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ECOLOGICAL FARMING SYSTEMS IN EUROPE COMPARING TO EXISTING ECO-FARMS IN PAKISTAN

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DEPARTMENT OF LANDSCAPE ARCHITECTURE

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M.Sc. THESIS

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Approval

We certify that we have read the thesis submitted by FARAH YASEEN titled **"ECOLOGICAL FARMING SYSTEM IN EUROPE COMPARISON TO EXISTING ECO FARMS IN PAKISTAN"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Landscape Architecture.

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Declaration

I therefore certify that all data, records, analysis and findings in this thesis were gathered and presented in compliance with the Near East University Institute of Graduate Studies' academic and ethical criteria. I further declare that I have properly referenced and cited any data and material that are not unique to this work, as required by these guidelines and code of conduct.

Farah Yaseen

18/June/2024

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Abstract

This study compared established ecological farming systems in Europe with the agricultural practices, challenges as well as significance for the future of ecological farming in Pakistan. In order to comprehend how Pakistani eco-farms may benefit from and improve upon European ecological farming methods in terms of production and sustainability served as the driving force behind the study. The research utilized a mixed method approach by using both qualitative and quantitative data collection methods. Hence, to acquire better understanding of the experience and practices of 100 ecological farmers in Pakistan, survey questionnaires were given to them. While the qualitative data from the interviews were thematically assessed to identify essential patterns and themes, the data collected was examined through descriptive statistics. Ecological farming approaches that promote more biodiversity, soil health, and fewer chemical inputs, such as crop rotation, cover crops, agroforestry, and integrated pest management among others, were widely used. Farmers faced several challenges such as water scarcity, pressure from pest and disease as well as limited access to organic inputs. To address these problems sustainable water management methods including drip irrigation was vital. Drip irrigation helped managed water resources efficiently, mitigating the issue of water scarcity. Additionally, practices like crop rotation, cover crops, as well as agroforestry were extensively used to promote biodiversity and soil health while reducing reliance on chemical inputs. Integrated pest management strategies were also essential in managing pest and disease pressure. Overall, sustainable approaches like drip irrigation, crop rotation and integrated pest management were crucial in overcoming the key obstacles faced by farmers. Similar to European farms, Pakistani eco-farms demonstrated an outstanding dedication to sustainable practices but they lack technology development and institutional backing. This thesis made various recommendations such as strengthening education, gender equity, funding R&D, spreading market accessibility, endorsing legislative measures as well as implementing sustainable land management methods. These initiatives which are modeled after European agricultural methods, have the possibility to strengthen Pakistani ecological farming’s expansion as well as sustainability while also enhancing its food systems.

Keywords: ecological farming, sustainability, biodiversity, water management

AVRUPA'DA EKOLOJİK TARIM SİSTEMİNİN PAKİSTAN'DAKİ MEVCUT EKO ÇİFTLİKLERLE KARŞILAŞTIRILMAS

Farah Malik

Temmuz 2024, 76 sayfalar

Soyut

Bu çalışma, Avrupa'daki yerleşik ekolojik tarım sistemlerini tarımsal uygulamalar, zorluklar ve Pakistan'daki ekolojik tarımın geleceği açısından önem ile karşılaştırmıştır. Pakistan eko-çiftliklerinin üretim ve sürdürülebilirlik açısından Avrupa ekolojik tarım yöntemlerinden nasıl yararlanabileceğini ve geliştirebileceğini anlamak, çalışmanın arkasındaki itici güç olmuştur. Araştırmada hem nitel hem de nicel veri toplama yöntemleri kullanılarak karma yöntem yaklaşımı kullanılmıştır. Bu nedenle Pakistan'daki 100 ekolojik çiftçinin deneyim ve uygulamalarını daha iyi anlamak için onlara anket anketleri verildi. Görüşmelerden elde edilen nitel veriler, temel kalıp ve temaların belirlenmesi amacıyla tematik olarak değerlendirilirken, toplanan veriler betimsel istatistiklerle incelenmiştir. Daha fazla biyoçeşitliliği, toprak sağlığını ve daha az kimyasal girdiyi destekleyen ürün rotasyonu, örtü bitkileri, tarımsal ormancılık ve entegre haşere yönetimi gibi ekolojik tarım yaklaşımları yaygın olarak kullanıldı. Çiftçiler su kıtlığı, haşere ve hastalıklardan kaynaklanan baskı ve organik girdilere sınırlı erişim gibi çeşitli zorluklarla karşı karşıya kaldı. Bu sorunları çözmek için damla sulama da dahil olmak üzere sürdürülebilir su yönetimi yöntemleri hayati önem taşıyordu. Damla sulama, su kaynaklarının verimli bir şekilde yönetilmesine yardımcı olarak su kıtlığı sorununu hafifletti. Ek olarak, ürün rotasyonu, örtü bitkileri ve tarımsal ormancılık gibi uygulamalar, kimyasal girdilere olan bağımlılığı azaltırken biyoçeşitliliği ve toprak sağlığını geliştirmek için yaygın olarak kullanıldı. Zararlı ve hastalık baskısının yönetilmesinde entegre zararlı yönetimi stratejileri de önemliydi. Genel olarak damla sulama, ürün rotasyonu ve entegre haşere yönetimi gibi sürdürülebilir yaklaşımlar, çiftçilerin karşılaştığı temel engellerin aşılmasında çok önemliydi. Avrupa çiftliklerine benzer şekilde Pakistan eko-çiftlikleri de sürdürülebilir uygulamalara olağanüstü bir bağlılık sergilediler ancak teknoloji geliştirme ve kurumsal destekten yoksunlar. Bu tez, eğitimin güçlendirilmesi, cinsiyet eşitliği, Ar-Ge finansmanı, pazar erişilebilirliğinin yaygınlaştırılması, yasal önlemlerin onaylanması ve sürdürülebilir arazi yönetimi yöntemlerinin uygulanması gibi çeşitli önerilerde bulunmuştur. Avrupa tarım yöntemlerini örnek alan bu girişimler,

Pakistan'ın ekolojik tarımının genişlemesini ve sürdürülebilirliğini güçlendirmenin yanı sıra gıda sistemlerini de geliştirme olanağına sahip.

Anahtar Kelimeler: ekolojik tarım, sürdürülebilirlik, biyolojik çeşitlilik, su yönetimi

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CHAPTER I

Introductıon

1.1 Background of the Study

Organic agriculture is a notable solution to the pressing need to boost yields while limiting environmental effect. Organic agriculture is recognized by both consumers and legislators as a potential solution. The output of organic farming has grown from 15 million hectares in 2000 to over 773 million hectares now, even though it still accounts for less than 2% of total agricultural land (California Air Resource Board, 2022). Though it still accounts for a very small percentage of total agricultural land worldwide, organic farming has seen substantial growth. Customer demand and regional and legislative initiatives such as European Unions' Farm to Fork plan and the California Air Resources Board's efforts to become carbon neutral have both contributed to this growth (California Air Resource Board, 2022).

According to the study of Larsen et al., (2024) the objective of organic agriculture that is characterized by a rejection of persistent as well as environmentally hazardous pesticides, herbicides along with genetically engineered seeds, is to enhance environmental conditions, specifically soil and water quality. This strategy often leads to species composition changes in organic fields that are advantageous to beneficial organisms like natural enemies that fight pests. Therefore, a reduction in chemical pest control may also result in an increase in insect population that disperse over the surrounding area, generating a complex ecological dynamic.

According to Schurings et al., (2024), organic agriculture has ecological implications that affect the whole agricultural landscape in addition to the management of individual fields. Hence, behavioral and economic factors involve the competition among surrounding landowners to use the least quantity of pesticides that highlight the interconnection of agricultural methods and their impacts (Salat-Molto et al., 2023)

Understanding the ecological agriculture system requires measuring its effects on environmental outcomes, pesticides use as well as pest management. It also includes investigating any variation in these impacts (environmental outcomes and pesticide use), based on the kind of field and pesticides usage methods (Alignier et al., 2020).

The research focuses on Kern Country, California, a well-known crop production and pesticide using region in the United States, 2018, the Kern country recorded over $7.4 billion in agricultural productivity, reflecting the production of several high value crops like carrots, lettuces, almonds and grapes. The analysis is based on filed level data totaling approximately 7300 observations of organic fields and 91,000 observations of conventional fields, covering the years 2013 through 2019. Hence, this translates to approximately 14,000 allowed fields annually. Kern country, California offers an intriguing case study which illuminates the broader national implications of organic agriculture because of its significance agricultural output and pesticide use (California Air Resource Board, 2022).

The transition to a more sustainable form of agriculture has been given major attention by the European Union. The Farm to Fork strategy seeks to establish a food system that is safe as well as nutritious, can adapt to climate change, reverses the loss of biodiversity, and is environmentally neutral or positively influenced. Furthermore, the common Agriculture Policy (CAP) intends to assist efficient natural resource management in order to lower the consequence of climate change, stop and reverse biodiversity loss, enhance ecosystem services and protect habitats and landscapes. Either way, adopting more sustainable agricultural practices by EU farmers is crucial to realizing these goals (Thompson et al., 2024).

According to the study of Thompson, et al., (2024) Agricultural economists have long been interested in understanding the reasons that lead to the adoption of ecological practices, which are seen to have benefits for the environment, economy, and society. As a result, a large body of research has been written on the topic. Three significant weaknesses exist in recent assessments of this material.

Firstly, a lot of evaluations are topically limited because they focus on contractual adoption, like EU Agri-environment programs, or they assess the adoption of a limited set of practices, such organic farming, nutrient and soil management methods, or precision technology. Second, the range of factors is limited. While some reviews focus primarily on farm and farmer characteristics, others only include behavioral variables. Thirdly, a large number of narrative reviews exist, with some concentrating solely on noteworthy findings and very few adhering to a review procedure or performing a meta-analysis. All in all, this indicates that it is challenging

to obtain a comprehensive evaluation of the evidence about the characteristics that are consistently found to be significant variables in the adoption of ecological practices, or that are significant for some practices but not for others (Thompson et al., 2024).

1.2 Aim of the Research

The aim of this study is to present a comparison between the ecological farming systems that are currently used in Europe and Pakistan. Using an examination of the resemblance, differences, challenges and prospects between these two environments, the study aims to clarify critical factors impacting the uptake and prosperity of ecological farming systems in different agricultural contexts. By identifying strategies and treatments influenced by the best practices and experiences, the study ultimately seeks to improve sustainable agriculture in Pakistan.

1.3 Research Question and Objectives

1. What ecological agricultural techniques are most commonly used by farmers in Europe and Pakistan?
2. How are pests, diseases, water supplies and soil fertility managed by ecological farmers in Europe and Pakistan?
3. What are the challenges ecological farmers in both regions (Europe and Pakistan) encounter, and is there a difference between the two?
4. What marketing technologies are used by European and Pakistani ecological farmers?
5. What practices and lessons from ecological farming systems in Europe could be useful for Pakistani ecological farmers?
6. What opportunities do Pakistani ecological farmers see for the development of ecological farming in their area?

1.4 Significance of the Study

This study is significant because it can fill in important knowledge gaps as well as guide policy and practice regarding the ecological farming systems in Pakistan. This research will to produce insightful findings and recommendations for advancing sustainable agriculture in the area by comparing ecological farming systems in Europe with currently operating eco farms in Pakistan.

The Food and Agriculture Organization (FAO) states that ecological farming as well as other sustainable agriculture methods are crucial to ensuring food security

and reducing the effects of climate change. Policymakers can create focused policies and interventions by knowing the factors impacting the uptake and effectiveness of ecological agricultural methods in Pakistan and Europe. By 2020, more than 15%of EU agricultural land will be farmed organically, as a result of the Common Agriculture Policy's (CAP) growing emphasis on promoting agro ecological techniques on the continent (Morepje, et al., 2024).

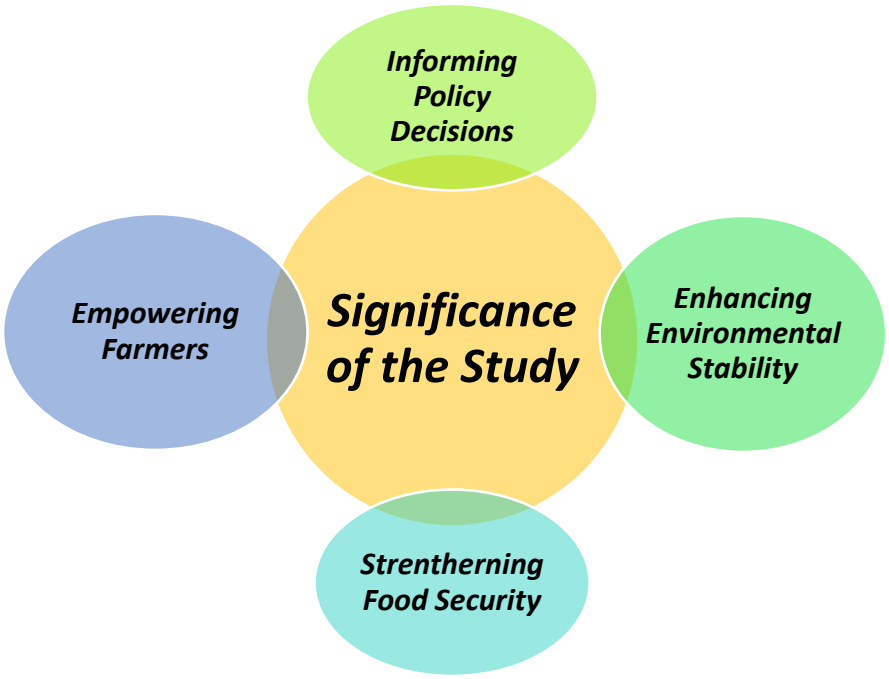
In Pakistan, where over 40% of the population works in agriculture, smallholder farmers make up a sizable share of the labor force in the sector. However, they struggle with issues like diminishing soil fertility as well as water scarcity. These farmers stand to gain from ecological farming in the form of better soil health, lower input costs, along with diverse revenue streams. Ecological farming techniques can lower greenhouse gas emissions by up to 48% while enhancing yields by up to 79% (Morepje, et al., 2024).

Traditional farming systems can exacerbate environmental degradation in Pakistan. For example, soil erosion affects more than 80% of Pakistan's agricultural area. Chemical pesticides and fertilizers contaminate water sources, harming human health and biodiversity. An all-encompassing strategy for agriculture that places an emphasis on environmental sustainability is ecological farming. This research can help mitigate environmental problems and encourage the conservation of natural resources by encouraging the use of ecological farming methods (Kwapong, et al., 2024).

Pakistan has a problem with food security. About 18% of the population is undernourished. By boosting agriculture resistance to climate change, improving yield stability as well as encouraging the development of a variety and nutrient dense food, ecological farming has the potential to enhance food security. Agroforestry systems are common ecological farming methods that can enhance crop productivity by up to 128% when compared to monoculture systems (Kwapong et al., 2014)

Figure 1:

Significance of the Study (Kwapong et al., 2024)



CHAPTER II

Literature Review

2.1 Ecological Farming system

The proportions of elements utilized by farms will naturally alter as farming moves toward low-input farming. In this article's first section, we'll concentrate on how low-input farming methods—that is, ecological farming approaches—may change farm labor returns. Determining how policies that support the adoption of ecological techniques affect economic returns to labor is crucial from a policy perspective. The use of ecological practices varies greatly throughout farms, though, and socioeconomic results might differ greatly between conventional and highly ecological farming (Davidova et al., 2022).

This study examines the literature on the adoption of ecological practices that are voluntary and non-contractual from 2010 to 2022. In order to address a specific research issue, a systematic strategy finds empirical data that satisfies predetermined inclusion criteria (Snyder, 2019). In the context of this review, this entails locating the data that supports the impact of formal institutional, behavioral, and social factors in addition to farm structural and sociodemographic factors on the adoption of ecological practices. This is accomplished by employing a vote-count technique to determine the frequency with which a given variable has been included as an independent variable in adoption studies and the frequency with which that variable has been determined to be significant at the 5% level. Additionally, the scope of independent variable studies is broadened, providing a comprehensive analysis of the data. This enabling us to group them according to their significance and frequency of inclusion. We further break down these results according on the kind of practice and whether adoption of a new farming system, several practices (intensity), or single practices was taken into consideration (Borges et al., 2019).

Narrative reviews have shown to be helpful in covering the diverse literature on the adoption of ecological practices. The constraints of rational actor models (Carlisle, 2016) and the impact of particular types of factors, like behavioral factors (Dessart et al., 2019), have been emphasized recently. However, narrative studies lack a solid evidence base upon which to plan future research or formulate policy, as

evidenced by their description of only important results (Dessart et al., 2019) or lack of use of a systematic approach (Carlisle, 2016).

Climate change, biodiversity loss, and environmental degradation are mostly caused by food systems. High yields of food and feed production in Europe and other developed nations have come at the expense of serious ecological damage, including greenhouse gas (GHG) emissions, biodiversity loss on agriculture, and deterioration of air and water quality due to pesticide and nitrate use. 10% of all greenhouse gas emissions in Europe are thought to come from the agricultural sector, with 70% of those emissions coming from the production of cattle (Gur and Zamir, 2004).

In response, the European Commission introduced the Farm-to-Fork (F2F) and Biodiversity Strategy towards 2030 under the context of the Green Deal. Among these are goals to lessen the effects of the food system on the environment while promoting the shift to food systems that are healthier, more sustainable, and equitable. The use of mineral fertilizers and pesticides is to be significantly reduced, and more ecologically friendly agricultural methods and farm management systems are to be adopted. These policies will need to be integrated and supported by the upcoming Common Agricultural Policy (CAP) 2023–2027, which will oversee a budget of 270 billion euros to support European farmers while pursuing ambitious environmental goals, even though they are not legally enforceable (Rega et al., 2022).

Ecological farming is essential to adapt to drought. Plants have evolved natural drought-resistance mechanisms over millions of years, with water shortage acting as the primary growth limitation. These systems, which range from improved root development to regulation of leaf water loss, are intricate and multifaceted. Breeding crops under perfect, well-watered environments frequently results in the loss of characteristics that allow the crop to survive on less water. The variety of plant characteristics that can survive with little water in industrially farmed crops has decreased in the rush to create greater industrial monocultures powered by agrochemicals and extensive irrigation. Nonetheless, wild relatives and agricultural types continue to exhibit this variability. For instance, even under drought-stricken conditions, scientists were able to achieve more than 50% greater yields by utilizing the diversity of wild relatives of farmed tomatoes (Gur and Zamir, 2004).

2.2 Implementation of Ecological Farming systems in Europe

Reduced Tillage

A research conducted among European organic farmers revealed that 89% of them used decreased tillage as a conservation agriculture technique. Lowering the mechanical disturbance of the soil by less tillage helps to maintain soil moisture, biodiversity as well as structure while lowering erosion and loss of carbon (Bilibio et al., 2023).

According to the study Pohlitz et al., (2024) grain yield did not significantly change as a result of tillage during the crop rotation. Reduced tillage (RT) typically had the best returns in 2018 and 2019, but the lowest yield in 2020. There were no discernible changes between the tillage variations in terms of additional crop attributes (not shown), such as protein content, crop density, spiked stalks, grain weight, grains per ear, or pods per plant.

Table 1:

Yields (dt ha−1) for summer barley (2018), winter wheat (2019/2020), and winter oilseed rape (2018/2019) under three different tillage systems: conventional (with plow, CT), conventional-reduced tillage (CRT), and reduced tillage with cultivator (RT). (Pöhlitz et al., 2024)

Tillage System	Summer Barley	Winter oilseed rape	Winter wheat
CT	75+5	31+4	129+4
CRT	76+3	32+4	132+8
RT	79+5	33+2	123+10

No Tillage

Around 27% of the farmers questioned used no tillage that was less prevalent than reduced tillage. By growing crops without disturbing the soil, a practice known as no tillage, erosion is decreased, water infiltration as well as retention are improved, and soil structure and organic matter are preserved (Bilibio et al., 2023).

Table 2:

Area under No Tillage by Continent (Li et al., 2023)

Continent	Area (ha)	Percent of total (%)
South America	49,579,000	46.8
North America	40,074,000	37.8
Australia & New Zealand	17,162,000	11.5
Asia	2,530,000	2.3
Europe	1,150,000	1.1
Africa	368,000	0.3
World total	115,863,000	100

Other non-inversion tools are commonly used in place of mouldboard ploughs for the cultivation of row crops, primarily potatoes (Solanum tuberosum L.) and maize, as well as for the addition of cover crops. Field trial data and farmers' experiences to date indicate that reducing deep plowing can improve soil quality and yield without having a detrimental effect. Khan et al., (2024) broke up a two-year clover grass ley and utilized the moldboard plough (20 cm depth) three times in a seven-year cycle for winter rye (Secale cereale L.) and winter wheat (Triticum aestivum L.) (Bilibio et al., 2023).

Green Manures

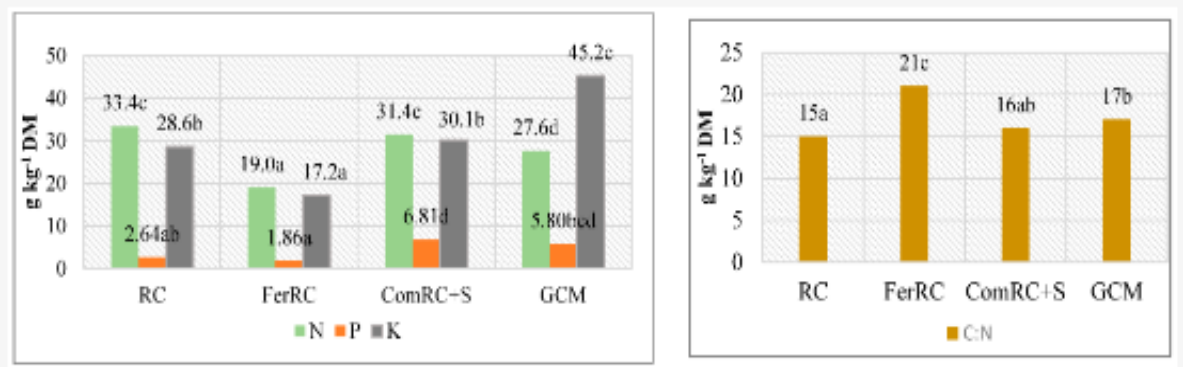
Of the farmers polled, 74% used green manures, growing particular cover crops mostly legumes or grasses and adding them to the soil are the methods known as green manures, that increases fertility of soil, prevent weed growth and improve soil structure as well as activity of microbes (Toleikiene et al., 2024).

The pace of breakdown is predetermined by plant material alone. The primary biotic variables are the chemical and physical properties of the straw, such as its lignin to N ratio, nutritional content, C: N ratio, and concentrations of cellulose, hemicellulose, and polyphenols. Furthermore, the chemical characteristics of plants influence the metabolism of decomposers and govern community functioning. Legume residues with lower C: N ratios decompose more quickly than cereal residues, but they also produce more dry matter and are absorbed by the next crop. On the other hand, legume mass breakdown occurs quickly with a very narrow C: N ratio. Within the first 2.5 months of being incorporated into the soil, red clover decomposes

extremely quickly, whereas other crops disintegrate more slowly over the next 2.5 to 26 months (Toleikiene et al., 2024).

Figure 2:

The employed green manures' chemical makeup and C: N ratio (Toleikiene et al., 2024)



Crop Rotation

The majority of the farmers used crop rotations that last six years on average. Hence, crop rotation is an essential ecological farming method that includes growing different crops in succession on the same plot of land or area in order to strengthen nutrient cycling, reduce insect and disease pressure as well as promote soil health.

Schieler et al., (2024) stated that as a model species, we employed the pea moth (Cydia nigricana, Lepidoptera: Tortricidae). Pea moths have the ability to seriously harm pea seeds (Pisum sativum, Fabaceae), which reduces yield and quality. In the soil of former pea areas, the model species overwinters as the fifth instar. Attracted by the scent of pea blooms, the adults come out in the spring and look for fresh pea locations. Previous research concentrated on the minimum crop rotation distance (MD) of pea moths, which indicates the separation between previous year's afflicted pea locations and this season's. For instance Schieler et al., (2024), found that a 500 m MD for green peas had a favorable impact on a decline in pea moth infestation.

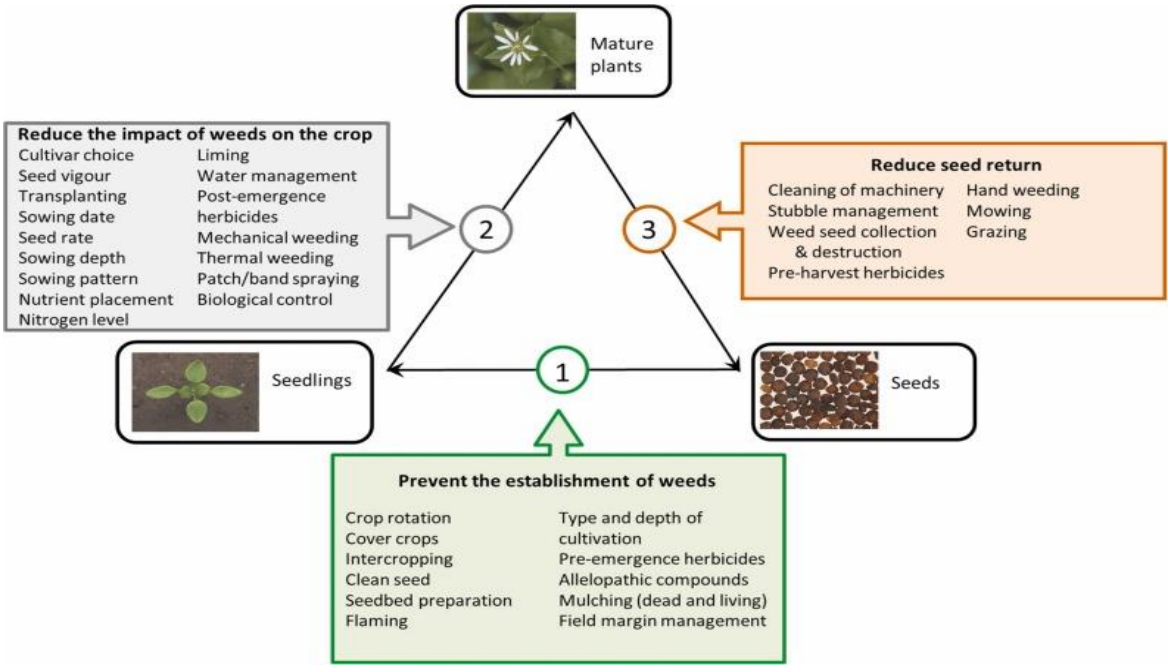
Weed Management Techniques

Based on available data, it appears that European organic farmers are using creative weed management methods that do not involve the use of herbicides. Weed management techniques include biological weed management with cover crops and

intercropping. In addition to biological weed management, mechanical weed control techniques include non-inversion tillage (Peigné et al., 2016).

Figure 3:

*Integrated Weed Management (Riemens et al., 2022***)**



Palma-Guillén et al., (2024) stated that direct-seeded rice fields are not economically feasible for manual weeding, and because the task is physically taxing, there is a shortage of skilled weeding people. Another crucial method for controlling weeds is water management, which lowers the diversity and density of weed species and has an impact on rice crop production. Farmers use the stale seed bed technique and then flood the land before sowing. In order to do this, the rice field must be flooded in order to encourage the first generation of weeds to emerge. These weeds are then mechanically puddled using a rotovator or treated with herbicide prior to rice being sown. Due to the low temperatures during rice maturity, this strategy suggests delaying the sowing of rice, hence endangering the production of long-cycle kinds (Hong et al., 2024).

2.3 Adoption of Ecological Farming System in Pakistan

Pakistan's economy is mostly reliant on the agriculture industry, which is frequently referred to as the country's economic foundation. 62% of the rural

population works in agriculture, accounting for 47.0% of the labor force either directly or indirectly (Mazrou et al., 2024).

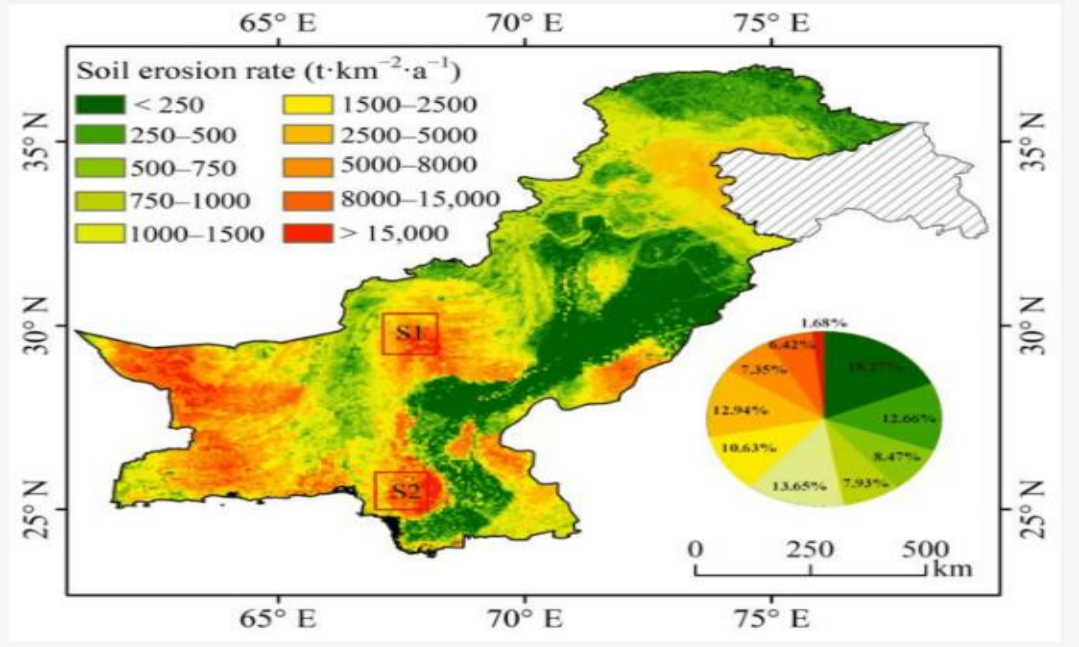
With a large percentage of the workforce employed and a substantial GDP contribution, Pakistan's agriculture sector is essential to the nation's economy. Conventional farming methods have brought about a number of environmental and socioeconomic problems like chemical contamination. Water scarcity as well as soil degradation. It is noted that ecological farming is becoming more popular among farmers and policy makers as a substantial solution to these challenges. Such methods are still in their infancy in Pakistan, number of trends and efforts point to a slow but steady transition towards ecological farming system.

In Pakistan, soil degradation is a significant issue impacting agricultural output. It is caused by factors such as erosion, salinization as well as nutrient depletion. The Food and Agriculture Organization (FAO) estimated that 58% of Pakistan's land is in a degraded state. Cover crops, crop rotation and organic farming are a part of ecological farming practices that can help lower soil degradation by enhancing soil health and fertility as well (Yang et al., 2023).

The primary agricultural regions are the Potohar Plateau and the surrounding hilly areas. These places have higher soil water content, viscosity, and quality, and their soil types are primarily calcisols and cambisols. However, there are frequent human operations like deforestation, and the terrain is undulating. The maximum value of the R-factor is 5534 (MJ·mm·ha−1·h−1·a−1), which is around eight times greater than Pakistan's average rainfall erosion force (717.16 MJ·mm·ha−1·h−1·a−1) (Yang et al., 2023).

Figure 4:

Pakistan's soil erosion rates' geographical spread (Yang et al., 2023)



In Pakistan, crop diversification is becoming more popular as farmers look for ways to increase soil fertility and health, increase crop resilience to climate change as well as diversify their sources of income. The Ministry of National Food Security and Research states that programs like agroforestry, promotion of high value crops and organic farming are being put into place to promote agriculture variety with reducing dependency on crops that require a lot of water and other various outputs (Rahman et al., 2024).

According to Azeem et al., (2024) water scarce situations and increased water productivity in agriculture are driving the promotion of water efficient irrigation technologies involving sprinkler as well as drip irrigation. According to the Pakistan Agriculture Research Council, the Drip irrigation for smallholder project is one of the efforts that aims to enhance smallholder farmer's use of drip irrigation methods particularly in areas that receive limited water.

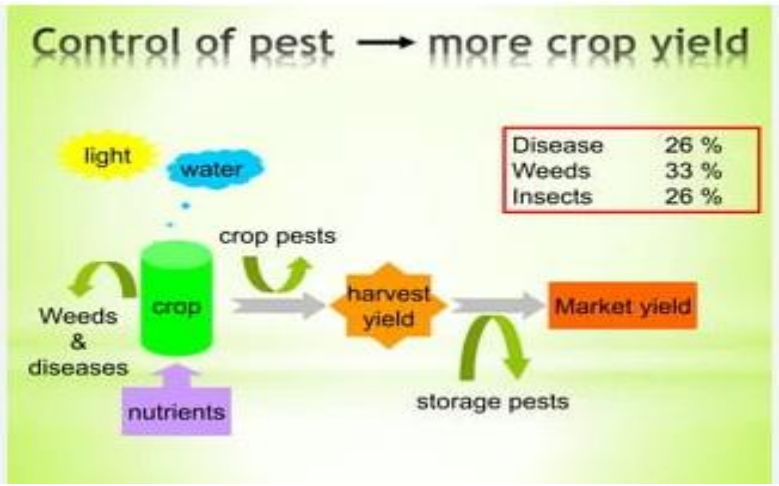
2.4 Pest and Disease Management by Ecological Farming

In Europe and Pakistan, managing pests and disease pose quite serious problems for ecological farmers. However, ecological farmer's use different strategies based on agro-ecological principles, while conventional agriculture primarily relies on

chemical pesticides. Integrated pest management approaches, cultural practices as well as biological control are some of the methods used to reduce the burden of pests and diseases while avoiding adverse environmental effects and maintaining the health of ecosystems (Sandy et al., 2024).

Figure 5:

Integrated Pest Management



2.5 Challenges and opportunities for Ecological Farming

Farmers encounter a number of challenges that prevent ecological farming from being adopted and scaled up, in spite of potential benefits. The study highlight the main hurdles including limited access to organic inputs, market challenges, pest and disease pressure as well as water scarcity. Therefore, there exist aspects for surmounting these obstacles via operations pertaining to market development, knowledge exchange, policy support and capacity building (Singh et al., 2024).

CHAPTER III

Material and Methods

3.1 Study Design

This study used a survey based study which was structured to gather comprehensive data about ecological agricultural systems in Pakistan and the comparison of these systems with Europe. Focus was laid on the farmers in Multan and the surrounding areas. This enabled the study in compiling a substantial amount of information regarding the methods of agriculture, challenges and opportunities faced by the ecological farmers in Multan. Through the use of a survey questionnaire, the study will create awareness and a source of motivation towards the promotion of sustainable agriculture in Multan by providing the current state of ecological farming.

3.2 Study Area

The Punjab province of Pakistan which includes Multan, Muzaffargarh, Bahawalpur and the neighboring districts Vehari, Lodhran and Khanewal are included in the research area. Multan is known as “City of Saints” as well as the “Mango Capital of Pakistan” and is an important agricultural hub in the region and has a rich historical background.

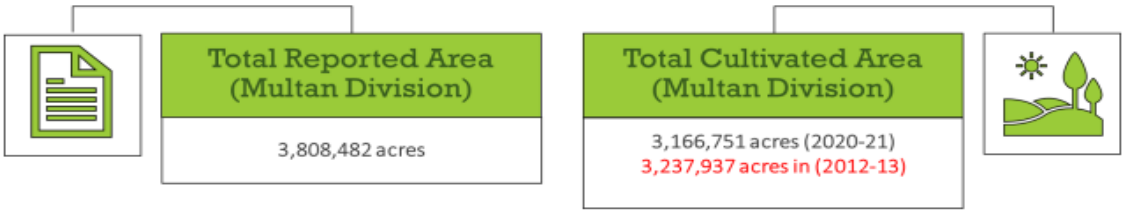
3.3 Description of Study Areas

3.3.1 Multan

The Chenab and Ravi rivers, which provide fertile alluvial plains that support a variety of agricultural operations, are the main sources of fertility in Multan’s agricultural landscape. Multan’s area is well known for producing a significant variety of crops like citrus fruits, vegetables, wheats, cottons, mangoes and sugarcanes. Hence, within this agricultural tapestry, forward thinking farmers have incorporated both contemporary agricultural technology as well as traditional farming methods such as crop rotation and irrigation (Urban Unit, 2023).

Figure 6:

The rate of annual area growth and continuous urban development in Multan (Urban Unit, 2023)



Contiguous Urban Development in Multan District	Total
1995-2005	74%
2005-2015	40%

Annual Area Growth Rate in Multan District	Total
1995-2005	5.7%
2005-2015	3.4%
1995-2015	4.6%

Figure 7:

Map of the Multan District

Figure 8:

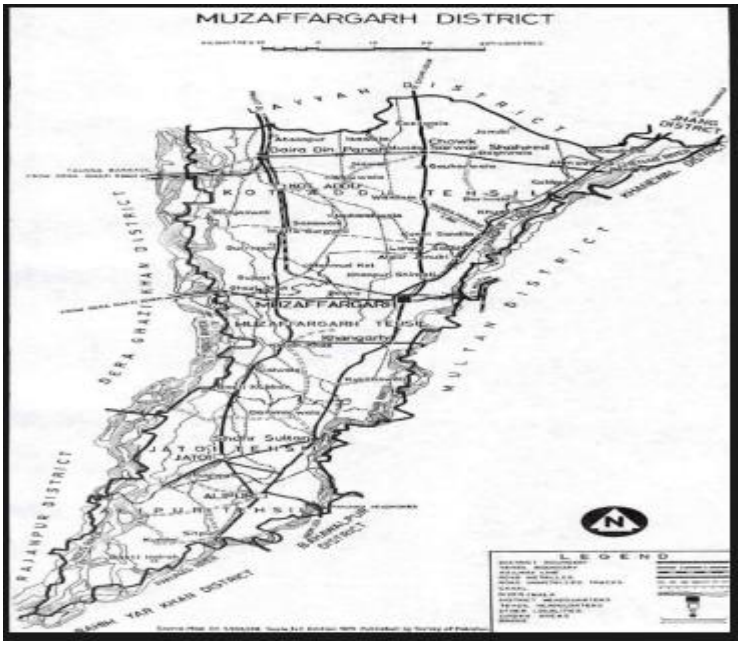
Survey of the Multan Region (Author, 2024)

3.3.2 Muzaffargarh

Muzaffargarh is situated near Pakistan's precise geographic center. Multan is the closest large city. There are several citrus and mango fields in the flat alluvial plain that encircles the city, making it an excellent place for agriculture. In order to supply fields with water, canals also cross the Muzaffargarh District (Zubair et al., 2023).

Figure 9:

Map of the Muzaffargarh District



The town of Jatoi is situated in Punjab, Pakistan's Muzaffargarh District. It is renowned for its agricultural importance in the area and is located along the banks of the Indus River. The town has a distinct cultural legacy and is primarily home to Saraiki-speaking populations. In Jatoi, agriculture is the main source of income, especially for those who grow cotton and wheat (Jahanzaib, 2024).

Figure 10:

Jatoi Muzaffargarh (Jahanzaib, 2024)

Figure 11:

Survey of the Muzaffargarh Region (Author, 2024)

3.3.3 Bahawalpur

The province of Punjab's southeast is home to Bahawalpur. Karachi is 889 kilometers away from Bahawalpur City. The Sindh region, which envelops Bahawalpur to the west, is an abundant alluvial tract in the Sutlej river basin, watered

by floodwaters, densely populated, and covered in date palm plantations. This district is well known for its dates, sugarcane, wheat and cotton farming. Bahawalpur's economy is mostly reliant on agriculture with farmers using both contemporary and conventional farming methods (Hussain et al., 2024).

Figure 12:

Agriculture Produce Bahawalpur (The Express Tribune, 2016)

Figure 13:

Map of the Bahawalpur District

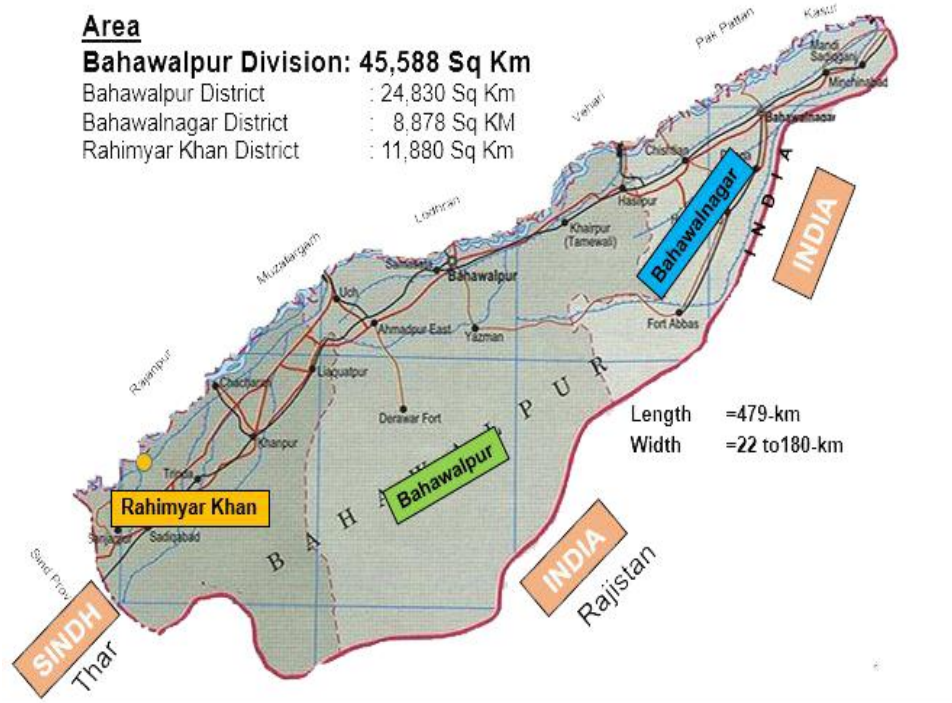


Figure 14:

Survey of Bahawalpur (Author, 2024)

3.3.4 Lodhran

District Lodhran is located at latitude 29° 32′ 16.67″ North and longitude 71° 37′ 41.64″ East within the Multan Division. July 1st, 1991 saw the creation of District Lodhran. The area is 2,778 square kilometers. The primary source of irrigation in the district, which has an agrarian economy, is the canal system. The two main crops grown in this area are wheat and cotton. Additionally, the district serves as a significant center for agriculture, cultivating a variety of crops including rice, wheat, cotton as well as sugarcane. The majority of the local population makes their living from agriculture and farmers use both traditional and contemporary methods (Punjab Police, 2021).

Figure 15:

Map of the Lodhran District

Figure 16:

Survey of Lodran Region (Author, 2024)

3.3.5 Khanewal

Khanewal a region in central Punjab is home to lush, Chenab River irrigated fields. The area in a significant hub for agriculture, growing rice, cotton, wheat and sugarcane. The majority of the people in the Khanewal area work in agriculture, focusing both cutting edge agricultural technologies and conventional farming methods (Government of Pakistan, 2023).

Figure 17:

Map of District Khanewal

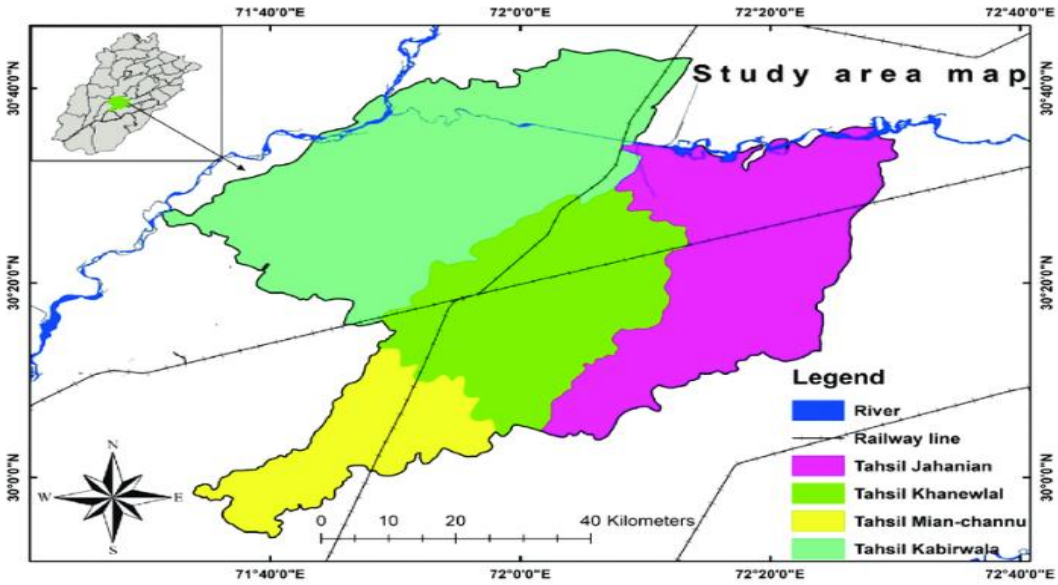


Figure 18:

Survey of Khanewal Region (Author, 2024)

3.3.6 Vehari

Vehari, a region, in southern Punjab, is known for its lush plains that are fed by the Ravi River. The district is well known for producing citrus fruits, cotton, wheat as well as sugarcane. Economy of Vehari is based primarily on agriculture with farmers using a variety of farming methods to enhance yield as well as sustainability (Hussain et al., 2024).

Figure 19:

Map of District Vehari

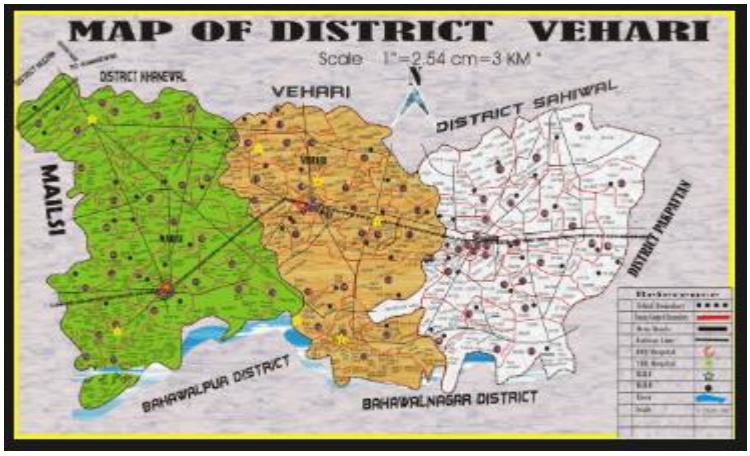


Figure 20:

Survey of Vehari Region (Author, 2024)

3.4 Sampling

For the survey, the sampling will be done through the purposive sampling method approach. The farmer selection includes academic and non-academic groups of farmers practicing ecological farming system in Multan city and its neighboring i.e. Bahawalpur, Muzaffargarh, Vehari, Lodhran and Khanewal. The selection will further consist of community networks working under sustainable agriculture programs, farmer cooperative, and local levels of agricultural groups. The sample to be applied will be determined upon the availability of ecological farmers in the accessible study area that will be possible to collect data for the research period. Considering that the study area is vast and much data collection is required, the sample may have 100 ecological farmers within in and around Multan city. This will enable logistics requirement for the investigation and available resources for data analysis and interpretation of results raised from the data questions.

3.5 Data Collection

The ecological farmers in Multan and the surroundings will have data collected by the use of the structured questionnaires. In that regard, data on various dimensions of ecological farming, including farming methods, land management strategies, managing diseases and pests, soil and water conservation, and marketing approaches, will be gathered using the survey questionnaires.

Electronic surveys will be disseminated through email, internet platforms, and social media accounts pertinent to the study area's ecological agricultural communities.

Furthermore, in-person interviews will be carried out with certain farmers who might have restricted access to technology or who would rather communicate face-to-face. Clarification of survey replies and deeper conversations will be facilitated during the in-person interviews, allowing for a more thorough understanding of the replies.

Face to face contacts will take precedence when gathering data directly from the farmers, especially in situations where technology restrictions exist or for more in depth questions. However, to maintain consistency in the methodology, standardized questions will be implemented. Via these encounters, the researcher will be able to gather data in a personalized manner, gaining insights as well as nuanced information straight from the farmers. This method guarantees inclusivity as well as accuracy in collecting information particularly from farmers who might not have access to or feel at ease using digital survey platforms.

3.6 Data Analysis

Comparative Analysis

A comparative analysis is a methodical side-by-side comparison that identifies the similarities and contrasts between two or more items (Kumar et al., 2023). Comparing survey information from ecological farmers in Pakistani regions with information from ecological agricultural systems in Europe. This could entail contrasting the two region's prospects, challenges encountered, frequency of particular agricultural practices as well as adoption of sustainable farming practices.

Cross Regional Comparison

Finding parallels and variations in ecological agricultural methods, challenges as well as opportunities will require analyzing the qualitative and quantitative data independently for each region Pakistan and Europe, and comparing the results.

Literature Review

Incorporating information from the body of study on ecological agricultural technique in Europe while discussing the conclusions of the research. To provide context as well as insights into the similarities and contrasts noted, this will entail contrasting the results of the study with accepted trends and norms in Europe.

3.7 Ethical Consideration

All survey participants will be asked for their informed consent and confidentiality and anonymity will be maintained at every step of the gathering as well as processing of data. Identifying information like names or contact details will not be connected to survey responses in order to protect participant's anonymity while gathering clarifications through online surveys. Additionally, participants will be ensured that there will be no repercussions if they choose not to continue participation or leave the study at any point.

CHAPTER IV

Results and Discussion

4.1 Results

Section A: Demographic Profile of Respondents

Gender, Age and Occupation

Male respondents made up 70% of the sample that was followed by female respondents 29%. 1% of respondents did not give a response. This also includes information on the number and percentage of people in each group of age. The categories of age are as follows" "18-30, "30-40", "40-50" and "Over 50". These categories were selected to encompass wide range of age groups, facilitating the review of any variations in replies. By segmenting the data, pattern and trends that can differ across younger and older individuals can be found. 35% respondents of the sample as a whole are classified as "18-30". 30 participants in the age range "30-40" make up 30% of the sample. With 20 respondents, "40-50" makes up the share that is 20% of the total. 15 individuals out of 100 make up the "Over 50" category, expressing 15% of the sample. Professions are divided into four categories: "Full time farmer (FTF)", "Part time farmer (PTF)", "Agricultural Consultant (AC)", and "Others". Of the responses provided by 65 people or 65% sample as a whole, the majority identify as full time farmers. 20% of the sample, identify as part time farmers. 10% of the total consist of Agricultural Consultants. 5% of the sample are classified as "Other" participants.

Table 3:

Gender, Age and Occupation of Participants (%)

Age	Occuupation	(%)	Male (Frequency)	Female (Frequency)
18-30	FTF	65	50	15
30-40	PTF	20	11	9
40-50	AC	10	6	4
Over 50	Other	5	3	1
Total		100	70	29

Education of Framers

Table 4 illustrates the number and percentage of person in each education group, giving a general picture of the educational attainment of respondents within the agricultural community. Four categories represent the different degrees of education. “No formal education”, Primary education”, “Secondary education”, and “Higher secondary education”. 50% of the sample state they have never attended college. Meanwhile, 30% of the sample have finished their primary schooling. 15% of the respondents have completed secondary education. In addition, 5 individuals or 5% of the sample have completed higher secondary education.

Table 4:

Education of the Participants (%)

Education of Farmers	Frequency	Percentage
No formal education	50	50
Primary education	30	30
Secondary education	15	15
Higher secondary education	5	5
Total	100	100

Section B: Experiences and Practices of Ecological Farming

Part 1: How long have you been practicing ecological framing?

Table 5 shows how long the respondents engaged in ecological farming, together with the frequency and percentage of people in each period of time. Response possibilities ranged from “Less than 1 year”, “1-5 years”, “5-10 years” and “More than 10 years”. These categories were selected to represent a variety of experiences, from those who were new to those who had substantial long term experience. According to the answers, 40% of the sample as a whole had been practicing ecological farming for less than a year. 30% of the sample reports having practiced ecological farming for 1-5 years. 18% of the respondents have been involved in ecological farming for 5-10 years. In addition, 12% of the total have accumulated more than 10 years.

Table 5:

Participant's responses about "How long have you been practicing ecological framing? (%)

Duration	Frequency	Percentage
Less than 1 year	40	40
1-5 years	30	30
5-10 years	18	18
More than 10 years	12	12
Total	100	100

Part 2: What is the total area of the farm dedicated to ecological farming?

In Table 6, the distribution of participant's answers for the total land area devoted to ecological farming is shown, along with the frequency and percentage of each area type. When asked what size their ecological farming operations were, respondents had choice of responding with the following options "Less than 1 acre", "1-5 acres", "6-10 acres" and "More than 10 acres". 20 individuals or 45% of the sample as a whole cultivate less than 1 acre of land for ecological farming, while 25% of respondednts manage farms with between 1-5 acres. 20% of the respondents commit 6-10 acres to ecological agricultural operations and small fraction of respondents comprising 10% of the total sample cultivate more than 10 acres.

Table 6:

Participant's responses about "What is the total area of the farm dedicated to ecological farming?" (%)

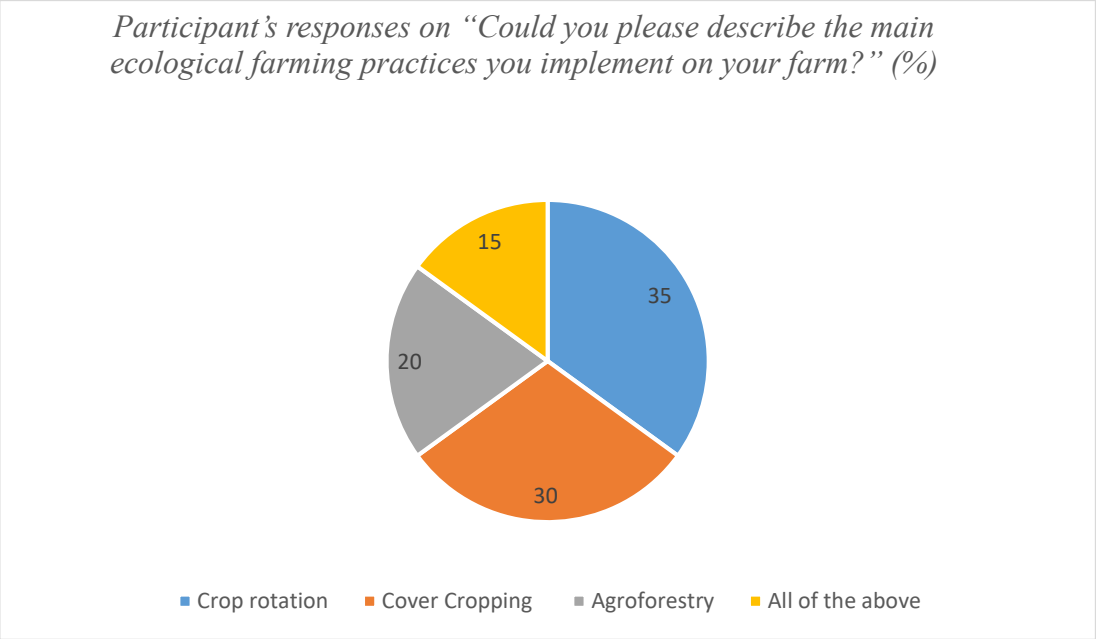
Areas	Frequency	Percentage
Less than 1 acres	45	45
1-5 acres	25	25
6-10 acres	20	20
More than 10 acres	10	10
Total	100	100

Part 3: Could you please describe the main ecological farming practices you implement on your farm?

Graph 1 illustrates an overview of the main ecological farming methods that the respondents used on their farms along with the frequency and percentage of each practice type. When asked what their primary ecological farming methods are, respondents may choose "Crop Rotation", "Cover Cropping", "Agroforestry" and "All of the above". Data shows that 35% of the respondents of the sample as a whole implement Crop rotation as an important ecological farming strategy, 30% of the respondents apply cover cropping, of the total, 20% have implemented agroforestry technique while 15% of the sample use all of the previously described methods on their farms.

Figure 21:

Participant's responses on "Could you please describe the main ecological farming practices you implement on your farm?" (%)



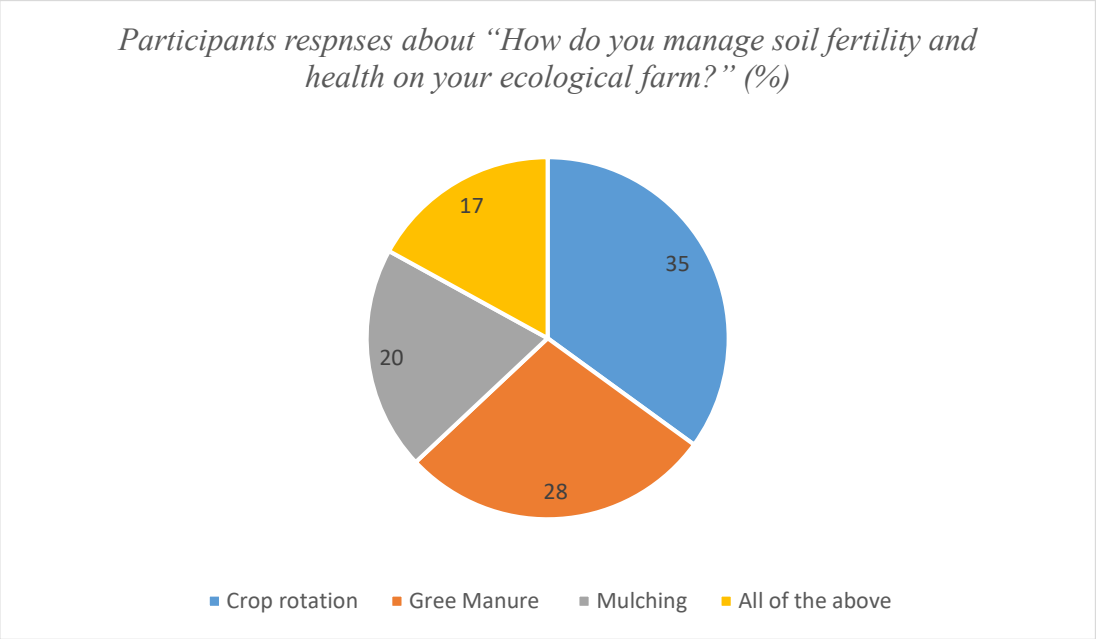
Section C: Soil Fertility and Health Management

Part 1: How do you managesoil fertility and health on your ecological farm?

Graph 2 presents the frequency and percentage of participants' responses for each management category related to how they maintain soil fertility and health on their ecological farms. When asked what techniques they use, participants may choose from "Crop Rotation," "Green Manure," "Mulching," or any combination of these techniques." The information demonstrates that 35 individuals, or 35% of the sample as a whole, use crop rotation as a soil management technique. Furthermore, participants (28%) comprise 28% of the sample, use green manure, while 20 participants (20% of the sample) mulch. Moreover, 17 participants, or 17% of the sample, use all of the previously described techniques to keep their ecological farms' soil healthy and fertile.

Figure 22:

Participants respnses about "How do you manage soil fertility and health on your ecological farm?" (%)



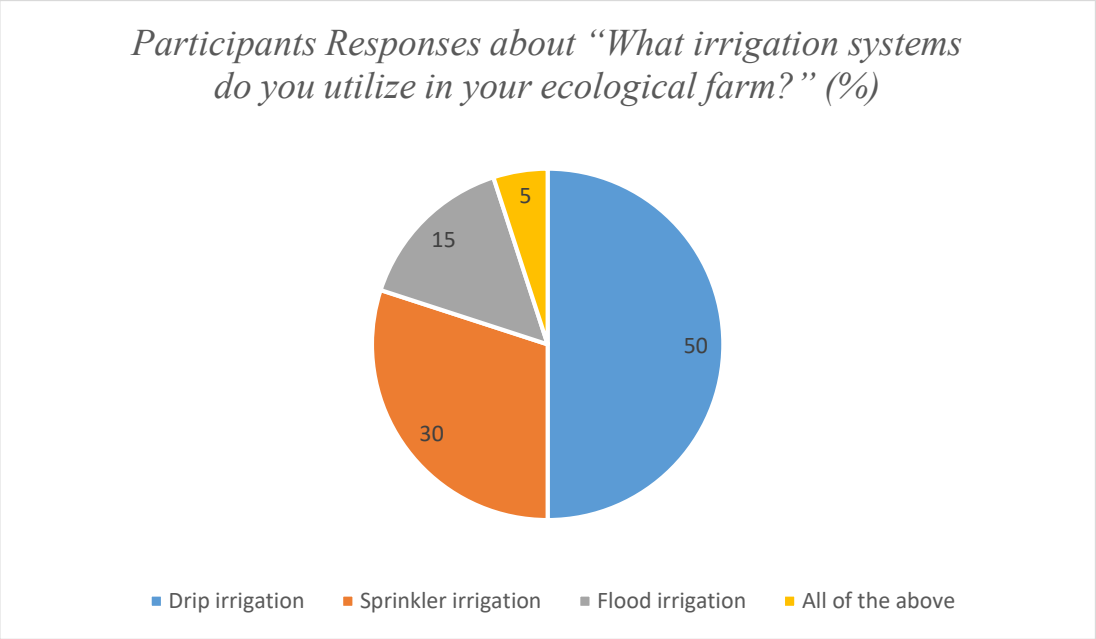
Section D: Irrigation System and Water Sources

Part 1: What irrigation systems do you utilize in your ecological farm?

The distribution of participant responses on the irrigation methods that are used on their ecological farms is shown in graph 3, along with the percentage and frequency of each irrigation type. When asked about their methods of irrigation, the participants may choose between "Drip irrigation," "Sprinkler irrigation," "Flood irrigation," and any combination of these." According to the data, 50 individuals, or 50% of the sample as a whole, use drip irrigation as their main method of irrigation. Moreover, 30 individuals, or 30% of the sample, use sprinkler irrigation, and 15 individuals, or 15% of the sample, use flood irrigation. Furthermore, 5% of the farmers, use all of the irrigation technologies indicated above on their farms

Figure 23:

Participants Responses about "What irrigation systems do you utilize in your ecological farm?" (%)



Part 2: What are the water sources for your irrigation systems?

The responses of respondents about the water sources they use for their irrigation systems are included in Table 7, along with the percentage and frequency of each category of water source. When asked where their irrigation water came from, participants may choose between "groundwater," "rainwater harvesting," "municipal water supply," and "canal water." According to the data, 40 individuals, or 40% of the sample as a whole, primarily obtain their irrigation water from groundwater. Additionally, 30 individuals, or 30% of the sample, engage in rainwater gathering. 20% of the participants, get their irrigation water from municipal water supplies. Additionally, 10 individuals, or 10% of the farmers, use canal water.

Table 7:

Participants Responses about "What are the water sources for your irrigation systems?" (%)

Water sources	Frequency	Percentage
Groundwater	40	40
Rainwater Harvesting	30	30
Municipal water supply	20	20
Canal water	10	10
Total	100	100

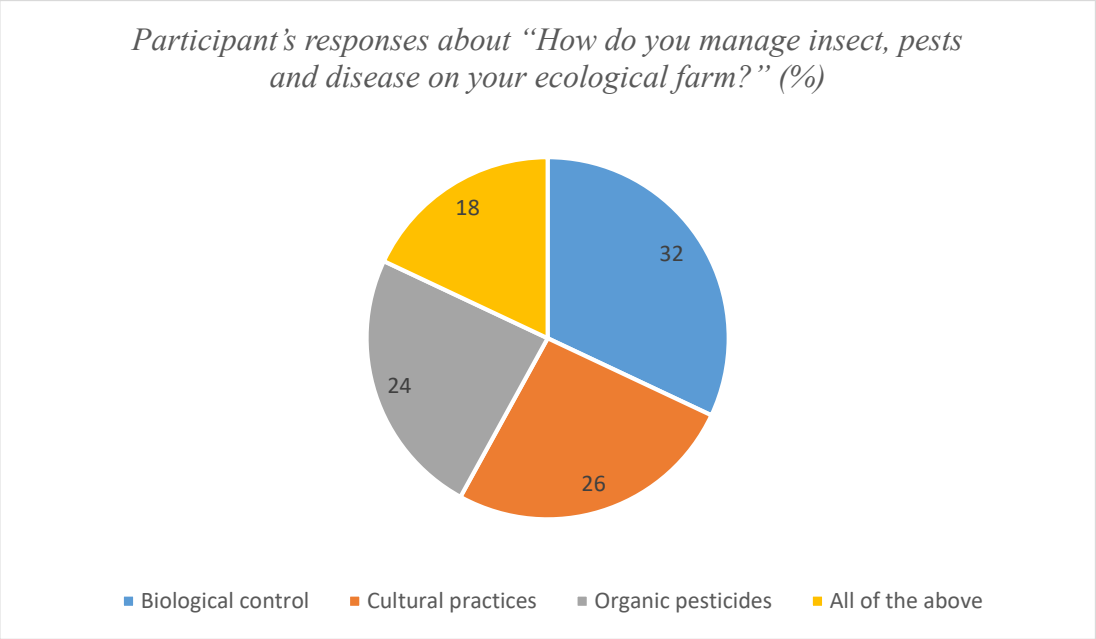
Section E: Pest and disease Management

Part 1: How do you manage insect, pests and disease on your ecological farm?

An overview of the respondents' approaches to controlling illnesses and insect pests on their ecological farms is provided in Graph 4, which also includes information on the frequency and percentage of each management category. The choices for responding to questions on pest management strategies were "Biological Control," "Cultural Practices," "Organic Pesticides," and "Integrated Pest Management." The information shows that 32 individuals, or 32% of the sample as a whole, use biological control techniques as their main approach to managing pests. Furthermore, 26 participants, or (26%) of the sample, utilize cultural practices, while 24 participants, or 24% of the sample, use organic pesticides and 18% of the sample, use integrated pest control strategies.

Figure 24:

Participant's responses about "How do you manage insect, pests and disease on your ecological farm?" (%)



Part 2: Do you practice Integrated Pest Management techniques?

Table 8 shows information about the use of Integrated Pest Management (IPM) practices by respondents on their ecological farms. This indicates whether the participants apply integrated pest management, when asked if they used IPM approaches, participants may choose to answer "Yes" or "No." According to the data, 65% of the sample as a whole, or the majority of participants, use integrated pest management on their farms. In contrast, 35% of participants don't use IPM strategies. All told, the data includes the answers of 100 respondents, providing insight into the IPM adoption rate in the sample.

Table 8:

Participant's responses about "Do you practice Integrated Pest Management techniques?" (%)

Options	Frequency	Percentage
Yes	65	65
No	35	35
Total	100	100

Part 3: How do you do weed control in your farm?

Table 9 shows the frequency and proportion of each control method category used by participants in their methods to weed management on their farms. When asked about their methods for controlling weeds, the participants may choose between "Mulching," "Hand Cleaning," "Cutting with machinery," and "Others." The data shows that 45 individuals, or 45% of the sample as a whole, use mulching as their main technique for controlling weeds. Furthermore, 15 participants, or 15% of the sample, practice using the proper machinery for cutting, whereas 30 participants, or 30% of the sample, use hand cleaning. Additionally, 10 individuals, or 10% of the sample, use weed management techniques other than those listed in the alternatives.

Table 9:

Participant's responses about "How do you do weed control in your farm?" (%)

Weed Control	Frequency	Percentage
Mulching	45	45
Hand Cleaning	30	30
Cutting with machinery	15	15
Others	10	10
Total	100	100

Section F: Challenges and Marketing

Part 1: What specific challenges do you face in practicing ecological farming in your region?

Table 10 shows a detailed summary of the obstacles faced by the participants when engaging in ecological farming in their various locations. It includes the frequency and percentage of each problem category. When asked to list the main difficulties they encounter, participants may choose from "Water Scarcity," "Lack of access to organic inputs," "Pest and Disease Pressure," and "Others." According to the findings, 40 participants—or 40% of the sample as a whole—cite water shortage as a major obstacle. Furthermore, 35 individuals (35% of the sample) report experiencing challenges as a result of not having access to organic inputs. 20% of the participants, or 20, mention the pressure from pests and diseases. Additionally, 5% of the sample, describe additional difficulties that are not covered by the alternatives given.

Table 10:

Participant's responses about "What specific challenges do you face in practicing ecological farming in your region?" (%)

Challenges	Frequency	Percentage
Water Scarcity	40	40
Lack of access to organic inputs	35	35
Pest and Disease Pressure	20	20
Others	5	5
Total	100	100

Part 2: How do you market your ecological farm products?

Table 11 shows the marketing tactics used by respondents to sell their ecological farm goods, together with the proportion and frequency of sales for each category. When asked which of the following were their main marketing strategies, participants may choose from "Direct Sales," "Wholesale to Retailers," "Online Sales Platforms," and "Combination of all these strategies." The information shows that

most of the participants—60% of the sample as a whole—sell their ecological farm goods directly to consumers. Furthermore, 25 participants, or 25% of the sample, use wholesale to retailers, and 10 participants, or 10% of the sample, use online sales platforms. Additionally, 5% of the sample, use food cooperatives for marketing.

Table 11:

Participants Responses about "How do you market your ecological farm products?" (%)

Marketing of Ecological Products	Frequency	Percentage
Direct Sales	60	60
Wholesales to Retailers	25	25
Online Sales Platforms	10	10
Combination of above	5	5
Total	100	100

Section G: Knowledge Exchange and Future Outlook

Part 1: Have you had any opportunities for knowledge exchange or collaboration with ecological farmers from other regions, either within your country or internationally?

Table 12 provides information on respondents' experiences with knowledge sharing and cooperation with other ecological farmers. It includes the frequency and proportion of participants who have had these chances. Response options for participants' answers to the question of whether they have collaborated or exchanged information with ecological farmers in other locations were "Yes" and "No." The data indicates that a significant proportion of participants, accounting for 70% of the sample as a whole, have had the opportunity to collaborate or share expertise with other ecological farmers in different locations. In contrast, 30% of participants say they haven't done any of these things.

Table 12:

Participant's responses about "Have you had any opportunities for knowledge exchange or collaboration with ecological farmers from other regions, either within your country or internationally?" (%)

Options	Frequency	Percentage
Yes	70	70
No	30	30
Total	100	100

Part 2: What lessons or practices from European ecological farming systems do you think could be beneficial for ecological farmers in your region?

Table 13 shows an overview of the frequency and percentage of each category and offers insights into how participants felt about lessons or practices from European ecological farming systems that may be useful for ecological farmers in their area. Specific lessons or practices were requested of the participants, and the choices were "Crop diversification," "Sustainable water Management Practices," "Agro-ecological approaches," and "Others." According to the findings, most participants—55 percent of the sample as a whole—think that crop diversity could be a good idea. 15% respondents indicated agro-ecological techniques, whereas 25 participants (or 25% of the sample) selected sustainable water management strategies. Additionally, 5% of the sample, describe other practices that aren't listed in the selections.

Table 13:

Participant's responses about "What lessons or practices from European ecological farming systems do you thick could be beneficial for ecological farmers in your region?" (%)

Lessens of European Ecological Farming	Frequency	Percentage
Crop diversification	55	55
Sustainable water Management Practices	25	25
Agro-ecological approaches	15	15
Others	5	5
Total	100	100

Part 3: How do you envision the future of ecological farming in your region?

Respondents' opinions about the future of ecological farming in their area are outlined in Table 14, along with the frequency and percentage of each category. In order to predict the future course of ecological farming, participants were asked to select the factors they believe will drive its growth. The categories provided were "Continued growth and expansion," which entails a steady increase in the adoption as well as the practice of ecological farming methods, "Adoption of Innovative Technologies," that referring to the integration of new methods and tools to improve farming sustainability and efficiency, "Increased Support from Government," showing more policies, subsidies and programs that favor ecological farming, and "Consumer Awareness and Demand for Organic Products" which entails a rising consumer preferences for sustainably and organic produced food products. According to the findings, 45 participants, or 45% of the sample as a whole, anticipate that ecological agricultural techniques will continue to flourish and expand in their area. Furthermore, 25 participants, or 25% of the sample, envisage greater government backing, whereas 20 participants, or 20% of the sample, expect the adoption of innovative technology. Moreover, 10 participants, or 10% of the sample, believe that in the future there will be a greater demand for and knowledge of organic products among consumers.

Table 14:

Participant's responses about "How do you envision the future of ecological farming in your region?" (%)

Future of Ecological Farming	Frequency	Percentage
Continued growth and Expansion	45	45
Adoption of Innovative Technologies	25	25
Increased Support from Government	20	20
Consumer Awareness & Demand for Organic Products	10	10
Total	100	100

4.2 Discussion and Interpretation

The participant's demographic profile shed important light on the makeup of ecological farmers in the area under study. With 70% of the sample being male and 29% being female, there was a definite gender majority among the responders. This gender gap is a reflection of larger patterns in the agricultural industry, where men predominately work in farming. However, as women's engagement may lead to more diversified viewpoints and approaches, efforts should be made to encourage more women to participate in ecological farming (Rao, and Moharaj, 2023).

The pariticipant's age distribution demonstrated a wide range with notable participation in several age groups. The majority of the sample (35%) was made up of people in their 40s and 50s, suggesting that middle aged farmers are important contributors to ecological farming techniques. Hence, this research shows that there appears to a significant amount ($P<0.05$) of experience as well as information within this age group that may be used to help programs aimed at increasing capacity along with exchange knowledge (Rey et al., 2017).

When it came to occupation, the majority of respondents (65%) said they were fully time farmers that indicate how deeply people has committed to ecological farming as their main source of income. This commitment ensures a steady focus on ecologically friendly agricultural methods that are essential for the expansion and viability of ecological farming projects. In addition, the percentage of agricultural

consultant (10%) suggests the existence of specialists support networks capable of giving farmers with knowledge and advice.

Majority of the respondents (50%) had finished at least secondary education that indicate a reasonably high level of educational achievement among them. This shows that people with a strong educational background are drawn to ecological farming and they may contribute invaluable information as well as skills to their agricultural operations (Engås et al., 2023).

The data demonstrated the wide variety of background and methods used by the respondents when going on to the experience and methods of ecological farming. A combination of seasonal as well as inexperienced farmers were evident in the duration of practice with a sizeable percentage of respondents having participated in the ecological farming for varied period of time. For promoting information exchange and innovation within the ecological farming community, the range of experience levels among respondents facilitates the sharing of best practices and insights.

The distribution of farm sizes also reflected the diversity: from small-scale to the bigger companies. The presence of so many farms with the land area from 1 to 5 acres demonstrates that a lot of ecological farmers work on a smaller scale, which corresponds to the ideas of diverse and sustainable agriculture. However, the presence of farms that are bigger than 10 acres suggests that ecological farming could develop and have a more significant impact on agricultural landscape.

All respondents, in the field of agricultural techniques, stated that their main approaches to ecological farming are the methods of crop rotation and cover crops. They are quite effective, they support and develop biodiversity, health of soils, and reduce reliance on synthetic inputs. Agroforestry unites an even more dedicated approach to integrating bushes and trees into agricultural systems. It can bring additional benefits, such as habitat recovery and carbon sequestration (Veste et al., 204)

The results proposed a multimodal recommendation to preservation health and soil fertility with respondents. This was characterized by the use of a mixture of methods such as crop rotation, mulching and green manure. As it promotes biological variety and reduces need for chemical inputs, this integrated approach is vital in

sustenance of resilience and soil fertility and ecological agricultural systems. From the data, crop rotation is popular conservation strategy as indicated by the high number of respondents who use it (Sunder et al., 2024).

The selected water sources and irrigation strategies embodied a combination of strategies adjusted to the local context and the resources available. Drip irrigation was the top favorite method for half of the respondents at 50% of the votes based on its high efficiency and potential to reduce water wastage. However, since the majority of respondents rely on groundwater as the primary source of water, the use of drip irrigation becomes indispensable for establishing sustainable water management within ecological farming. Integrated pest management methods employed by the respondents were also popular among 65% of farmers. The integrative approach encompasses numerous non-chemical pest control and prevention methods using biological controls and cultural methods to reduce the use of chemical pesticides and maintain low environmental footprint while encouraging ecosystem sustainability.

Mulching was the most preferable means of dealing with the weed. Manual cleaning and the use of machines were the options for the large and mid-size fields. The abovementioned methods are aimed at reducing the use of pesticides and help keep soil health and biodiversity that aligns with the scheme of ecological farming. Nevertheless, there seems to be some connection between the size of the farm and the method of weed management. The preference for manual cleaning correlates with the size of the field. The analysis has shown that those who own a big farm preferred using machines because it was cheaper and effective: “To clean (weeds) I need around 30 people, it’s not feasible”.

The results also revealed the difficulties that ecological farmers face. The analysis showed how hard it is to organize a truly sustainable agricultural system. Water is one of the concerns that 40% of the respondents explicitly named. This illustrates how urgently regulations as well as techniques for water efficient farming are needed to solve resource constraints, particularly in connection with irrigation methods. Additionally, the burden of pests and diseases, and lack of access to organic inputs, were also noted as major hurdles. This emphasizes the importance of integrated pest management along with the need for infrastructure support for organic farming practices.

Direct sales became the most popular marketing strategy, as 60% of participants sold their goods to customers directly. The direct connection between customers and farmers plays a crucial role in building trust as well as guaranteeing just remuneration for ecological agricultural methods. Initiatives to diversify marketing channels such food cooperatives and internet platforms can aid in enhancing market reach and improving ecological farmer's financial sustainability.

There is a strong feeling of mutual support and community within the ecological farming industry as seen by the predominance of information sharing and collaboration among farmers. It's clear how important peer to peer learning as well as networking is because 70% of participants said they have shared knowledge with other farmers. These cooperative initiatives can help innovations and best practices spread, which will ultimately increase the ecological agricultural systems' sustainability and resilience (Sakapaji et al., 2024).

The practitioners in the examined region can gain significant ideas from studying ecological agricultural methods in Europe. A further reply from 55% of the participants who replied that crop diversity is a relevant practice shows how beneficial it can be. Agro-ecological methods and sustainable water management methods were other adaption approaches that appeared to matter. From these results, it appears clear how essential it is to recognize applicable techniques under local conditions and learn from different farm systems.

On the positive side, responders were in good spirits about the ecological farming industry's prospects for future development and expansion. Such positive outlooks would not be possible without trust that ecological farming has installed potential for prosperity in becoming a long-term substitute to traditional agriculture. Moreover, expectations of greater government support in future innovations and reliance on modern technology, in turn, reflect the perception of the challenges at hand and the need for technical and policy breakthroughs to address the current issues and promote further growth. Given that ecological farming might be a huge part of the solution to the rapidly mounting momentum dare for sustainable food systems due to better-informed and demanding conscious consumers (Boix-Fayos, and Vente, 2023)

The results of the survey provided meaningful data about the ways, issues, and possibilities for ecological farming in the investigated area. Ecological farmers can

become drivers of transformation towards more robust and sustainable food systems if they can capitalize on chances to innovate and collaborate and address critical underlying problems such as poor market opportunities, pest problems, and limited water supplies (Phonthanukitithaworn et al., 2024).

CHAPTER V

Conclusion and Recommendations

5.1 Conclusion

In this research, the purpose was to study investigate the prospects, problems, techniques, and population relationships of the ecological farming industry in the region under consideration. Detailed consideration of the survey material made it possible to draw a number of important conclusions in the conditions of the present and future development of ecological farming in the region.

Based on the results, most of the ecological farmers are men, and it complies with the obvious gender inequality in the agricultural sphere. Nevertheless, these data show a good turn-out from almost all age ranges, implying that the response to ecological farming is likely to be both the least experienced of age and quite familiar with experience. In addition, most of the participants go in farming for an occupation at full day and for a part-time as well. The smallest percentage of the participants obtained secondary school. However, even though a large percentage finished high school, it is the oldest worker group that requires the most in-depth understanding of the ecological farms.

Ecological farmers in the studied area practice agroforestry, integrated pest control, crop rotation, cover crops, and other sustainable agriculture techniques. It enables preserving biodiversity, improving the health of the soil, and reducing demand for chemical inputs. Nevertheless, the lack of water, fear of pests and diseases, and challenges related to access to organic inputs illustrate the need for continuous innovation and assistance for practices of ecological style.

If ecological farming should still be resilient and sustainable within the area, then several problems should need to be tackled. One among the foremost serious problems is water scarcity, which actually threatens agricultural production, especially in areas where there's little or no reliance on reliable sources. Rainwater harvesting, drip irrigation, and water recycling are some examples of water management techniques that should be used to attenuate the adverse consequences of water scarcity on ecological agricultural production. It is investments in infrastructure and water-

efficient farming practices are necessary for the longer term viability of ecological agriculture.

Pest and disease pressure constantly bother ecological farmers, and for that reason, one should establish integrated pest management solutions that would mitigate crop losses and retain the good health of the environment. These strategies are also based on chemical, cultural, and biological control techniques and reduce the need for synthetic pesticides and the harmful effects that they cast on the environment. Thus, to develop new control strategies for pests and diseases that are tailored to the needs and interests of ecological systems of farming, the research and development considerations also apply. It is difficult to maintain crop health and soil fertility in ecological farming systems due to limited access to organic inputs that is seeds, herbicides, and fertilizers. Therefore, investing in the local production and distribution networks responsible for the delivery of organic inputs and infrastructure network establishment would work.

When thinking about the future, the interviewed participants expressed optimism that ecological agricultural approaches would grow and expand in the region. Respondents mentioned the possibility of the government providing more support for ecological farming through funding R&D; passing legislation incentives for sustainable agricultural practices, and investments in infrastructure for organic production and marketing. Enabling the environment for ecological sustainable agriculture would require coordinating policies between governmental ministries, agricultural organizations, and associations involved in ecological farming.

Nutrient-based fertilizers are expected to make a significant contribution to the future of ecological farming. The development of cutting-edge methods and technologies, such as regenerative farming, precision agriculture, and agro ecology, will have a significant impact on the future of ecological farming. Researching and developing novel digital advancements that will be “tailored” to the demands of ecological agricultural systems and thus help boost sustainability, resilience, and production is one such area of focus. Organic products will be in greater demand as consumers become increasingly aware of the many positive benefits food campaign outreach, food produced in a sustainable, organic manner can have on the surroundings, as well as on their lives.

Ecological farmers will benefit from this pattern, provided they receive the necessary organic certification, demonstrate ethical, transparent production techniques, and sell their items via direct marketing networks. Ecological agriculture in the area has a promising outlook for the future, characterized by expansion, development, and care for the environment. By focusing on the major challenges and the most recent possibilities, ecological farmers can make a significant contribution to the development of sustainable food systems and environmental conservation.

5.2 Recommendations

Several recommendations are put forth following the research results to promote ecological farming development and implementation in the study area. To begin with, there must be a conscious effort to improve gender equality in the ecological agriculture sector. This could be achieved through targeted interventions, such as capacity-building initiatives, financing facilities, and gender-responsive policy rollout to boost women's paticipation.in ecological farming to boost the number of women participants.

Secondly, ensure that ecological farmers to access wider and varied opportunities for education and training instead of merely promoting more equitable subsidies. Indeed, providing wider educational resources, seminars, and extension services, and online courses on sustainable farming will not only improve sustainability but also enhance environmentally desirable behaviors. Additionally, I would support more research and development projects to solve the key problems of ecological farming, such as the water governance concern, pest and diseases control, and soil health enhancement.

Investing money into the organizers of these projects will ensure that money talks will inspire host creativity and the generation of workable ideas for farming systems' sustainability. Moreover, upscaling robust ecological farmers that share knowledge is a must. Platforms for peer-to-peer learning, demonstration farms, and farmers' networks can contribute to offering such possibilities by serving as spaces where farmers could learn from each other's experiences and practices as well as the frontier approaches.

Another point is to support specific legislative measures that pay farmers to grow ecologically sound crops. Other legislative actions they should try to get the

government to implement include a law where environmental sustainability is prioritized, financial incentives for efficient water technology, subsidies given to environment-friendly inputs. Consumers' access to markets for ecological farmers can also be encouraged by strengthening regional food systems, promoting direct marketing outlets, and increasing consumers' knowledge about financial gains from organic commodities.

Lastly, advocating for sustainable land management practices such as agroforestry, soil conservation, and watershed management may enhance resilience while reducing the impact of climate change on agricultural landscapes. It will be up to the concerned stakeholders to implement the recommendations and strive for an enabling environment for ecological farming, thereby nurturing resilience, sustainability, and affluence among the farming residents in the study domain.

SUMMARY

This study investigated practices, challenges as well as potentila implications by comparing Pakistani and Ecuropean ecological farming systems. Applying a mixed method approach, the research consist qualitative interviews as well as surveys of 100 ecological farmers of Pakistan. The study focused on typical ecological farming methods that encourage and support biodiversity as well as soil health while reducing chemical inputs, like integrated pest control, cover crops, crop rotation as well as agroforestry. Somes of the challenges faced by Pakistani farmers are pests, a lack of water, as well as restricted access to sustainable or organic inputs. Sustainable techniques such as integrated pest management as well as drip irrigation were crucial in order to address these challenges. Although Pakistani ecological farming systems adhere to sustainable farming techniques similar to those of European farming, and they are deprived of technological as well as institutional support. To improve Pakistani ecological farming, this study suggests enhancing education, financing R&D, gender equity, legislative support, market accessibility as well as sustainable land management. These measures, that draw inspiration from European farming methods, have the chance to enhance Pakistani'sfood systems by strengthening ecological farming's sustainability.

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APPENDICES

Appendix A

Survey Questionnaire

A Survey on Ecological Farming System in Europe Comparison to Existing Eco Farms in Pakistan

Section A: Demographic Profile

1. Gender

a) Male
b) Female
c) No response

2. Age

a) 18-30
b) 30-40
c) 40-50
d) Over 50

3. Occupation

a) Full time farmer
b) Part time farmer
c) Agricultural consultant
d) Other (Please specify)

4. Education of Farmers

a) No formal education
b) Primary education
c) Secondary education

d) Higher secondary education

Section B: Experience and Practices in Ecological Farming

5. How long have you been practicing ecological farming?

a) Less than 1 year
b) 1-5 years
c) 5-10 years
d) More than 10 years

6 What is the total area of your farm dedicated to ecological farming?

a) Less than 1 acres
b) 1-5 acres
c) 6-10 acres
d) More than 10 acres

7. Could you please describe the main ecological farming practices you implement on your farm?

a) crop rotation
b) cover cropping
c) Agroforestry
d) All of above

Section C: Soil Fertility and Health Management

8. How do you manage soil fertility and health on your ecological farm?

a) Crop rotation
b) Green manure
c) Mulching
d) All of above

Section D: Irrigation Systems and Water Sources

9. What irrigation systems do you utilize on your ecological farm?

a) Drip irrigation
b) Sprinkler irrigation
c) Flood Irrigation
d) All of the above

10. What are the water sources for your irrigation system?

a) Ground water
b) Rainwater harvesting
c) Municipal water supply
d) Canal water

Section E: Pest and Disease Management

11. How do you manage insect, pests and diseases on your ecological farm?

a) Biological control
b) Cultural practices
c) Organic pesticides
d) Integrated pest management

12. Do you practice Integrated Pest Management (IPM) techniques? If yes, please describe

a) Yes
b) No

13. How do you do weed control in your farm?

a) Mulching
b) Hand cleaning
c) Cutting with appropriate machinery
d) Others

Section F: Challenges and Marketing

14. What specific challenges do you face in practicing ecological farming in your region?

a) Water scarcity
b) Lack of access to organic inputs
c) Pest and disease pressure
d) Other (Please specify)

15. How do you market your ecological farm products?

a) Direct sales
b) Wholesales to retailers
c) Online sales platforms
d) Food cooperatives

Section G: Knowledge Exchange and Future Outlook

16. Have you had any opportunities for knowledge exchange or collaboration with ecological farmers from other regions, either within your country or internationally?

a) Yes
b) No

17. What lessons or practices from European ecological farming systems do you thick could be beneficial for ecological farmers in your region?

a) Crop diversification
b) Sustainable water management practices

c) Agro ecological approaches to pest and disease management
d) Others (Please specify)

18. How do you envision the future of ecological farming in your region?

a) Continued growth and expansion
b) Adoption of innovative technologies and practices
c) Increased support from government and institutions
d) Greater consumer awareness and demand for organic products

Appendix B

Similarity Report