The Role of Contract Farming in Market Satisfaction, Profit Anticipation, and Adoption of CSA (Climate Smart Agriculture): Case of Potato Farmers of Punjab, Pakistan

By

Tausif Iqbal

(Registration No: 00000400819)

Department of Agricultural Sciences and Technology

Atta Ur Rahman School of Applied Biosciences (ASAB)

National University of Sciences and Technology (NUST)

Islamabad, Pakistan

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Tausif Iqbal

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National University of Sciences and Technology (NUST)

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Signature: Sobia

Dr. Sobia Asghar
Assistant Professor
Dept. of Plant Biotechnology
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

Name of Supervisor: Dr. Sobia Asghar

Date: 16/08/2024

Signature (HOD):

Dr. Muhammad Faraz Bhatti
Head of Department (HoD)
Dept. of Plant Biotechnology
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST Islamabad

Date: 16/08/2024

Signature (Dean/ Principal)

A/Principal & Dean
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

Date: 16/08/2024

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MS THESIS WORK

We hereby recommend that the dissertation prepared under our supervision by:

Name: Tausif Iqbal **Reg #: 400819**

Titled: **The role of contract farming in market satisfaction, profit anticipation, and adoption of CSA (Climate Smart Agriculture): Case of potato farmers in Punjab, Pakistan** be accepted in partial fulfillment of the requirements for the award of **MS Agribusiness Management** degree with (A grade).

Examination Committee Members

1. Name: Dr Muhammad Waqas Alam Chattha Signature: _____

2. Name: Dr Khuram Yousaf Signature: _____

Dr. Khurram Yousaf
Ph.D., Postdoc NS4U, China)
Associate Professor
Deptt. of Plant Biotechnology
Atta-ur-Rahman School of Appl
Biosciences, NUST, Islamabad

3. Name: Dr Fawad Khan Signature: _____

DR. M FAWAD KHAN
Assistant Professor
Program Head (EMBA)
NUST Business School, H-12, Islamabad

Supervisor's name: Dr Sobia Asghar Signature: Sobia

Date: 13/08/2024

Dr. Sobia Asghar
Assistant Professor
Deptt of Plant Biotechnology (Agri Biotech)
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

Date: 13/08/2024

Dr. Muhammad [illegible]
Head of Department (ASAB)
Deptt of Plant Biotechnology
Atta-ur-Rahman School of Applied Biosciences, NUST, Islamabad

Head of Department

COUNTERSINGED

Date: 13/08/2024

A/Principal & Dean
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

Dean/Principal

CERTIFICATE OF APPROVAL

This is to certify that research work presented in this thesis, titled "The role of contract farming in market satisfaction, profit anticipation, and adoption of CSA (Climate Smart Agriculture): Case of potato farmers in Punjab, Pakistan." was conducted by **Mr. Tausif Iqbal** under the supervision of **Dr. Sobia Asghar**. No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Department of Agricultural Sciences and Technology in partial fulfillment of the requirements for the degree of **Master of Sciences (MS)** in field of **Agribusiness Management**, Department of Agricultural Sciences and Technology, Atta ur Rehman School of Applied Biosciences, National University of Sciences and Technology, Islamabad.

Student Name: Tausif Iqbal Signature Tausif Iqbal

Examination Committee:

a. External Examiner 1: Signature _____
(Dr Fawad Khan, Assistant Professor, NBS, NUST)

DR. M FAWAD KHAN
Assistant Professor
Department (NBS)

b. Internal Examiner 1: Signature _____
(Dr Muhammad Waqas, Assistant Professor, ASAB, NUST)

c. Internal Examiner 2: Signature _____
(Dr Khurram Yousaf, Associate Professor, ASAB, NUST)

Dr. Khurram Yousaf
Ph.D., Postdoc (NAU-China)
Associate Professor
Deptt. of Plant Biotechnology
Atta-ur-Rahman School of Applied Biosciences, NUST, Islamabad

Supervisor Name: Dr Sobia Asghar

Signature _____

Dr. Sobia Asghar
Assistant Professor
Deptt of Plant Biotechnology (Agri Business)
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

Name of HoD: Dr. Muhammad Faraz Bhatti Signature _____

Dr. Muhammad Faraz Bhatti
Head of Department (HoD)
Deptt of Plant Biotechnology
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

AUTHOR'S DECLARATION

I Tausif Iqbal hereby state that my MS thesis titled "The Role of Contract Farming in Market Satisfaction, Profit Anticipation, and Adoption of CSA (Climate Smart Agriculture): Case of Potato Farmers of Punjab, Pakistan" is my own work and has not been submitted previously by me for taking any degree from National University of Sciences and Technology, Islamabad or anywhere else in the country/ world.

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Student/ Author Signature: _____

Name: (Tausif Iqbal)

Supervisor Signature: _____

Name: (Dr Sobia Asghar)

Dr. Sobia Asghar
Assistant Professor
Dept of Plant Biotechnology (Agri Biotech)
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST Islamabad

DEDICATION

To Allah Almighty & His beloved Prophet Hazrat Muhammad ﷺ.

&

My Parents

After that, I solemnly dedicate my words, which are an expression of my love and gratitude to my beloved family, who have strived day and night all these years to fulfill my every wish and will.

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All praise be to **ALLAH** the almighty, nourisher and the cherisher of the whole world, who has bestowed knowledge and wisdom endowed to all mankind. Countless salutations on the noble personage of **Hazrat Muhammad** ﷺ, and peace and mercy upon His noble companions' eminent members of family and true followers till the Day of Judgment.

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Tausif Iqbal

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ABSTRACT

This thesis investigates the sustainability of potato farming among contract and non-contract farmers in the Sahiwal Division of Punjab, Pakistan. Potato farming plays a crucial role in the agricultural landscape of Pakistan, and contract farming (CF) has gained prominence due to its potential to provide stability and support to farmers. The study aims to compare the sustainability of contract and non-contract farming practices by examining production processes, resource allocation, market access, and risk management techniques. Data collected from both groups of farmers were analyzed to evaluate the well-being, economic viability, and environmental sustainability of potato farming. The results reveal that contract farming provides several advantages, including better access to resources, improved market stability, and enhanced profitability. Contract farmers demonstrated higher satisfaction with market channels, greater adoption of sustainable practices such as water sprinklers and solar tubewells, and better risk management compared to non-contract farmers. The findings suggest that contract farming can significantly contribute to the sustainability of potato production by ensuring a stable income, reducing risks, and promoting environmentally friendly practices. However, the study also highlights limitations such as the focus on a specific region and the exclusion of other potential factors affecting sustainability. Despite these limitations, the research provides valuable insights for policymakers to promote sustainable agricultural practices and support both contract and non-contract potato farmers in the region.

Keywords: Contract farming, Non-contract farming, potato production, market dynamics, market access, market satisfaction, future perception, profit stability, risk management, agribusiness management, PepsiCo, charcoal, Climate Smart Agriculture (CSA)

CHAPTER 1

1 INTRODUCTION

1.1 Background of the Study

Potatoes are an essential staple crop and a major source of income for many farmers. Pakistan has emerged as a significant contender in global potato production, recently achieving a position among the top ten producers worldwide (Source: FAO - Food and Agriculture Organization). This achievement mirrors a substantial increase in potato cultivation area and advancements in agricultural practices employed by Pakistani farmers. Notably, potato production in Pakistan has experienced a remarkable surge of over 35% within the past three years, solidifying the nation's position as the world's ninth-largest producer of this crucial crop (Hasan, 2024). Nevertheless, despite its significance, approximately 30% of potato production is lost due to ineffective marketing methods (Maqbool *et al*., 2021).

Climate change is changing rainfall patterns, and it is also leading to extreme weather which causes floods and droughts that results in degradation of water and soil quality. Droughts are the cause of water shortage, causing soil to dry out, lose fertility, and an increased soil salinity, while floods can lead to soil erosion and contamination of clean water bodies with pollutants. All these climatic changes pose a risk to sustainability of water resources and degrade the soil quality. Ultimately, effecting the agricultural productivity and food security.

This emphasizes how urgently sustainable farming methods are needed to maintain both the environment and the economy over the long run.

Adoption of CSA (Climate Smart Agriculture) enables the farmers to adapt to the changing climate patterns enabling crop resilience and yield stability. This helps the farmer to provide consistent market supply, which ensures markets satisfaction due to reliable product availability and quality. Also, CSA helps to reduce production costs and risks, ensuring profit certainty for farmers by stabilizing their income and making their operations more sustainable in the longer run. Contract farming is becoming a widely used

agricultural technique that allows farmers and agribusiness companies to work together to grow certain commodities on mutually agreeable terms. This worldwide phenomenon, which dates to the early 20th century, provides stability and support to farmers while guaranteeing a steady supply of agricultural products for a range of sectors (Ncube, 2020).

In Punjab, where a large percentage of the potato crop is grown in multiple growing seasons, contract farming (CF) has emerged as a key component of potato production tactics. According to Khan et al. (2019), the incorporation of contracts into potato farming has improved market efficiency and stability for the potato business, as well as the supply of high-quality potatoes for processing and retail uses. One of the main forces behind the expansion and development of potato farming in Pakistan is CF, which promotes cooperation between producers and consumers. Based on Farooq et al. (2020), this organized system gives farmers the ability to take advantage of market opportunities and contemporary agricultural techniques, which increases yields and improves the quality of produce while also boosting economic success for all parties.

1.2 Contract Farming in Pakistan

Potato CF has become more popular in Pakistan in recent years. Farmers sign contracts with agribusiness companies to produce high-quality potatoes that meet predetermined requirements and quantity (Hassan et al., 2020). This approach, which is especially common in important potato-producing areas like Kasur, Okara, Depalpur, Sahiwal, and Pakpattan in Punjab, has greatly improved the nation's potato production efficiency and market dynamics (Zafar *et al*., 2020). Pakistan's agricultural landscape has changed because of the introduction of potato contract farming, particularly in areas known for potato growing. Specific terms and conditions are established through strategic agreements between farmers and agribusiness businesses to guarantee that the development of targeted potato varieties satisfies demanding quality benchmarks and volume requirements (Hassan *et al*., 2023). These kinds of agreements not only give farmers access to vital resources like better seeds and expertise in the field, but they also ensure a steady market for their produce, which helps farmers reduce the risks associated with farming and create reliable sources of revenue, both of which improve the operations' overall sustainability (Ncube, 2020).

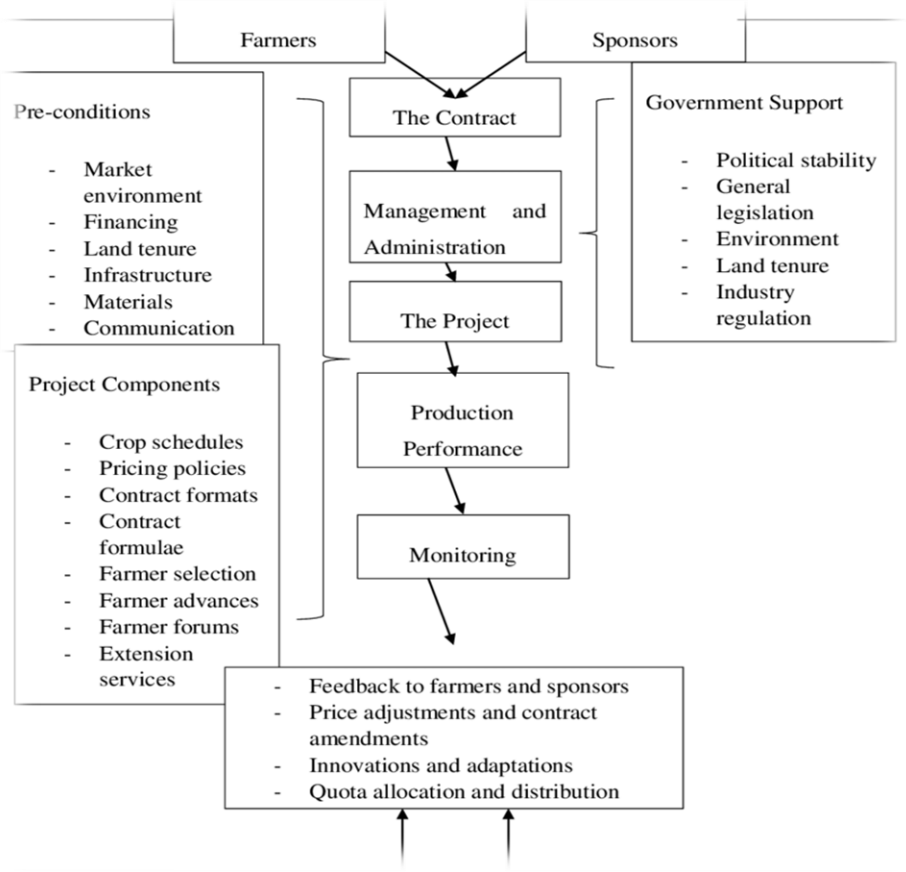


Figure 1: Contract Farming Framework (Source: Ncube, 2020)

Reductions in food insecurity have been linked to increased profitability, revenue, and productivity. Because of the expenses associated with transactions and quality standards, farmer participation in CF arrangements is still a crucial concern. Input, extension services, credit, and linkages to foreign markets for high-value crops were all made available to farmers through CF (Kumar et al., 2014).

1.3 Objectives

1.3.1 Overall Objective

The overall objective of the research was to investigate the role of contract farming in market satisfaction, profit expectation and adoption of CSA among potato farms in Punjab, Pakistan's Sahiwal Division.

1.3.2 Specific Objectives

- To analyse factors affecting potato farmers choice of contract farming in Sahiwal Division
- To assess the influence of contract farming on market satisfaction and profit expectation of potato farmers in Sahiwal Division.
- To assess the influence of contract farming on adoption of climate smart agriculture techniques in potato farmers in Sahiwal Division.

1.4 Rationale of the Study

Farmers frequently experience financial instability and income uncertainty because of the price volatility in conventional agricultural markets, especially considering the present economic difficulties in Pakistan. Research on the beneficial effects of pricing stability on income stability and overall economic resilience in these markets is imperative (Komarek et al., 2020). It is critical to investigate cutting-edge agricultural techniques that can promote sustainable growth considering the difficulties presented by depleting resources. This entails increasing market accessibility, fostering rural development projects, establishing quality control procedures, adopting technology breakthroughs, guaranteeing farmers' income stability, and optimizing resource efficiency. The agriculture industry may contribute to long-term sustainability and adjust to the shifting economic landscape by putting these measures into practice (Gyamfi et al., 2024).

In accordance with certain Sustainable Development Goals (SDGs) that are critical for promoting economic growth and sustainability, contract farming appears to be a viable strategy. Contract farming can serve as a catalyst for promoting positive socio-economic and environmental impacts within the agricultural sector by addressing goals like No Poverty, Zero Hunger, Gender Equality, Decent Work and Economic Growth, Responsible Consumption and Production, Life on Land, and Partnerships for the Goals (Varzakas & Smaoui, 2024).

In view of Pakistan's pricing stability and economic volatility, this study intended to delve deep into how CF can successfully support sustainable agricultural practices and match with these SDGs.

1.5 Scope and Limitations

Through a comprehensive analysis of markets link with profit expectation and adoption of CSA, the study aimed to offer insights into the economic and environmental sustainability of potato production in Sahiwal under contract farming arrangements. The main goal was to provide insightful information that would help inform policy decisions intended to promote sustainable practices for the mutual benefit of the region's potato growers, both contract and non-contract. In Sahiwal Division, Punjab, Pakistan, this study investigated the effect of contract farming on the sustainability of potato production. It attempted to evaluate the well-being of farmers, sustainable resource use practices, and risk management techniques between contract farming arrangements and traditional, non-contract farming methods. Input use, resource allocation, production techniques, pricing methods, marketing tactics, and market access obstacles for both contract and non-contract farmers were also examined in the study. The study is to contribute to policy decisions for promoting sustainable practices for the benefit of potato growers in the region by offering insightful information about the economic and environmental sustainability of potato production under contract farming arrangements in Sahiwal.

However, this study has its own set of limitations, firstly it is a cross-sectional design using data that was gathered at a certain point in time, which might not accurately reflect how dynamic agricultural methods and market circumstances are. Secondly it focuses on the Sahiwal Division in Punjab, Pakistan, which may limit how broadly the results may be applied to other areas. The availability and accuracy of data on farmer well-being, resource usage, and risk management techniques may also pose limitations to the study. Although the study attempts to provide light on the possible advantages of contract farming, it might not fully address the potential challenges and weaknesses associated with this agricultural practice.

CHAPTER 2

2 LITERATURE REVIEW

This chapter aims to give an overview of the previous research. This provides a discussion of both the major conclusions and study limitations from earlier research. This evaluation also identifies the gaps in the body of knowledge, supporting the case for the planned study.

2.1 Definitions of Key Terms

2.1.1 Contract Farming

A method where a farmer consents to grow crops in accordance with the demands of a customer. The buyer may guarantee a price for the crops as well as supply the farmer with inputs such as seeds, fertilizer, or other materials (Ton *et al*., 2018).

2.1.2 Corporate Farming

In a cooperative agricultural system, farmers combine their resources, such as land, tools, and labor, together. As a result, they can share manufacturing and marketing expenses and benefit from economies of scale (Ahmad, 2023).

2.1.3 Market Satisfaction

Market satisfaction is the degree to which the needs and expectations of customers and other market participants are satisfied by the goods or services offered. It includes elements like product quality, pricing, availability, and general customer experience.

2.1.1 Profit Expectation

The term "profit expectation" describes the projected or expected amount of profit that a company or individual hopes to make over a given time frame. It is dependent on variables like anticipated sales, expenses, market dynamics, and economic trends.

2.2 Traditional Output Markets in Pakistan

There are advantages as well as disadvantages keeping in view the traditional market in Pakistan. Traditional markets in Pakistan are dealing with several issues, such as:

2.1.4 Credit Inaccessibility

It's common for traditional farmers to have trouble getting loans from banks or other lenders. Because of this, it could be challenging for them to make commercial investments like buying new machinery or seeds (Sarhad & Agric, 2011).

2.1.5 Markets Inaccessibility

Limited access to markets for farmers' produce is also an issue. This results into their inability to obtain equitable prices for their crops.

2.1.6 Unavailability of Infrastructure

A proper infrastructure, including cold chains, storage facilities, and roads, is sometimes absent from traditional marketplaces. As a result, farmers may find it challenging to properly store and transport their produce to markets as a result.

2.1.7 Information Deficit

Information regarding current technologies, markets, and prices is frequently unavailable to traditional farmers. As a result, they find it challenging to make wise decisions regarding their enterprises.

2.1.8 Absence of Competition

One characteristic of traditional marketplaces is usually their lack of competition. This may increase the purchasing power of customers and make it more challenging for farmers to receive a fair price for their produce (Ahmad et al., 2013). Traditional potato farmers may not feel well because of these issues. They may make it more challenging for farmers to make ends meet, make business investments, and increase productivity. Poverty, food insecurity, and social instability may result from this. Some of the issues traditional potato farmers encounter may be resolved by contract farming. Farmers that engage in contract farming consent to produce crops or raise livestock in accordance with a buyer's instructions. In addition to offering the farmer supplies like seeds and fertilizer, the buyer may also guarantee a price for the crops. Farmers may benefit from having easier access to capital, markets, infrastructure, knowledge, and rivalry as a result.

There are drawbacks to contract farming as well. In addition to having little control over the price or quality of their produce, farmers may be susceptible to exploitation by purchasers. Contract farming also has the potential to worsen social inequality and environmental degradation. For potato farmers in Pakistan, the relative advantages and disadvantages of traditional markets and contract farming vary depending on several factors, including the particular circumstances of the farmers, the commodities they raise, and the markets in which they were involved. To create policies that can enhance the well-being of Pakistani potato farmers, more research is required to have a deeper understanding of these issues.

Role of Markets on Profitability of Crop Dey and Singh (2023) investigated how market involvement affected the well-being of small-scale Eastern Indian vegetable growers. The study concludes that farmers' economic and social well-being is positively impacted by active market activity, based on data from a representative sample and a matching approach. According to their findings, people who participate in the market have greater incomes, consume more, and own more assets than others who participate in it less. Both contemporary and traditional markets benefit farmers' profits. Social networks, credit availability, and education are examples of socioeconomic variables that affect how much profit comes from market participation.

2.3 Farmers Choice of Contract Farming and its Impact on their Output

An overview of the literature on smallholder farmers' motivations for contract farming and the effects it has on them is presented by Dupa (2018). The study reviews the literature to determine the reasons smallholder farmers engage in contract farming and looks at the many effects, both favorable and unfavorable, that contract farming has on their means of subsistence. The author wants to provide readers a thorough grasp of the motivations behind contract farming as well as how it affects smallholder farmers in general. According to the study, farmers were motivated to engage in contract farming by things like market certainty, financial availability, and technical assistance. The assessment does note certain drawbacks, though, such as the possibility of exploitation, unequal power dynamics, and the requirement for a precise and binding contract.

Kumar et al., (2011) investigated the determinants of CF participation and examined the its financial benefits. The study used data of 1,331 producers of pomegranate, okra, and onion producers in Maharashtra, India. Propensity score matching and the 2-Stage Least Squares approach were used in the study to determine whether CF offers smallholders larger returns than independent farmers (14.5 PKR per kilogram). Participation in CF is greatly influenced by variables including personal vehicle ownership, farm size, loan availability, extension services, and migration.

The effect of contract farming on farmers' income along Vietnam's food value chain is examined theoretically and empirically by Zung Hoang (2020) using mixed methods such as focus groups, questionnaires, and interviews. The results show that contract farming increases farmers' income through several channels, including easier access to credit, more options for technical assistance, and increased market share. Furthermore, contract farming minimizes the risks associated with price volatility and variable revenue for farmers. The author also investigates how a variety of elements, including market accessibility, transaction costs, and contract design, affect the financial results for farmers that use contract farming. The study does, however, identify certain limitations, including the possibility of abuse by agriculture companies and the requirement for open and just contract structures.

Another study by Yakubu et al. (2019) uses farm data to investigate how income, resource availability, and general well-being were affected by CF for yam farmers. The findings show that farmers' well-being is impacted by contract farming in both positive and negative ways. Although it makes credit, input, and market opportunities more accessible. But the study also draws attention to certain drawbacks, like difficult financial availability, difficulties fulfilling contractual duties, and unbalanced power relationships between farmers and agribusiness companies.

2.4 Impact of Contract Farming on Income and Profit

The contract farming pattern and income disparity between potato producers growing Atlantic and Granola types were examined by Pramana and Rondhi (2020). The impact of contract farming arrangements is taken into consideration when the study compares the two types of income and other pertinent characteristics. The authors hope to shed light on

the patterns and differences in income that come with contract farming for potato growers. According to the report, potato farmers who engage in contract farming earn more money than those who do not. The study does acknowledge certain limitations, though, including differences in the terms and conditions of contracts, unequal bargaining power, and difficulties in fulfilling the quality criteria set by the contracting firms.

Another study analyzes the factors that influence CF participation among smallholder sunflower growers in Northern Uganda. The socioeconomic traits, market accessibility, and institutional elements that influence smallholder sunflower growers' involvement in contract farming were examined. According to the study, important determinants include market price stability, buyer-farmer trust, and information availability. Notwithstanding, the study recognizes constraints associated with the implementation of contracts such as deficient extension services, and restricted availability of capital and inputs for small-scale producers (Akumu et al., (2020).

Bist et al., (2021) look at a wide range of factors that affect wheat seed production, including market accessibility, agronomic methods, seed availability, and challenges faced by local farmers. The writers want to help farmers overcome their obstacles and increase the output of wheat seeds. The study identified important characteristics like landholding size, credit availability, and the availability of improved seeds. Inadequate irrigation facilities, low seed replacement rates among farmers and lack of technical knowledge can be considered as few of the limitations of this study.

To better understand the effects of contract farming on horticultural farmers in Bandung, Indonesia, Sita and Aji (2018) presents a case study on an intercropping system between tea and horticulture in Gambang Estate. The research investigates the intercropping system's contract farming structure, production methods, market accessibility, and financial results for horticulture producers. The authors hope to shed light on the advantages and efficacy of contract farming in this situation. According to the report, contract farming raises farmers' incomes, lowers production risks, and expands their access to markets and inputs. Nevertheless, the study admits its shortcomings, such as poor farmer education, volatile prices, and difficulties upholding crop quality standards.

Mishra et al., (2018) investigate the effects of contract farming, specifically in a low-income nation, on yield, costs, and profitability in the setting of low-value crops. The study investigates how farmers who grow low-value crops were affected by contract farming in terms of yield levels, production costs, and profitability. The researchers offer evidence-based perspectives on the effects of contract farming in this agricultural environment. Main findings showed that contract farming reduces production costs, positively influences crop yield and improves profitability for farmers. However, certain limitations were highlighted such as the lack of alternative market options, limited access to credit, and the need for effective contract enforcement mechanisms.

2.5 Contract Farming and the Adoption of Climate Smart Agriculture Techniques

In the study by Caroline et al., (2023) the relationship between contract farming and the adoption of sustainable agricultural techniques in Ghana's cashew farming community is examined in this study article. The authors provide strong evidence of how contract farming influences farmers' decision-making process to adopt sustainable practices through the application of an empirical study. According to the study, contract farming can be helpful in promoting the adoption of sustainable farming methods, such as better soil management, water conservation, and less use of pesticides. The authors also point out several important elements, like market-driven incentives, farmer training programs, and financing availability, that support the adoption of sustainable methods. The results highlight the critical role that contract farming plays in advancing sustainable agriculture and strengthening. These insights can be used by stakeholders involved in contract farming arrangements, policymakers, and agricultural extension agencies to help them make well-informed decisions and promote positive change in the industry.

2.6 Impact of contract farming on satisfaction of farmer from the market channel

The study evaluates the impact of contract farming (CF) on the efficiency of wheat growers in Haryana, India. CF adopters were found to be more efficient, but some farmers face financial constraints. CF benefits rural economies but remains contentious.

It improves farmers' income but can lead to unequal preferences, loss of autonomy, and debt. CF reduces production risks and market volatility. The study recommends addressing

challenges and offers insights for effective policy measures. This study addresses the lack of research comparing the production efficiency of contract farming (CF) and non-contract farming (NCF), specifically in Haryana, India. The analysis of 754 wheat growers reveals that CF has higher costs, crop yield, net returns, and benefit-cost ratio compared to NCF. CF adopters demonstrate 16.6% higher technical efficiency than non-adopters. Inputs like land, labor, seeds, fertilizers, and irrigation significantly influence production. CF adopters need to reduce certain inputs to improve output efficiency. CF adoption positively impacts technical efficiency, with adopters experiencing a 16% increase, while non-adopters would benefit by 12%. Large farmers benefit the most from CF, followed by medium farmers and smallholders. Financial constraints were more prevalent than technological or extension constraints. The study recommends involving marginalized and small-scale farmers in CF to enhance their well-being. Addressing concerns such as delayed payments, input availability, and training is crucial for maintaining positive relationships with farmers. Including crop loss compensation in CF contracts and offering insurance would encourage small-scale farmers to participate.

2.7 Farmer–buyer relationships and Risks

The impact of farmer-buyer relationships on the adoption of sustainable agricultural practices within vegetable supply chain in Chile were investigated by Altuna et. al. (n.d.) The main objective was to explore the factors that shape these relationships and their influence on the adoption of sustainable practices. This research highlights how crucial it is to build trusting relationships between farmers and consumers in order to advance sustainable agriculture. It also looks into the function of middlemen and coordination systems in promoting information sharing, cooperation, and knowledge transfer between farmers and purchasers. The results show that long-term contractual agreements, trust, and good communication were important factors that support the adoption of sustainable practices. This research provides insightful information for policymakers, industry stakeholders, and farmers looking to improve sustainable agricultural practices within food supply chains by illuminating the dynamics of farmer-buyer relationships and their importance in fostering sustainability in Chile's vegetable sector.

2.8 Theoretical Framework of the Study

The theoretical framework illustrates the various factors influencing market participation, the choice of marketing outlets, increased farmer income, and the adoption of Climate Smart Agriculture (CSA). Here's how the role of Contract Farming can be interpreted within this framework in relation to market satisfaction, profit anticipation, and CSA adoption:

2.8.1 Demographic Characteristics:

Contract farming agreements can provide stability to farmers of varying demographic backgrounds, particularly those who are older or have larger families. By reducing uncertainty, contract farming can encourage more farmers to participate in the market, regardless of their demographic characteristics.

2.8.2 Socio-Economic Characteristics

Farmers involved in contract farming might have better access to credit and transportation as these are often provided or facilitated by the contracting company. This can improve their socio-economic standing, allowing them to engage more effectively in the market and potentially adopt CSA practices.

2.8.3 Institutional Factors

Contract farming often includes access to institutional support such as training, marketing assistance, and sometimes subsidies. This institutional support can enhance market satisfaction by providing better market access and improved profitability through guaranteed purchase agreements. Additionally, institutions may promote or require the adoption of CSA practices as part of the contract.

2.8.4 Market Factors

The stability offered by contract farming can mitigate market risks such as fluctuating prices or distant markets. This stability can enhance market satisfaction as farmers can anticipate profits with more certainty, which can lead to increased income and potentially motivate the adoption of CSA practices.

2.8.5 Farmer and Specific Characteristics

Contract farming example advise farmers to allocate more land to specific crops, like potatoes in this example, and adopt CSA practices to meet quality or sustainability standards set by the contracting company. The experience gained through these contracts can further improve market participation and income.

2.8.6 Market Participation

By securing a market through contracts, farmers are more likely to participate actively in the market. This participation is influenced by the stable prices and guaranteed market access provided by contract farming, leading to higher levels of market satisfaction and profit anticipation.

2.8.7 Choice of Marketing Outlet

Farmers in contract farming often have limited choices for marketing outlets since they are obligated to sell to the contracting entity. However, this can lead to increased market satisfaction due to reduced uncertainty and stabilized income streams.

2.8.8 Increased Farmer Income

By offering guaranteed prices and a secure market, contract farming can significantly increase farmer income. This increase in income is directly linked to higher profit anticipation and greater financial capacity to adopt CSA practices.

2.8.9 Adoption of Climate Smart Agriculture (CSA)

With increased income and institutional support, farmers are more likely to adopt CSA practices. Contract farming can also include specific requirements or incentives for adopting CSA practices, aligning environmental sustainability with economic benefits.

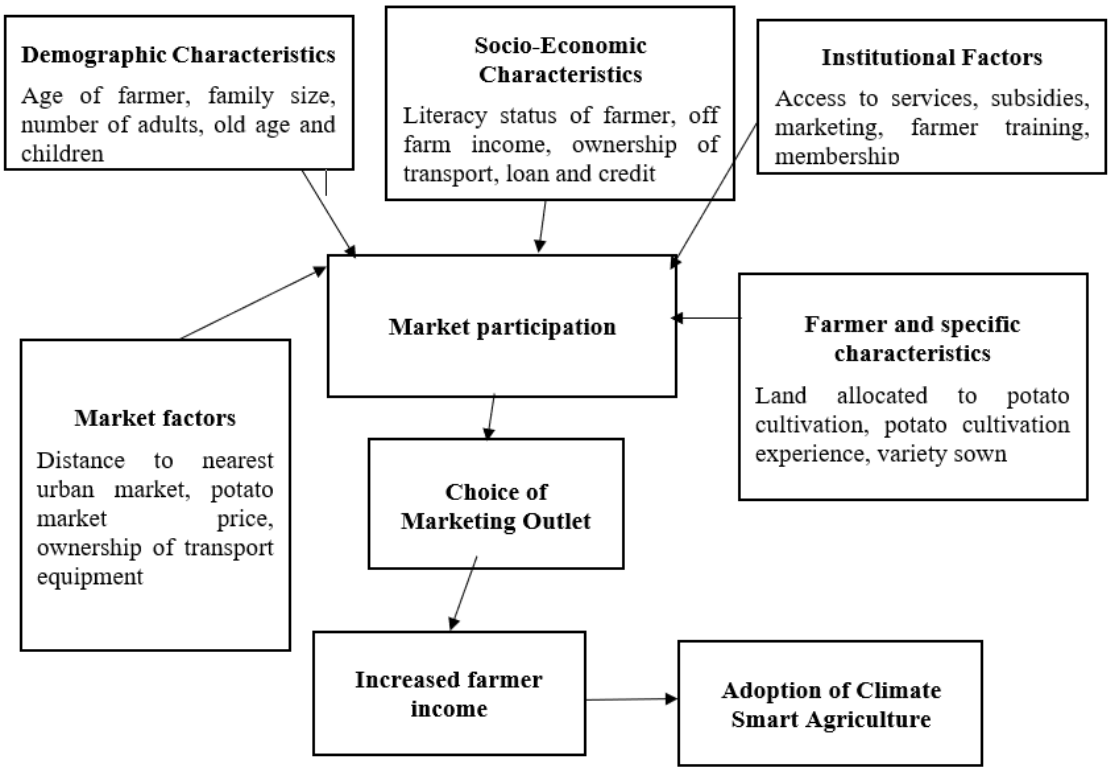


Figure 2 : Theoretical Framework of The Study

CHAPTER 3

3 METHODOLOGY

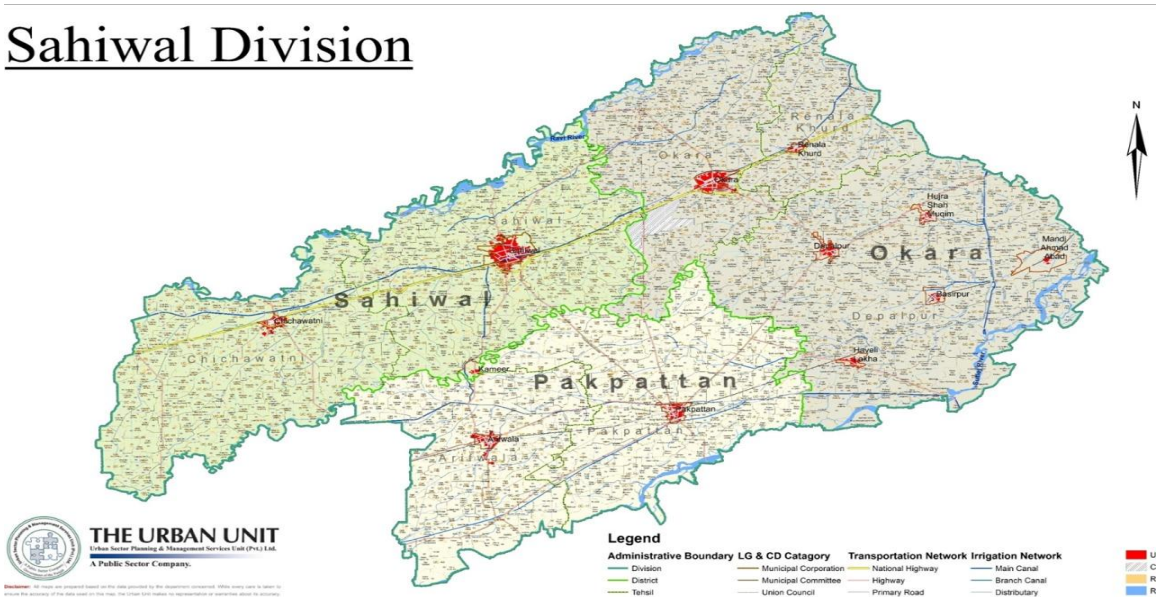
To evaluate the effects of contract farming (CF) on potato farmers' experiences and operations in comparison to traditional market players, this exploratory research used a statistical technique.

3.1 Study Area

Geographically Sahiwal Division is bordered by Faisalabad Division to the west, Lahore Division to the north, Bahawalpur Division to the east, and Multan Division to the south. Sahiwal Division comprises of three districts: District Sahiwal, District Okara and District Pakpattan.

Sahiwal Division was selected as the study area because it is one of the major Potato production areas in Punjab, Pakistan. It has well-developed marketing channels and easy access to the desired sample and data set. Sahiwal Division is known for its agricultural significance. Contributes significantly to Pakistan's economy through its agricultural produce and natural resources.

Figure 3: Study Area Map



Source: Government of The Punjab, Division Insights, Sahiwal Division

3.2 Data Collection

Potato farming households were asked in-person to complete surveys in order to collect comprehensive primary data; each plot was used as the analysis unit.

3.3 Sample Size and Technique

Using random selection techniques, participants were chosen from the general population (non-CF farmers) and contracting firms (CF farmers). This ensured a representative sample and reduced the possibility of bias arising from secondary data sources, which frequently lack individual farmer experiences.

The total sample size for the study was 158 farmers out of which 100 were contract farmers and 58 were non-contract farmers.

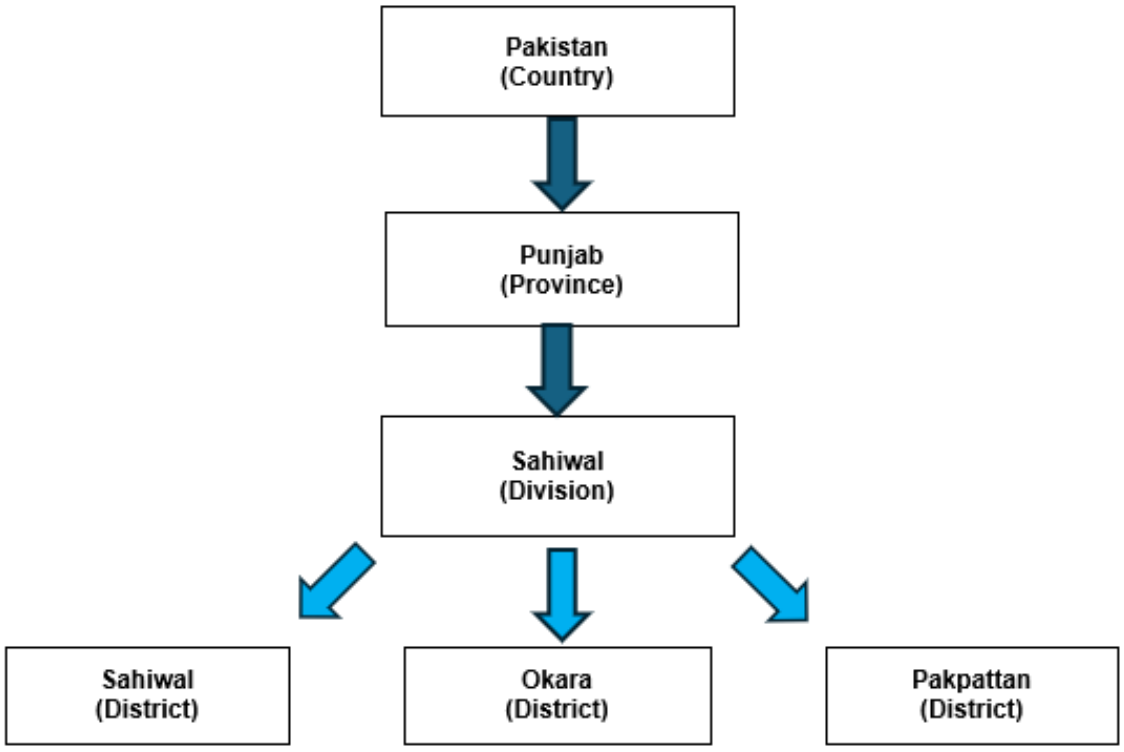


Figure 4: Schematic Diagram for Study Area

3.4 Variables of the Study

The analysis included two sets of variables:

3.4.1 Dependent Variable

A fabricated variable indicating participation or non-participation in the contract program.

Table 1: Dependent variables of the study, their definition and measurement

Variable	Unit	Description
Farmers Choice of contract farming	Contract/Non-Contract	Either contract farmer or non-contract farmers
Farmer satisfaction from market channel	Satisfied/Not satisfied	If the farmer is satisfied from their product selling market channel
Farmer perception about the profitability of future crop	Profitable/Otherwise	The perception of farmer about the future of their crop
Adoption of solar tubewell	Adopted/Not Adopted	If the farmer has adopted solar tube as a mean of climate smart agriculture
Adoption of charcoal as supplement	Adopted/Not Adopted	If the farmer has adopted charcoal for supplement usage as a mean of climate smart agriculture

3.4.2 Independent Variables

Factors influencing participation, such as farm characteristics (land size, distance to market), farmer characteristics (education, age, family size), and farming experience.

Table 2: Independent variables of the study, their definition and measurement

Variable	Unit	Description
Age of the farmers	Years	No. of years of age
Education of farmer	Years	No. of years of education
Experience of farming	Years	No. of years of farming experience
Area owned by farmer	Hectare	Total area owned by the farmer
Area rented-in by farmers	Hectare	Total area rented-in by the farmer
Distance to nearest input market	Km	Distance of farm from the nearest market with agricultural inputs
Training	Yes/No	Farming practices training
Adults in family	No. of individuals	Adult individuals in the family
Members permanent	No. of individuals	Family members who are permanently working on farm
Members temporary	No. of individuals	Family members who are temporarily working on the farm

3.5 Hypothesis

3.5.1 Hypothesis 1

H0= Potato crop profit is statistically same between contract and non-contract farmers

H1=Potato crop profit differs between contract and non-contract farmers

3.5.2 Hypothesis 2

H0= Contract farming does not impact farmers' market satisfaction and profit expectations

H1= Contract farming impacts farmers' market satisfaction and profit expectations

3.5.3 Hypothesis 3

H0= Contract farming and market satisfaction do not impact CSA Adoption

H1= Contract farming and market satisfaction impacts CSA Adoption

3.6 Data Preparation and Overview

3.6.1 Data Entry and Cleaning

Data collected through questionnaires was entered into MS Excel table in which there was each column dedicated to one variable. While data entry each variable was standardized to the standard unit of analysis and the incorrect and inconsistent values were omitted.

3.7 Cost and Profit Measurement

To measure the overall cost for the potato crop different descriptives were used to collect data these include cost of land preparation, seed cost, tubewell irrigation cost, chemical cost (pesticides, fungicides), fertilizer cost, and the cost for transportation to the market. For the calculation of profit earned from the potato crop the descriptives used were the maximum and minimum prices received for all the three varieties of potato grown.

Table 3: Cost and profit measurement descriptives

Variable	Unit	Description
Production cost	PKR / hectare	Cost of land preparation, seed, irrigation, chemical use and fertilizer
Maximum price	PKR / 120 Kg bag	Maximum price received for variety 1,2 & 3 of potato in one season
Minimum price	PKR / 120 Kg bag	Minimum price received for variety 1,2 & 3 of potato in one season
Transportation cost	PKR / hectare	Cost of transportation from farm to market

3.8 Farmer Choice and Perception

In order to estimate the farmer choice and perception about the market channel binary descriptives were used to record the data. These include Farmer choice of market channel, Farmers' satisfaction from the market channel selected, Farmers' perception about the profitability about the future crop that whether their future crop is going to be profitable or not, Farmers' behavior about the adoption of Climate Smart Agriculture (CSA).

Table 4: Farmer Choice and Preference Descriptives

Variable	Unit
Farmer choice of market channel	**(1=Contract Market; 0=Non-Contract market)**
Satisfaction with contract farming marketing	**(1=Satisfied; 0= no)**
Satisfaction with traditional markets	**(1=satisfied; 0= no)**
Future expectation (is potato crop profitable)	**(1=Profitable, 0=otherwise)**
Adoption of Solar Tube well	**(1= adopted, 0 = Not adopted)**
Adoption of Charcoal as supplement	**(1= adopted, 0 = Not adopted)**

3.9 Analytical Framework

The multivariate analysis attempted to identify important factors impacting farmers' choice of a particular market channel source, i.e., (1) Contract market, (2) Non-Contract market. The models of choice among more than two options rest on underlying assumptions about the nature of individual decision-making. The choice models in farming studies are based on the theory that when farmers choose among different alternatives, they derive an indirect utility from each alternative. This indirect utility of each alternative is a function of a vector of the socio-economic factors of the individuals, and a vector of the attributes associated with a particular alternative. A farmer chooses an alternative if perceived utility of that alternative is greater than perceived utility of the rest of alternatives (Sheikh et al., 2003).

Given that the dependent variable (choice of source of groundwater irrigation) was a qualitative variable with multiple levels, the Classical Linear Regression Model (CLRM) could not be used. The binomial logit (Binary Logistic) model was applied instead of CLRM model because Binary Logistic model was more appropriate to model farmers' choice among multiple alternatives (Chuchird et al., 2017; Chunhabunyatip et al., 2018; Jumbe & Angelsen, 2011; Tsinigo & Behrman, 2017). The Binary Logistic model fits this requirement as it is derived from economic theories of utility maximization (Dow & Endersby, 2004).

The variables of interest in the study are Status of the farmer i.e., either CF or NCF, Satisfaction of the farmer from the market channel they are selling their crop produce to, Perception of the of a particular status about the profitability of their future crop and, Adoption of Climate Smart Agriculture (CSA) i.e., adoption of solar tubewell and adoption of charcoal as a supplement for their crop.

The binary logit model was used to analyze the impact of socio-economic and other key determinants on a set of binary dependent variables:

$$Y_i = \alpha + X_i\beta_0 + Z_i\beta_1 + \varepsilon_i$$

Y denotes the binary dependent variable value for ith farmer (such as status, adoption, satisfaction), X_i is a vector of socio-economic variables of the ith farmer, Z_i is a vector of other variables of the ith farmer.

CHAPTER 4

4 RESULTS

4.1 Average cost of production

In order to calculate the average cost of production there was a comparison of the average cost of production for potato crops between contract famers and non-contract farmers, measured in Pakistani Rupees (PKR) per hectare. The data highlights the costs associated with various stages of potato farming, including land preparation, seed purchase, sowing, fertilization, irrigation, chemical use, harvesting, transportation, and packing.

The overall cost of production per hectare is significantly lower for contract farmers whereas non-contract farmers face a higher total cost of PKR 537,645. This suggests that being part of a contract farming agreement may provide cost advantages across various aspects of production, potentially due to access to better resources, subsidies, or economies of scale.

Table 5: Average cost of production

Input (PKR/Ha)	**Contract farmers (n= 100)**	**Non-Contract farmers (n= 58)**
Land preparation cost	22970	20357
Seed cost	181865	235875
Sowing cost	8712	8030
DAP cost	116670	109690
Urea Cost	37907	36850
Tubewell irrigation cost	6132	8945
Chemical use cost	31005	31985
Harvesting cost	38760	32195
Transportation cost	14500	18372
Grading, sorting, cleaning and packing cost	14990	14138
Total Cost	487290	537645

Source: Calculated from authors own data collected in cropping season 2023-24

4.2 Average output price and profit margin

There was a comparison of the average output prices, quantities harvested, total revenue, and total profit per hectare for contract farmers versus non-contract farmers growing potato crops. The data illustrates significant differences in both the selling prices and profitability between the two groups.

For the quantities of the crop harvested, the average quantity harvested of Variety 1 is slightly higher for contract farmers as compared to non-contract farmers. For Variety 2, non-contract farmers harvest more, as compared to contract farmers. In the case of Variety 3, non-contract farmers harvest more than the contract farmers. The contract farmers received a significantly higher price of their produce for all the three varieties grown as compared to the non-contract farmers.

The total revenue for contract farmers is substantially higher at PKR 5,803,200 per hectare, compared to PKR 3,379,960 for non-contract farmers. Total profit also reflects a similar trend, with contract farmers earning PKR 5,315,910 per hectare, nearly double the PKR 2,842,315 earned by non-contract farmers.

Overall, the data demonstrates that contract farmers benefit from higher output prices and ultimately achieve greater revenue and profit per hectare. The higher prices and profit margins suggest that contract farming provides more lucrative opportunities, likely due to better market access, favorable agreements, or premium pricing for produce. Despite non-contract farmers harvesting more of certain varieties, their lower output prices result in significantly lower overall profitability.

Table 6: Average output price and profit

Output Quantity and Price	Contract farmers (n= 100)	Non-Contract farmers (n= 58)
Output price of variety 1 (PKR/120Kg bag)	6480	3599
Output price of variety 2 (PKR/120Kg bag)	9120	4071
Out price of variety 3 (PKR/120Kg bag)	6480	4528
Quantity harvested of variety 1 (120 Kg bag/ha)	275	250
Quantity harvested of variety 2 (120Kg bag/ha)	237	270
Quantity harvested of variety 3 (120Kg bag/ha)	287	305
Total revenue (PKR/ha)	5803200	3379960
Total profit (PKR/ha)	5315910	2842315

Source: Calculated from authors own data collected in cropping season 2023-24

4.3 Farmers Choice of Contract Farming

In evaluating farmers' choice between contract farmers and non-contract farmers, several variables displayed significant differences as per the analysis. Among the factors considered, experience on the farm, farm size, distance to market, education of farmer, total potato income, and the number of family members temporarily working on the farm showed significant differences with p-values of 0.004, <0.001, <0.001, <0.001, <0.001 and, <0.001 respectively. While age and the number of family members permanently working on the farm did not show significant disparities between contract and non-contract farmers, indicating that these aspects are likely consistent irrespective of the contract status.

Table 7: Evaluation of the farmers choice of contract farming

Variables	B - coefficient	P Value
Age of farmer (years)	1.8	0.257
Experience farming (years)	1.9	0.004
Farm size (hectares)	2.0	<0.001
Distance from the input market (Km)	1.3	<0.001
Education (years)	2.3	<0.001
Potato revenue (PKR/season)	1.6	<0.001
Family members permanently working on farm	2.1	<0.001
Family members temporarily working on farm	1.5	0.703
No. of observation (n)	158	

Source: Calculated from authors own data collected in cropping season 2023-24

4.4 Perception of Farmer about Profitability of Future Crop

Farmers' perception of future crop profitability was analyzed using factors like age, experience, farm size, distance to market, education, income from potatoes, and socioeconomic status. Lower scores indicate stronger significance. Area owned, distance to market, education, potato income, and socioeconomic status had highly significant influences. Age and farm experience were less significant.

Table 8: Factors impacting farmer's perception of future crop profitability

Variables	B - coefficient	P value
Age of farmer (years)	1.2	0.257
Farming experience (years)	8.1	0.004
Farm size (hectare)	5.2	<0.001
Distance from the input market (Km)	4.4	<0.001
Education of farmer (years)	8.5	<0.001
Potato revenue (PKR/Hectare)	1.5	<0.001
Farmers having training (Yes/No)	2.1	0.003
Status of farmer (Contract/ Non-Contract)	8.2	<0.001
No. of Observations (N)	158	

Source: Calculated from authors own data collected in cropping season 2023-24

4.5 Satisfaction of Farmer from Market Channel

Using binary logistic regression satisfaction of farmer from market channel were analyzed. Variables included age, experience, farm size, distance to market, education, technical training of farmer, potato income, and socioeconomic status. Lower scores indicate stronger influence. The analysis revealed significant impacts from farm size, distance, education, potato income, and socioeconomic status. Strong significant levels were shown by the following variables: farm size, distance from market, education of farmer, technical training of farmer, total income from potato, and socioeconomic status. Nevertheless, variables like age were found to be less significant or not significant factors in shaping the farmers' perceptions.

Table 9: Factors impacting satisfaction of farmer from market channel.

Variables	B - coefficient	P value
Age of farmer (years)	1.6	0.257
Farming experience (years)	6.2	0.004
Farm size (hectare)	4.0	<0.001
Distance from the input market (Km)	1.4	<0.001
Education of farmer (years)	5.0	<0.001
Potato revenue (PKR/Hectare)	3.2	<0.001
Farmers having training	3.5	<0.001
Status of farmer (Contract/ Non-Contract)	5.0	<0.001
No. of observations (N)	158	

Source: Calculated from authors own data collected in cropping season 2023-24

4.6 Adoption of Charcoal as Supplement

The analysis of adoption of charcoal as a supplement in the study presented significant findings with respect to several variables amongst the farmers surveyed. Farm size, distance to market, education of farmer, and total potato income, technical training of farmer all had significant positive associations with adoption. This suggests larger farms, closer proximity to markets, higher education levels, greater potato income and technical

training of farmer were linked to charcoal adoption. Interestingly, the age of the farmer did not significantly influence adoption.

Table 10: Factors impacting adoption of charcoal as supplement.

Variables	B-Coefficient	P - Value
Age of farmer (year)	3.1	0.076
Farming experience (year)	7.3	0.007
Farm size (hectare)	4.9	<0.001
Distance from the input market (Km)	7.2	0.007
Education of farmer (year)	2.6	<0.001
Potato revenue (PKR/Hectare)	6.9	<0.001
Training of farmer (Yes/No)	2.3	<0.001
Status of farmer (Contract/ Non-Contract)	6.8	<0.001

Source: Calculated from authors own data collected in cropping season 2023-24

4.7 Adoption of Solar Tubewell

The statistical analysis conducted to determine the factors influencing the adoption of solar tubewells reveals significant variability in factors such as education, total income from potato farming, technical training of farmer and the status of the farming household. The values obtained, specifically for farm size, education, total income from potato farming, and socioeconomic status, were highly significant with p-values less than 0.001. This suggests that these factors play a crucial role in the decision to adopt solar tubewells in the area under study. In contrast, variables like age, experience in farming, and distance to the market, demonstrated higher p-values, indicating a weak or non-significant impact on the adoption of solar technology.

Table 11: Factors influencing the adoption of solar tubewells.

Variables	B - Coefficient	P - value
Age of farmer (year)	0.2	0.616
Farming experience (year)	2.5	0.110
Farm size (hectare)	2.5	<0.001
Distance from the input market (Km)	2.7	0.099
Education of farmer (year)	2.2	<0.001
Potato revenue (PKR/Hectare)	7.6	<0.001
Training of farmer (Yes/No)	9.0	0.002
Status of farmer (Contract/ Non-Contract)	1.4	<0.001

Source: Calculated from authors own data collected in cropping season 2023-24

CHAPTER 5

5 DISCUSSION

The significant differences in variables among contract and non-contract farmers suggest distinct and socio-economic patterns. Contract farmers likely have more experience, higher education levels, greater land ownership, and higher total potato income, indicating that they may be more skilled, better connected to markets, and more resource-endowed. The requirement for more temporary farm labor among contract farmers highlights the intensive management and larger scale of contract farming operations compared to non-contract farming. These findings emphasize the potential influence of these factors on agricultural policies and rural development initiatives targeting farm communities, underscoring the importance of considering the various dynamics at play in contract versus non-contract farming scenarios.

The notable findings draw attention to the elements that have a major impact on farmers' future crop profitability. The socioeconomic status (status), which reflects one's ability to acquire resources and manage finances, has been identified as a significant predictor of farmers' hopeful outlook. Total Income from Potatoes indicates how past performance affects expectations for future profitability, whereas Education and Total Area Owned highlight the significance of knowledge and scale in favorably impacting perceptions. One of the most important factors in cutting expenses, improving productivity, and increasing profitability possibilities is distance from the market. However, factors like age and family members who work on the farm permanently have less of an impact, suggesting that they will have less of an influence on how profitable people perceive the future to be. In order to improve farmers' expectations for the future, the findings recommend measures that support socioeconomic position, education, market access, and successful income experiences.

Both the farmer's perception of the profitability of future crop factors and their degree of satisfaction from the market channel showed very similar results, with comparable outcomes and the same significant level. Farmers' satisfaction with market channels and their expectations for crop profitability in the future appear to be strongly correlated, as

suggested by the parallel significant levels, which suggests that variables affecting one may also have an impact on the other. This alignment emphasizes how farmers' attitudes and decisions were shaped by their perceptions of profitability and market satisfaction in the setting of agriculture.

The findings indicated that use of charcoal as a farming supplement has been significantly influenced by economic and educational factors. Greater cash input and risk tolerance may be reflected in larger farms, which makes it possible to use cutting-edge techniques like adding charcoal to the soil to improve its quality. The importance of distance to market highlights the economic analysis that farmers may make before implementing new methods, considering the logistics and possible market prospects. Education is a vital element because it implies that adoption may be influenced by knowledge and understanding of the advantages of charcoal, highlighting the critical role that agricultural education and extension services play in promoting sustainable practices. The insignificance of the permanency of family labor suggests that the decision to adopt innovative practices like charcoal supplement might not depend solely on available labor but rather on the economic and educational standing of the farm operator, which aligns with the significant roles indicated by farm size, education, and income. This underscores that interventions aimed at boosting sustainable farming practices might need to consider multifaceted approaches that encompass financial, educational, and logistical support to effectively enhance adoption rates among farmers.

Important variables impacting the uptake of solar tubewells were revealed by the significant findings for status, education, and total revenue from potato cultivation. Farmers with higher education levels are probably more knowledgeable about and open to new technologies, such as solar tubewells. Greater investment capacity is made possible by increased farming income, which may encourage adoption. Furthermore, the relevance of 'Status' highlights how crucial socioeconomic status is for adopting new technologies. These results highlight the need to concentrate on income production, socioeconomic empowerment, and educational outreach to encourage farming communities to adopt sustainable agricultural technologies such as solar tubewells.

CHAPTER 6

6 CONCLUSIONS AND FUTURE RECOMMENDATION

In summary, this study provides insightful information about factors that affect farmers' perceptions of crop profitability in the future, market satisfaction, and the uptake of contemporary agricultural technologies. The findings demonstrated the important influence of socioeconomic, educational, and economic aspects on farmers' decision-making procedures and operational results. Several important variables that shape many elements of agricultural practices have been identified, including education level, total income from potato growing, farm size, distance to market, and socioeconomic position. The results show the intricate interactions among these variables that shape farmers' decisions, and the necessity of focused interventions aimed at resolving these complicated dynamics in order to advance sustainable farming methods and raise total agricultural productivity.

6.1 Recommendations

Future opportunities for improvement lie in creating customized interventions that target the significant variables that have been found, building on the knowledge gained from this study. Policies that support sustainable farming methods ought to give priority to programs that improve farming communities' socioeconomic empowerment, income creation, and educational opportunities. Additionally, increasing agricultural output and enhancing general livelihoods can benefit from initiatives to close the gap between market dynamics and farmers' needs. Future studies could focus further on comprehending the complex relationships that exist between technological adoption, educational empowerment, and economic forces in order to improve farming practices' resilience and sustainability in changing agricultural environments. Policymakers, agricultural extension services, and industry stakeholders can collaborate to promote a more sustainable and diverse agricultural sector that benefits farmers and the public by utilizing these findings.

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Dr. Sobia Asghar
Assistant Professor
Dept of Plant Biotechnology (Agri Business)
Atta-ur-Rahman School of Applied Biosciences (ASAB), NUST, Islamabad

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By

Tauslf Iqbal

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