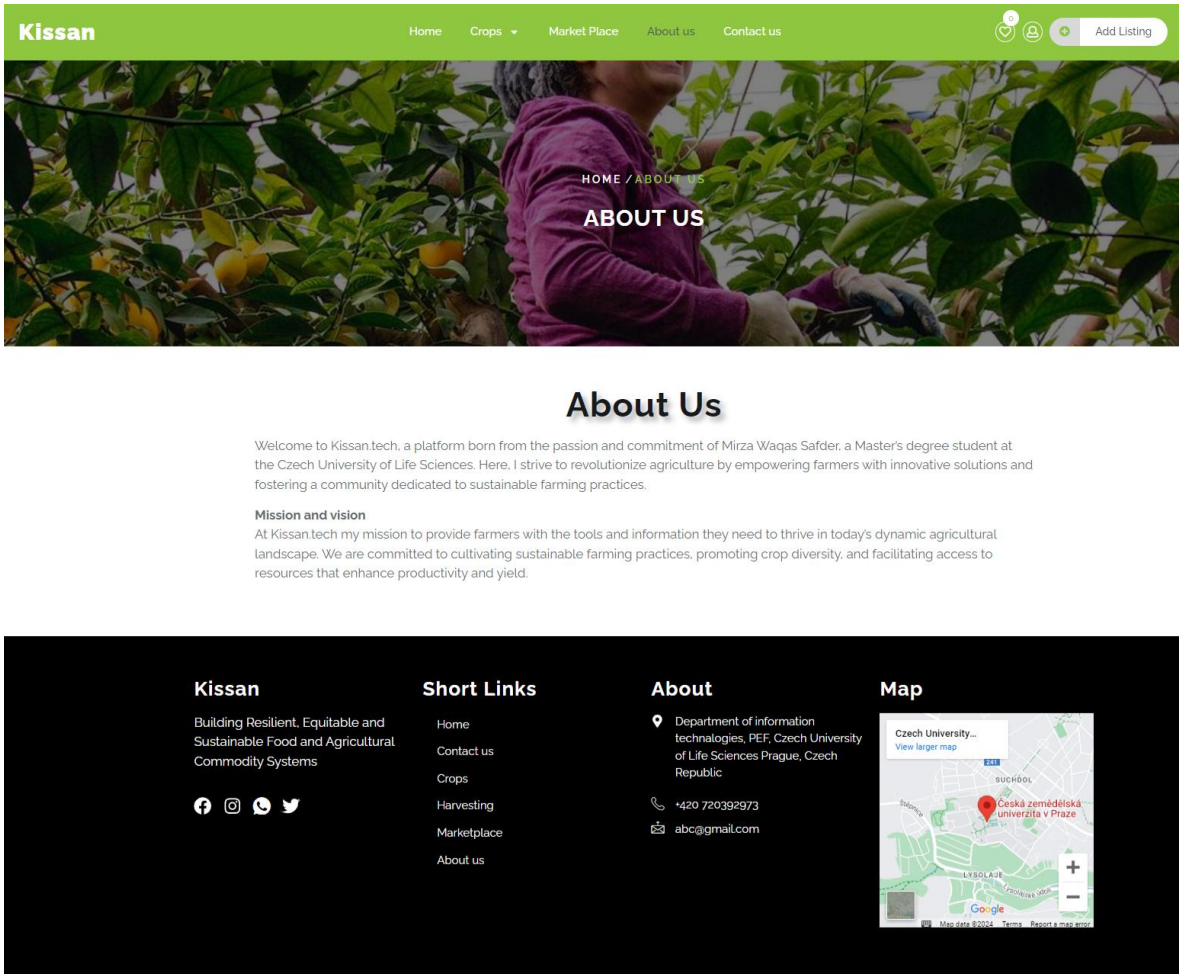

Figure 38: High Fidelity Wireframe for About Us (Source: Author)

4.6.8 High Fidelity Wireframe for Contact Us

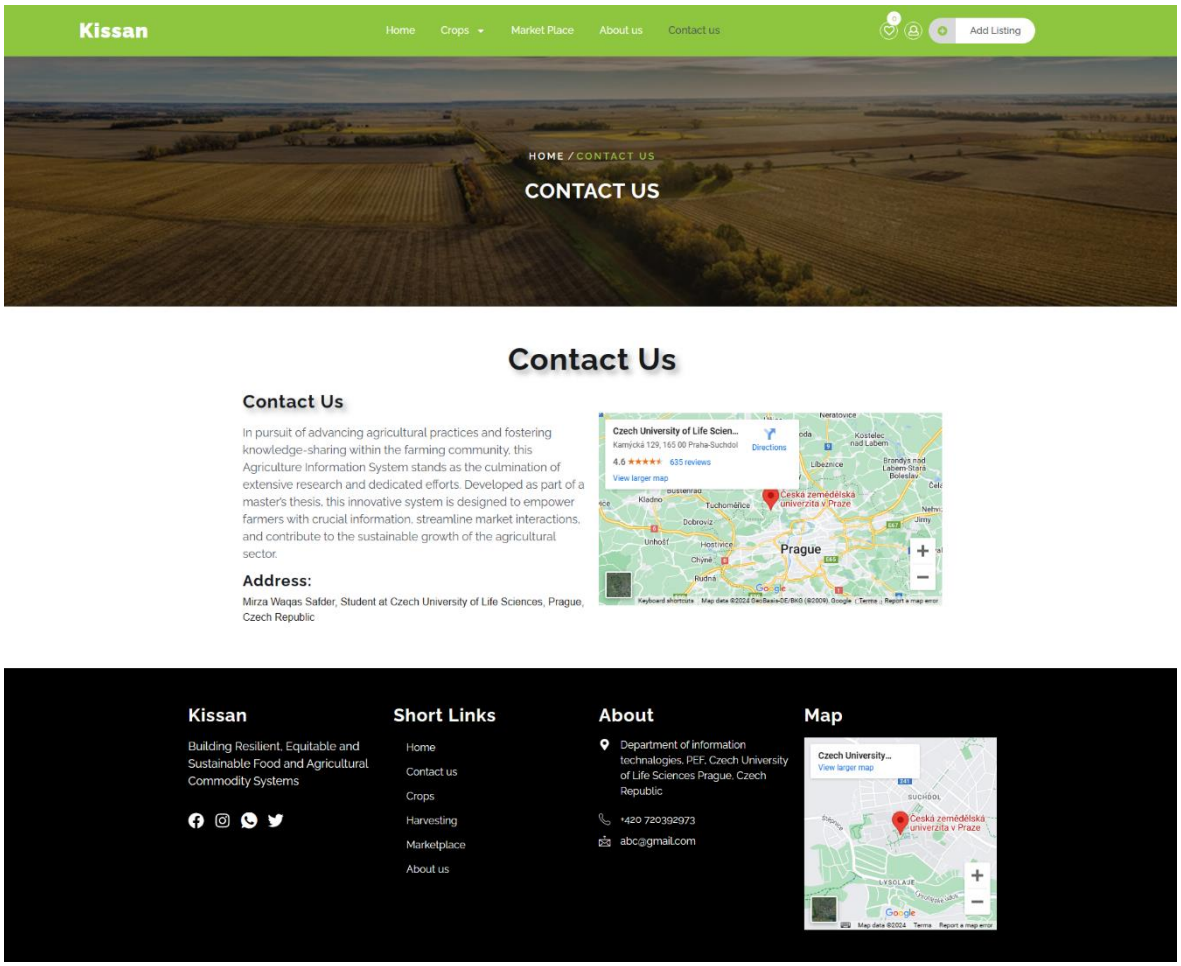

Figure 39: High Fidelity Wireframe for Contact Us (Source: Author)

4.7 Proposed Prototype Agriculture Information System

The prposed prototype of Agricultural Information System (AIS) is a platform crafted with the aid of Unified Modeling Language (UML) and Wireframes, aimed at meeting the changing demands of the agricultural sector. The prototype was designed using CMS frameword & accessible through the http://kissan.tech/ the AIS serves as a welcoming gateway to a specialized space dedicated to farmers and agricultural customers. The protoype AIS named "kissan" after the native Urdu term for agriculture farmer. Through this platform, farmers can easily access information on various crops, connect with buyers, and become part of a supportive community.

The proposed AIS is envisioned as a comprehensive solution to bridge critical gaps in existing information systems. By offering timely and accurate data, the system aims to empower farmers, researchers, policymakers, and other stakeholders in making informed decisions. In addition to providing wholesale commodity prices in the market, the AIS serves as a platform for farmers to sell their produce online by posting ads. This direct marketplace facilitates direct dealings between farmers and buyers, eliminating the need for intermediaries and promoting economic efficiency.

Comprehensive information about different crops, including necessary facts and alternatives, can be found under the "Crops" menu. The purpose of this section is to provide farmers with information on various crops so they may make well-informed decisions regarding their farming practices.

The farmers can explore the options for purchasing and selling agricultural goods in the "Marketplace." In order to promote a sustainable and effective exchange of goods, this part cultivates a direct relationship between farmers and the market. The maketplace will help them to stop contacting middle man (Broker) between farmers and buyers. They can sell their profucts directly to the buyers.

The Agriculture Information System's history, goals, and core beliefs are explained in detail under the "About Us" option. Users may get more information about the platform, the people who built it, and its main objective, which is to uplift and help the farming community.

Users can communicate directly with the platform administrators using the "Contact Us" feature. This menu item promotes candid communication and teamwork when someone needs help, wants to offer feedback, or has a specific question.

Furthermore, the proposed prototype AIS is designed with scalability in mind, allowing for future development and enhancement. As stakeholders consider the implementation of this system, it holds the potential to significantly impact the agricultural economy. By empowering farmers with access to vital information and market opportunities, the AIS can contribute to the growth and sustainability of the agricultural sector. As such, the implementation of the AIS represents a step towards realizing a brighter future for agriculture in Pakistan.

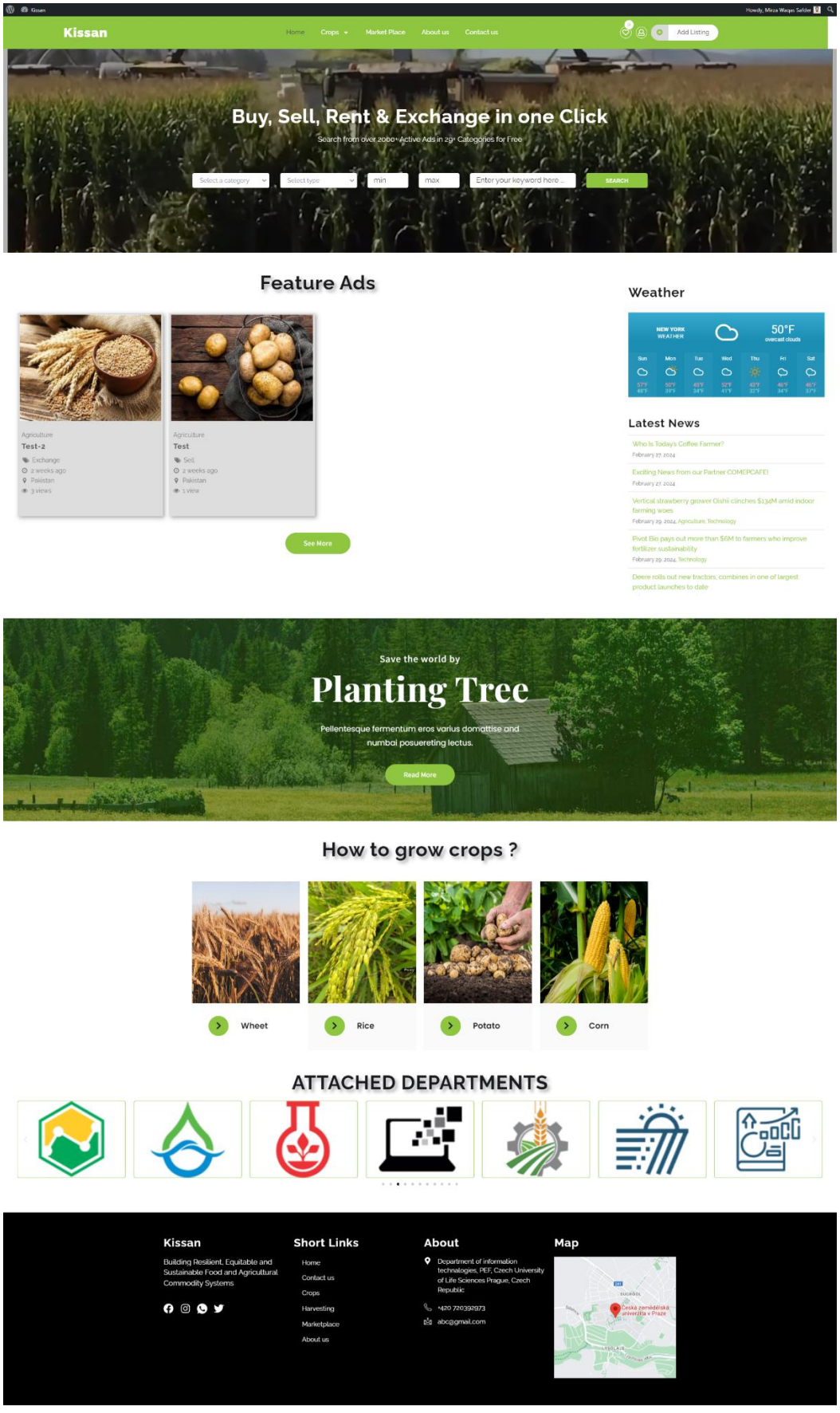

Figure 40: Proposed Prototype web-based information system (Source: Author).

4.8 User Acceptance Testing & feedback

The protoype agricultural information system Kissan.tech was tested using Alpha User Acceptance Testing (UAT) on March 4, 2024, by Mirza Waqas Safder which is the developer of AIS. The sixteen acceptance criteria (functional and security tests) are listed in the table 4.1. Each test is defined priority level (high, medium, or low). The test results (reject/accept), testing date, and any related comments or feedback are also included in the table. Adding, editing, and deleting crops; interacting with and sharing news articles; accessing current weather and location-based weather searches; posting advertisements in the marketplace; user sign-up procedures; verifying about us information; seamless navigation across sections; responsive design across multiple devices; secure data handling; browser compatibility; and page loading speed were just a few of the many functionalities covered in the UAT.

Remarkably, the majority of tests including critical functionalities such as crop management, news interaction, and marketplace activities, passed successfully. However, two notable exceptions were the inability to submit a contact form due to its unavailability and the second was to search the weather through location. The UAT outcomes provide valuable insights into the system's readiness for deployment, highlighting areas of strength and pointing out specific aspects requiring attention. The feedback gathered will contribute to further refinement and optimization, ensuring a robust and user-friendly web-based agriculture information system for the end-users.

Item #	Acceptance Criteria or Requirement	Test type	Owner or Responsible	Priority	Test Result	Test Date	Feedback
1	Add new crop	Functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The new crop successfully added in the list
2	Edit Existing crop	Functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The existing crop edited successfully
3	Deletion of crop	Functional	Mirza Waqas Safder	MEDIUM	Accept	4/3/2024	Successfully deleted an crop
4	Click on the news article in the news section	Functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The article displayed with proper format & images
5	Share news article	Functional	Mirza Waqas Safder	MEDIUM	Accept	4/3/2024	The shared link direct users to the news article
6	View current weather	Functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The weather details is accurate & up to date

7	Weather search by location	Functional	Mirza Waqas Safder	MEDIUM	Reject	4/3/2024	The location was unaable to change
8	Posting adds in Marketplace	Functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The add succefully posted.
9	Signup for new user	functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	Signup was succefull
10	Submit contact form	functional	Mirza Waqas Safder	LOW	Reject	4/3/2024	There is no contact form available
11	Verify about us information	Functional	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The page provide the clear understanding & website pupose
12	Navigation across sections	Functional	Mirza Waqas Safder	MEDIUM	Accept	4/3/2024	The pages and content loaded without error.
13	Responsive design	Functional	Mirza Waqas Safder	LOW	Accept	4/3/2024	The website is responsive & appropriety adopting to new devices like computer and mobile
14	Secure data handling	Security	Mirza Waqas Safder	HIGH	Accept	4/3/2024	The website handling user data securely.
15	Browser compatibilty	Functional	Mirza Waqas Safder	LOW	Accept	4/3/2024	The website is working on different browsers.
16	Evaluate loading speed	Functional	Mirza Waqas Safder	LOW	Accept	4/3/2024	The pages loaded within acceptable time.

Table 22: Website Acceptance Criteria, Test Results, and User Feedback (Source: Author)

5. Results and discussions

In the previous chapter we analysed web-based information systems that are currently in use in Pakistan were evaluated for their useability, User interface & Navigation and information availablity related to agriculture production technalogy. It has been discovered through a study of farmers that there are a number of shortcomings within the existing information systems. According to statistical analysis a significant portion of respondents fell within the age bracket of 25-30 years, indicating a young farming population in Pakistan.

While a considerable number of respondents were aware of agricultural information systems like Pakissan.com, AMIS.pk, and PARC.gov, Pakissan.com emerged as the most frequently visited & used website. Overall, respondents expressed medium to low satisfaction with the user interface and navigation of the agricultural websites surveyed. The survey concluded that Pakissan.com was deemed most useful by half proportion of respondents for market price information on agricultural commodities, while only 12.5% proportion of respondets rated informative both Amis.pk and PARC.gov.pk. Notably, 25% of respondents expressed that none of the provided websites were helpful. However, there was no statistically significant difference in satisfaction levels across different age groups for each website.

By keeping in mind the farmers needs for updated agricluture information the UML diagrams and high Fidelity Wireframes were designed to propose a prototype informatin system using CMS framework with an emphasis on user-centered design principles and thorough information providing for farmers in response to the deficiencies of the current web-based information systems. With a user-friendly design developed with farmers' requirements in mind, the proposed information system seeks to address the challenges that have been identified. The proposed prototype design's main attributes are its easy-to-use navigation, information categorization and interactive tools for accessing agricultural production technology. The proposed prototype design offers Pakistani farmers a more user-friendly and comprehensive solution than the current web-based information systems, which is a major improvement.

The user acceptance testing (UAT) on the proposed prototype informaiton system was conducted and results revealed that the system successfully meets the required needs of farmers in Pakistan.

The results of this study have significant implications for Pakistan's agricultural industry's development of web-based information systems. In order to solve present problems and satisfy the demands of farmers, the suggested prototype design is a major step forward. To enhance user experience and improve its influence on farming practices, the web based information will require additional development and refinement in the future. Further study and cooperation with stakeholders will be necessary to guarantee the proposed platform's acquired availability and usefulness in assisting Pakistani farmers in sustaining their livelihoods. Based on the findings, several recommendations made to improve agricultural information systems and address the identified gaps:

1. **Enhanced User Experience:** Continuously improve the user interface and navigation of agricultural websites to enhance user experience and satisfaction.
2. **Content Enhancement:** Regularly update and expand the content of agricultural websites to provide comprehensive and relevant information to farmers, addressing a wide range of agricultural topics and needs.
3. **Targeted Outreach:** Conduct targeted outreach and awareness campaigns to increase awareness and usage of agricultural information systems among farmers, especially those in rural areas or with limited access to technology.
4. **Feedback Mechanism:** Establish a feedback mechanism to gather input from users on their experience with agricultural websites, allowing for continuous improvement based on user feedback.
5. **Tailored Information:** Provide tailored information and resources on farming techniques, market prices, and other relevant topics to meet the specific needs of different farmer demographics and regions.
6. **Integration of Technology:** Explore opportunities to integrate emerging technologies such as mobile applications, artificial intelligence, and data analytics to enhance the effectiveness and accessibility of agricultural information systems.

By implementing these recommendations, agricultural information systems in Pakistan can better serve the needs of farmers, contribute to improved farming practices, and ultimately enhance agricultural productivity and sustainability in the region.

6. Conclusion

The purpose of this research was to conduct a thorough assessment of Pakistan's existing agriculture information systems, pointing out both their advantages and disadvantages as well as offering solutions for several major shortcomings. We highlighted the important role and purpose of agriculture information systems in the agricultural sector through the study of the literature.

One of the main component of study was the survey comprising 15 questionnaires was conducted via Google Forms to gather valauable inofrmation.The survey's findings provide insightful information for analysis, highlighting the difficulties farmers confront and the areas in which improvements needs to be fulfilled. We statistically examined the survey data using descriptive statistical analysis, cross-tabulation, and inferential statistics, such as ANOVA tests to get the results.

Shortcoming sdrawn from the Analyses:

1) The analysis revealed that significant amount of the respondents was dissatisfied with the information related to agriculture present on the websites.
2) The significant prportion of farmers expressed dissatisfaction with the user interface (UI) and navigation of existing information systems.
3) The significant proportion of respondents indicated that none of these websites were useful for providing Marketprices for agriculture comodities.
4) The study showed that more than half of respondents found some influence on their farming practices. While significant proportion of responding found no influence on their farming practices

Our recommendations for improving the effectiveness of Pakistan's Agriculture information systems are based on the statistical analyses that we conducted, which identified patterns and trends in the replies.

Furthermore, Keeping in mind shortcomings inside the existing information systems we designed UML diagrams & high Fidelity Wireframes to propose a comprehensive prototype web-based Agriculture information system by using CMS framework. The proposed prototype encompasses comprehensive crop production technology, while its

user interface (UI) and navigation prioritize user-centered design principles. The prototype proposed system facilitates farmers to directly post their agricultural products, thereby reducing reliance on middlemen. By conducting Alpha UAT testing, we concluded that the proposed prototype system fulfilled functional requirements and incorporated the user feedback to enhance its design.

This Study offers valuable perspectives on the status of Pakistan's agriculture information system and presents actionable suggestions for enhancement. By rectifying recognized deficiencies and deploying the suggested framework for a web-based system, stakeholders in the agricultural sector can improve access to vital information, thereby fostering sustainable development within Pakistan's agriculture industry.

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8. List of Figures, Tables, and Abbreviations

8.1 List of Figures

8.2 List of Tables

8.3 List of Abbreviations

AIS: Agriculture information system
CMS: Content management system
UI: User interface
UML: Unified modelling language
UAT: User Acceptance Testing
IOT: Internet of Things
CC: Cloud computing
ICT: Information and communication Technology
UAV: Unmanned Aerial vehicle
GIS: Geographic information system
RFID: Radio frequency identification
WTO: World trade organization

9. Appendix

9.1 Survey Questionnaire

1. **What is your age?**

    1) 25-30 Years
    2) 30-35 Years
    3) 35-45 Years
    4) Above 45 Years

3. **What is your gender?**

    1) Male
    2) Female
    3) Prefer not to say

4. **How many years have you been engaged in farming?**

    1) 2 Years
    2) 5 Years
    3) 10 Years
    4) More than 10 Years

5. **What type of crops or livestock do you primarily focus on?**

    1) Common staple crops
    2) Specialized crops
    3) Cash crops
    4) Genetically modified crops

6. **Have you heard about the following agriculture information systems in Pakistan?**

    1) Pakissan.com
    2) AMIS.pk
    3) PARC.gov

7. **If yes, please indicate how familiar you are with each of the systems ((Pakissan.com, Amis.pk, and PARC.gov.pk)**

    1) Not familiar
    2) Somewhat familiar
    3) Moderately familiar
    4) Very familiar

8. **How often do you visit these websites?**

    1) Daily
    2) Weekly
    3) Monthly
    4) Rarely/Never

9. **Which website do you use more frequently?**

    1) Pakissan.com
    2) AMIS.pk
    3) PARC.gov.pk

10. **Which website do you find most helpful for obtaining market price information for agricultural commodities?**

    1) Pakissan.com
    2) AMIS.pk
    3) PARC.gov.pk
    4) None

11. **Which website do you consider the most informative for agriculture-related topics?**

    1) Pakissan.com
    2) AMIS.pk
    3) PARC.gov.pk
    4) None

12. **How satisfied are you with the user interface and navigation of the AMIS website?**

    5) Very dissatisfied
    6) Dissatisfied
    7) Neutral
    8) Satisfied
    9) Very satisfied

13. **How satisfied are you with the user interface and navigation of the Pakissan website?**

    1) Very dissatisfied
    2) Dissatisfied
    3) Neutral
    4) Satisfied
    5) Very satisfied

14. How satisfied are you with the user interface and navigation of the PARC website?

1) Very dissatisfied
2) Dissatisfied
3) Neutral
4) Satisfied
5) Very satisfied

15. Has the information from any of the websites positively influenced your farming practices?

1) Yes, significantly
2) Yes to some extent
3) No, It hasn't influenced my practices
4) I'm not sure

16. If yes, which website has been most impactful on your farming practices?

1) Pakissan.com
2) AMIS.pk
3) PARC.gov.pk