Economic Comparison of Tunnel and Traditional Farming System: A Case Study of Tehsil Chichawatni and Tehsil Kamalia

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2022

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CERTIFICATE

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Author's Declaration

I **Abdul Haseeb** hereby state that my MPhil thesis titled **"Economic Comparison of Tunnel and Traditional Farming System: A Case Study of Tehsil Chichawatni and Tehsil Kamalia"** is my own work and has not been submitted previously by me for taking any degree from Pakistan Institute of Development Economics or anywhere else in the country/world.

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Date: 11/03/2022

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AKNOWLEDGEMENT

First and foremost, my efforts and aptitude gone into making of this thesis is Allah SWT's blessing. For this, no amount of thanks is enough.

My parents have been my source of inspiration and guidance since I entered this world. I owe everything to them. My only regret is not being able to show my achievement to my late Mother Noor Saba Khanam, who left us for the afterlife during my degree time. I am sure, she would be smiling with affection while I am writing these words. My father is a beacon of affection who in the difficult time of our mother's passing, kept encouraging us to pursue our studies. Alhamdulillah, her dream continues to be realized with each passing day. When in need and always was this case, my younger siblings deserve praise for supporting me in conducting this study.

To those who guide and teach, my teacher and Supervisor: Dr. Abedullah. I am honored to be one of his students and have him as my supervisor. His guidance, patience in listening to my endless queries, extending help in solving intricate mathematical problems enabled me to work hard with focused direction. I am also indebted to my teachers: Dr. Muhammad Iqbal, Dr. Rehana Siddique, Dr. Usman Mustafa, Dr. Aneel Salman, Dr. Anwar Hussain, for teaching and helping us gain insight into our field of research.

Friends…they are hard to find yet a joy to keep once found. It would be a miss not to mention these good fellows who kept me company in good and hard times. Firstly, I owe greatest thanks to Alam Zaib, to whom I always turned to whenever challenging times came on me. Without him, this thesis would have become more challenging. Secondly, a whole bunch of friends deserves to be acknowledged Muhammad Azhar, Babar Abbasi, Umar Daraz Khan, Muhammad Mudassir, Muhammad Naveed. At the end, the administration of my department deserves praise.

ABSTRACT

This study aims to make economic comparison of two production technologies (tunnel and traditional) by accounting for health impacts due to pesticide in Tomato and Cucumber production, in two Tehsils: Chichawatni and Kamalia. In Tehsil Chichawatni farmers are using conventional methods to grow Cucumber and Tomato, and in Tehsil Kamalia farmers are using tunnel farming to grow Tomato and Cucumber. This difference is the base of conducting a comparative study to see the alterations in both cities simultaneously, in tunnel farming and traditional farming technology along with economic feasibility of both production techniques. The total sample of respondents including sprayer and farmers was 140 out of which 70 sprayers belonged to Tehsil Chichawatni and 70 belonged to Tehsil Kamalia. Using Poisson regression model and Health Cost Function. This study used the toxicity level of pesticides by EIQ values in replacement of toxicity category method. Study finds that value of EIQ, un-observance of protective gears, habit of eating meal after the spray, and smoking greatly increases the incidence of pesticide related diseases and health cost of sprayers of Tehsil Chichawatni as compared to sprayer of Tehsil Kamalia. Economic comparison shows that BCR ratio for Tunnel farming is 1.7 with a very high IRR rate of 95.2%. These values are high enough and reasonable to attract investment in this segment. This study recommends that to get the maximum production and sustainability we need technological advancement and new methods for agriculture like tunnel farming with less health risks.

Key words: Health impacts, pesticides, Tunnel farming, Health cost, Tomato, Cucumber

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CBA	Cost Benefit Analysis
BCR	Benefit Cost Ratio
DDT	Dichlorodiphenyle Trichloroethane
EIQ	Environmental Impact Quotient
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IPM	Integrated Pest Management
IRR	Internal Rate of Return
KPK	Khyber Pakhton Khan
NPV	Net Present Value
OCl	Organochlorine
OLS	Ordinary Least Square Method
PBS	Pakistan Bureau of Statistics
2SLS	2 Stage Least Square Method
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Contextual

Prime objective of all countries is to increase the food production. The FAO (Food and Agricultural Organization) predicted that world's food production needs to upsurge by 70%, in order to cover the demand of increasing population, which put a gigantic pressure on the existing agricultural system. To meet the required needs of food from same current resources as land, water etc., the modern ways for the productions like tunnel farming is very essential. Amplified crop production has seemed an inevitable component of current agricultural system in order to support the increasing pressure of population (Hakeem et al., 2016).

The agriculture of Pakistan is wide ranging sectors of the economy with 18.5% contribution to GDP and employing about 38.5% of the labour force, while high performing agriculture is a key to economic development and poverty reduction ("Pakistan Economic Survey," 2019). Technological espousal for value added crops is making progress by introducing tunnel farming. Tunnel technology is one of the most important alterations in advanced farming methods that is an arrival of plastic-culture, which is known as usage of plastic material in the farm sector. For the first time tunnel farming was introduced in 1948, it was an inexpensive form of greenhouse. Later, more functioning and economical species of tunnel farming was familiarized around the globe (Adeniji, 2019).

Technological adoption in agriculture sector of Pakistan is now moving in a constructive direction., but in this race of sustainability and high productivity, use of pesticides play a very important role. In the progression of crop production, the use of insecticides, fungicides, nematicides and fertilizers has been increased than in the past (Espí et al., 2006). These chemicals have mainly come into the use in 1940 after the introduction of synthetic insecticides, when OCl (Organochlorine) insecticides were first used for pest control. Before this, sustainable practices such as cultural, mechanical, and physical control strategies were using to control weeds, pests, insects and diseases (Waterer, 2003).

Farmers used insect killer for high production from crops so that the high use of pesticide results in acute health symptoms which will increase the health cost of illness of the farmers such as medical treatment cost and medical bills (Antle & Pingali, 1994; Kumar et al., 2007).There is no doubt that farmers are using pesticides to get maximum yield from crops, but one thing that should must consider in mind that pesticide are injurious to human health and poses unavoidable risk to its direct exposure (Evenson & Gollin, 2003). Pesticides are injurious to life cycle of organisms living both on land and sub-surface water they stay underground for an elongated period of time, destructing the quality of underground water there by effecting crop yield in the long run. They mix up with the food produced and when consumed seriously affect the human body (Kishi et al., 1995). In the modern times practically 44% of the insecticides, 30% of herbicides, 21% of fungicides and 5% others are used (Mathur et al., 2005). It is a wide-ranging consent that use of pesticides is linked with many social and environmental glitches (Peshin & Dhawan, 2009). It specifies on the way to the pollution spread that can be either direct or indirect, the rural labors are exceedingly exposed to the perilous fumes emanating from pesticide spray (Schwartz et al., 2018).

On the other hand, the handling of pesticides in a well-managed way and in suggested concentration in the field requires the use of good and suitable equipment for the personal care and fortification of the sprayers. This equipment also includes the use of gloves for the hands and the masks for the mouth, protective personal hygiene, suitable footwear, and headgear etc. (Atreya, 2007). Due to less knowledge about hazardous effects of pesticides, in developing countries it was seen that sprayers or farmers don't care about their health and also the safety measure, and also no necessary protective actions are not been taken while managing the pesticides (Alavanja et al., 2004).

In developing countries like Pakistan where is lack of knowledge about the application of pesticides, farmers combine different types of pesticides in a vessel directly with bared hands (Helweg et al., 2002). While spraying pesticides, some of the spraying workers were observed chewing betel nut, tobacco etc., and some were found smoking. Mostly the sprayers use unhygienic clothe materials as a mask for their mouth (Tukura et al., 2013).

Direct or indirect exposure to pesticide primarily leads to multiple costs extending from self-treatment to hospitalization. Indirect costs comprise cost of transport, expenditures on specific diets suggested by doctors, frequent checkup visits put more financial burden on the sprayers. Loss of working hours collective with decrease in working efficiency form another aspect of indirect costs that put straining on financial setup of the farmers. Loss of time is not just one cost that only experienced by a single person but it's a cost also faced by the family members who sacrifice their time - either leisure time or work time to look after the patient (Langley & Mort, 2012).

Now in this given gratified, this study investigates this problem in case of Chichawatni and Kamalia. This study has done a comparative analysis of two Tehsils in the Punjab province. Consequently, in Tehsil Kamalia most of the farmers are using tunnel technology for the maximization of yield and profit but the other Tehsil far behind in adopting the tunnel technology. We will investigate the knowledge of farmers regarding the health threats and damages occurs with pesticides usage, the costs incurred, and possible impacts on pesticide applicator's health also we will do cost benefit analysis for both production methos (tunnel farming and traditional farming). Thus, our comparative analysis Tehsil where farmers are influenced by technical advancement and practicing high tunnels with the one where the farmers are still using old practices have helped to understand that how both practices are affecting sprayer's health and profitability.

1.2 Chemical used in pesticides in Pakistan

In Pakistan, about 145 active substances have been registered, with pyrethroids having the greatest portion (45 %), followed by organophosphates (39 %), Organochlorine (9 %) and carbamates (4 %). Organochlorine and organophosphates are formulated and mass-produced. Pakistan ranked 19th of per acre practice of pesticide, and its per acre usage is 1.3 kg. (Nation, 2000; Derived June 2015).

Considering the formulation and the active ingredients presence in pesticide's chemical composition, these can be categorized as (Saeed et al., 2017).

i. Organochlorine: Endosulfan, Dichlorodiphenyle Trichloroethane (DDT).
ii. Organophosphates: Malathion, Parathion, Chlorpyrifos, Dieldrin,aldrin, heptachlor, chlordane.
iii. Phenoxyacetic acidic Herbicides: 2.4-D, MCPA.
iv. Carbamates: Carbaryl, Aldicarb, Carbofuran, Carbaryl.
v. Pyridiniumherbicides: Picloram, Paraquat, Diquat.
vi. Triazine Herbicides: Cyanazine, Simazine, Trietazine, Atrazine.
vii. Substitute Urea: Chlorotoluron, Isoproturon.

1.3 Focus of Study

The main focus of this study is to analyze the impact of pesticide usage on sprayers health. A comparison of two Tehsils: Tehsil Chichawatni and Tehsil Kamalia of Punjab province Pakistan is conducted, where Plant Protection department present in the former spreading awareness is operational. This study only concerns with the short-term exposure to the chemicals present in pesticide and their short-term health effect and also the costs that are related with the pesticides use. It does not take into consideration intentional poisoning, long term chronic illness, benefits and social costs of pesticide usage. Chaotic use of pesticide consequence in short term health impacts such as headache, skin impatience, eye irritation, breathing distress and throat uneasiness (Antle & Pingali, 1994).

1.4 Issues and Gap

There are some investigative issues that, why farmers undergo to use pesticides in their farms by discounting the health and environmental effects of pesticides and second thing is health cost of illness. Many global studies have stated several examples of the bad effects of pesticide use on human health and environment and their dangerous affects are in many forms like the deaths of animals, huge loss of predators of pest, and increased pesticide resistance in pests, birds and fishery loss, also a loss of subsurface water (Damalas & Eleftherohorinos, 2011; Malik et al., 2014). But this study compares the affected outcomes and cost incurred by the sprayers due to pesticide use in Tunnel farming and traditional farming methods.

Short term health effects from pesticide includes acute illness, such as headache, skin irritation, eye irritation, and respiratory and throat discomfort that are the core short-term diseases from pesticide usage in the farms (Crissman et al., 1994). Another problem that is very common in the whole topic is knowledge about the pesticides, that means knowledge about the attitude of pesticide use in the farms by farmer's also influences the degree of pesticide usage, these factors influence on the degree of exposure is in some ways in which the adoption of the safety measures by the farm workers, the proper way of handling the pesticides (Ngowi et al., 2007; Rapisarda et al., 2017).

1.6 Research Questions

1. What are the adversative impacts of pesticides usage on pesticide applicator's health of tunnel and traditional sprayer?
2. What cost is borne by the farmer's due to use of pesticides in the field?
3. Which farming system is more profitable i.e., tunnel or traditional?

1.7 Objective of the study

1) To investigate the different types of health damages from pesticide exposure among tunnel and traditional sprayers.
2) To explore the determinants of health cost faced by farmer due to pesticide use in tunnel farming and traditional farming.
3) Economic evaluation of two Tehsils, Chichawatni and Kamalia using conventional farming and tunnel farming respectively.

1.8 Significance and Plan of the Study

According to World Health Organization from United Nations has determine the extensive use of pesticides on agriculture cause 26 million non-fatal poisoning and in these non-fatal poisoning 3 million poisoning cases are hospitalized 220,000 deaths and about 750,000 suffered chronic illness every worldwide (WHO, 2006). The implication of this study is on the acquaintance to the hazardous fumes of pesticides that consequences in short term health effects on the sprayers, and the pesticide cost suffered by the local farmers in an intensive farming system more over study will investigate the difference of health cost acquired in tunnel farming and traditional farming by pesticide applicator. However, this study does not hold the long-term health effects by the pesticides use.

While on the other hand in underdeveloped countries including Pakistan, the ingesting is only 20% of the world's total chemical pesticide usage. Almost below the 1% level the pesticides experienced to the farm and crops can achieve their target pests but rest of the 99% pesticides affects adversely on unplanned targets which also includes the public health, and environmental health (Anderson & Adeniji, 2019).

So, in this scenario there is a need of a study, which analyzes that why famers continue to use pesticides in the farm and why they are ignoring their health effects of using pesticides. In this context, the study analyzes this issue for Pakistan. As Pakistan is an agriculturally based country and also a large portion of its economy depends on agriculture substantiating the reason that farmers used pesticides for the purpose of high production from the crops. There is also a need to analyze the unseen cost of pesticide in form of the health loss to the sprayers or farmers and their household. That is the main determination of this study is to evaluate this gap by analyzing the situation in the Tehsil Chichawatni and Tehsil Kamalia. In this study we will use EIQ (environmental impact quotient) values of different active ingredients present in pesticides to explain the toxicity of pesticides rather than categorical distribution of pesticides i.e., low, medium and high toxic (Abedullah et al., 2015).

1.9 Organization of the Study

This study consists of five chapters. Introduction given in chapter 1. The 2nd chapter of the study contains Literature Review. 3rd chapter consists of study area & data collection, sampling techniques and methodology, which is to be used for findings of the study. Chapter 4 of the study consists of Results and Discussions. In this chapter we will be discussing the results in detail. The conclusion and the policy recommendation are given in the 5th chapter of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 General Background

The misuse of pesticide is occurring mostly because the actual benefit of pesticides is very high, and this unsystematic use of pesticides negatively effects on the farmers health, and society either directly or indirectly. However, in this study we will only concern about the farmers who are directly affected by pesticides in tunnel farming. The uses of pesticides with such an irresponsible way this results in acute illnesses like stomach pain, vomiting, respiratory problems, skin rashes, headaches, sneezing and eye irritations mostly happens with the farmers. While long term diseases in which disruption, reproductive birth defects, cancer, asthma, dysfunctions, neuron behavioral disorders and dermatitis (Crissman et al., 1994).

A study estimated the general costs faced by the affected farmers for which including both direct and indirect costs of pesticides consumption. While in the direct cost many costs were included like fee for doctor checkup, medicine expenditure, transportation cost, loss of utility, payment to traditional healer and care taken when they are resting at home (Waibel, 2000). While in case of Pakistan a study was conducted in the cotton belt of the Punjab. He evaluated all the direct and indirect costs from the use of pesticides that were almost Rs7044 and Rs11567 million respectively. The estimated total annually cost was approximately Rs18611 million (Iqbal, 2002). The pesticides defiles mix-up with our food and environments that consequently have bad impacts on human and farmers health. There are millions of cases of pesticides poisoning reported annually from worldwide annually (Richter, 2002). A huge number of deaths reported due to pesticides poisoning from developing countries (Wilson, 2005; Damalas &

Eleftherohorinos, 2011). Again, and again exposures to hazardous chemical by the farmers are very frequent practices in the under developed countries (Swinton, 2003; Atreya, 2007). It is confirmed by the science that again and again exposure to toxic chemicals results in both acute and chronic disease. The short-term acute illnesses are stomach pain, vomiting, respiratory problems, skin rashes, headaches, and coma, sneezing and eye irritations (Pingali, 1994). The long-term chronic diseases include endocrine disruption, reproductive dysfunctions, immune mediated toxicity, neuron behavioral disorders, birth defects, cancer, asthma and dermatitis (Burger, 1997; Alavanja et al., 2004). There are some evidences that were found that due to pesticides exposure it may cause for learning impairment and memory loss (Pimentel, 2002).

Different types of health damages which may cause by pesticides to put on very severe threat to progress and it can deduct the benefits made from agriculture growth (Townsend, 2000; Kishi et al., 1995). There is no doubt about it that pesticides have positive effects on the crop yields, but on the other hand adverse impact on the health of the farmers, as a result bad health have also negative effects on the crop yield (John et al. 1994).

Another study also said the same thing that the pesticides have positive effect on crops productivity and negative effect on health of the farmers (Donald et al. 1994). The unsystematic and irresponsible use of pesticides use resulted in having a very bad effects on the environment and the health of the farmers. When the used number of pesticides was greater than the prescribed dose that is written on the pesticide bottles (Shende et al. 2013). The pesticides have negatively effects on the environmental elements like soil, water and air contamination. It has also very bad effects on the non-targeted organisms (Burger et al. 2008).

The human health and environment are adversely affected by the use of pesticides this is all because of less knowledge about the handling of pesticides and also due to lack of information about the pesticides. Without knowledge about pesticides the use of more toxic chemicals and dangerous practices of are the main reason for the loss of health and environment (Khan, 2010). From these toxic chemicals the livelihood of large number of birds, animals, honeybees destroy. These are the costs uprising from the usage of pesticides to society are respectable and this study therefore measured its impacts on human health (Khan, 2007).

2.2 Thematic review of literature

2.2.1 Use of pesticide in agriculture sustainability

The sustainable agricultural escalation can be defined as producing extra crops yield from the same and equal area of land while decreasing the adverse environmental effects (Pretty, 2008; Conway & Wage, 2010). The pesticide can also be used for the agricultural sustainability. In other way the sustainable use of pesticides as lowering the negative and bad impacts/risks of pesticide application on the human's health and also the environment and encouraging the practices of "Integrated Pest Management" and also some other observable techniques in which non-chemical alternatives to pesticides (Horrigan et al., 2002). In 1960s, IPM was encouraged as a way of pest control system or techniques and at that time, approximately there were only a few types of IPM technologies and techniques available for field experience (Pretty et al., 2011). However, this technology was not so successful for that level. The adoption of IPM will lead to a decrease in pesticide use but also a complimentary a decrease in crop yield that is why mostly the farmers do not prefer the adoption of IPM (Peshin et al., 2009). The use of pesticides invites for formulation of strategies and techniques that take into consideration safe use of pesticides, controlling for adverse impacts on human health, non-target useful organisms and the environment (Peshin et al. 2009; Wilson et al. 2001).

2.2.2 Short term health affect with direct and indirect exposure to pesticide

There are mainly two factors of pesticide acquaintance in which first one is the direct exposure to the pesticide and the second is the indirect exposure to the pesticide (Grace et al. 2006). Direct exposure attacks only on those farmers who are personally involve in the experience of pesticide in agricultural occupational, or suburban settings and at the end their exposure level to pesticide is very high (Tukura et al., 2013), while on the other hand the indirect exposures attacks thee farmers and their families who are working out side of the farm through different ways in which the drinking water, the air they breathe in, dust in the environment, and food which they eat and signify routes of long term exposure to pesticide, normally low level exposures (Dutta et al., 2004) .The Indirect exposures is more harmful for the farmers and it may arise more frequently as compared to direct pesticide experience. Personal pesticide exposure in occupational and residential settings is affected by both the pesticide experience features and personal behavior. Unintentional actions such as hazardous pesticide spills also contribute to pesticide exposure. About thirteen years ago, it was predicted that about 25 million agricultural workers all over the world experience unexpected pesticide poisoning each year. (Alavanja, Hoppin, & Kamel 2004).

2.2.3 Farmer’s knowledge about pesticide and safety measure

The handling of pesticides in a managed way and also the use of those pesticides in suggested concentration in the field must requires the use of good and suitable equipment for the personal protection of the farmers as a safety measure against the exposure of pesticide (Cocco, 2002). This equipment also includes the use of gloves for the hand and the masks for the mouth, protective personal hygiene, suitable footwear, and headgear etc. (Sheikh et al., 2011).

While in the field it was seen that sprayers or farmers in many study areas don’t care about their health and also the safety measure, and also no necessary protective actions while managing the pesticides (Khan M, 2009). The best preparation of pesticide is to mix up in a drum, with a wooden or any type of stick that is often not practiced. Mostly the farmers use old clothes materials as a mask for their mouth. While spraying pesticides, some of the spraying farmers were observed chewing betel nut, tobacco etc., and some were found smoking (Dey et al., 2013).

2.2.4 Signs and symptoms of illness among farmers

The signs and symptoms were informed by a large number of spraying farmers and also the non-sprayers stated, some of these symptoms and the signs with a higher rate of occurrence were unnecessary sweating, stinging /itching eyes, dry/sore throat, skin redness/white patches, (Pingali, 1994). Chest pain/burning sensation, excessive salivation, Headache, dizziness, muscular twitching, skin allergy, respiratory discomfort, etc., (Pingali, 1994; Yasin, Mourad & Safi, 2002; Dey et al., 2013).

2.2.5 Health cost of illness due to pesticide exposure

Exposure to pesticide leads to multiple costs ranging from self-treatment to hospitalization. Although some cost is borne by the hospitals, yet major portion of cost are borne by the farmers themselves (Iftikhar, 2002). Indirect cost incurred informs of transport cost and opportunity cost of time for another set of disadvantages posed by use of pesticide. Expenditures on special diets recommended by doctor's frequent consultancy visits and travel cost put financial burden on the farmers as their profession is like of hired labor (Atreya, 2008). Loss of working hours collective with decrease in working effectiveness form another aspect of indirect costs that put strain on financial setup of the farmers. Loss of time is not a singular cost experienced by a single person but it's a cost experienced by the family member, others members have to sacrifice their time either leisure time or work time to look after the patient there by decreasing the efficiency of the whole households (Maumbe, 2000; Swinton, 2002) High costs incurred in these abrupt situations indirectly increased the cost of production of crops which leads to an overall decrease in revenue generation that is no or less profit are made (Bishal, 2012).

2.2.6 EIQ as health impact assessment

Environmental and health impressions of pesticides could be captured more comprehensively by using the environmental impact quotient (EIQ). The EIQ was first consequential by (Kovach et al., 1992) and provides a composite approximation of potential impacts of pesticide active ingredients used at the farm level. EIQ was used to estimate and compare the environmental risks of pesticides in the studies (Abedullah et al., 2015).

2.3 Conclusion of themes

- Pesticides are necessity. Only the pesticide practices in an unsustainable manner led to a negative impact on crop yield and human health. Although it is established fact that the practices such as Integrated pest management are no longer, favorable as they cause a decrease in crop yield which is not suitable for global food and security (Peshin & Dhawan, 2009).
- Pesticide exposure can be either direct or indirect. The indirect exposure has a greater impact scale which not only affect the direct users but also the living organism living in the immediate surroundings (Damalas & Khan, 2017).
- Sustainability requires observance of certain practices and habits, when spraying in the field. Use of protective equipment knowledge about the hazardous fumes of pesticides, greatly reduce the magnitude of negative impacts of pesticides (Helweg et al., 2002).
- Adverse exposure to pesticides results in bearing the multiple health costs. The range from hospital expenses, medical test expenses the transport expenses and many other complimentary costs which put strain on a person’s income (Anderson et al., 2019).
- EIQ values of pesticides could elaborate more emphatically the hazardous effects on human health (Abedullah et al., 2015).

CHAPTER 3

METHODOLOGY

To investigate the research questions a survey is conducted in two adjacent Tehsils Chichawatni and Kamalia from district Sahiwal and Toba Tek Singh correspondingly. This chapter describes the study area, data collection procedure, and sampling. It also explains the procedures implemented for collection of data. Finally, it deliberates the econometrics tools to analyze the data to attain the objectives of the study.

3.1 Cucumber

Cucumber (Cucumis sativus) is a very adaptable vegetable due to the wide range of applications, which range from salads to pickles, as well as digestive aids and cosmetic treatments. It was shown to be effective in treating and improving digestion. Vitamin C, niacin, iron, calcium, thiamine, fiber and phosphorus are all found in fresh cucumbers (Ali et al., 2016). In Pakistan the total production of Cucumber was 54.29 thousand tons harvested from an area of 3.38 thousand hectares with the average yield of 16-18 tons per hectare in 2016 (Pakistan Bureau of Statistics, 2018). Almost the entire Cucumber production is marketed domestically.

If we compare the average yield at experiment stations with the farm level yield, the gap is about 60%. To overcome this gap tunnel farming plays a vital role in the production specially in off season (Khan et al., 2011). Punjab is the leading province in producing Cucumber all over the Pakistan as it occupies 52.5% of Cucumber area and has share of 82.8% of production in 2016 (Table 3.1). Per ha yield is also highest in Punjab at 25.3 tons per ha while 7.3 tons in Balochistan (Soomro, 2020).

Table 3.1 Production area of Cucumber by province during 2015-16

Province	Production (Tons)	%Production share	Yield (ton/ha)	Area (ha)	%Area share
Punjab	44919	82.8	25.3	1772	52.5
Balochistan	6777	12.5	7.32	925	27.3
Sindh	2592	4.7	3.79	684	20.2
Pakistan	54288	100	16	3381	100

Source: MNFS&R (2016)

3.2 Tomato

Tomato (Lycopersicon esculentum) is rich from Folate, vitamin C, and potassium. Carotenoids are the phytonutrients that are. most prevalent in tomatoes. The most common carotenoid is lycopene, which is followed by beta-carotene, gamma-carotene, phytoene, and a few other minor carotenoids. The antioxidant properties of lycopene and other carotenoids, as well as their abundance in tomatoes makes them good sources of antioxidant activity. Vitamin A, vitamin E, trace minerals, flavonoids, Phyto-steroids, and Phyto-sterols are just a few of the additional health-promoting components found in Tomatoes (Beecher, 1998). In Pakistan it is mainly grown by small farmers due to its wide seasonality. The availability of Tomato and its price vary widely throughout the year. Pakistan annually produces two crops, first in spring season and 2nd in autumn season. Though, in Sind and in the Southern Pakistan, Tomato can be grown throughout the year with the help of tunnel farming adaptation (Soomro et al., 2020). As population of the country is around 210 million as described in census of 2017 and growing at a theatrical rate of 2.1 percent every year. Annual per capita Tomato availability stands at 2.73kg, which has improved gradually from 1.5 kg in 2000. Annual per capita consumption of Tomato has reached at 20.0 kg. Consequently, incredible demand gap exists in the domestic market. Though, to cover this demand gap

Pakistan should focus to increase production to meet the off-season domestic demand by advance production methods (Soomro et al., 2020).

Table 3.2 Production area of Tomato by province during 2016-17

Province	Area (ha)	Production (ton)	%Area share	%Production Share	Yield (ton/ha)
Punjab	8.1	105.6	13.4	18.6	13
Sindh	26.4	195.8	43.6	34.4	7.4
KPK	13.4	127.6	22.1	22.4	9.5
Balochistan	12.6	140	20.8	24.6	11.1
Pakistan	60.5	569	100	100	9.4

Source: MNFS&R (2017)

3.3 Study Area

Two cities are taken as study area Chichawatni and Kamalia purposively. Reason for choosing these adjacent areas is that one is advanced and other is following the traditional method we have tried to motivate the people of Chichawatni to adopt the tunnel farming for more growth and profit, and reason for choosing tomato and cucumber is that these two vegetables are available around all the year with high consumption.

3.3.1 Chichawatni

Located one hundred and fifty kilo meters from the city of Multan city, the Chichawatni presently serves as the main city of Sahiwal Division, subdivided into three City Union Councils and 34 rural Union Councils (District Pre-Investment Study, 2012). is home to many agricultural activities having deep historical roots. It is an important agricultural area whose major agricultural products are Cotton, wool, Wheat, Sugarcane, Oil seed, Bajra and Juwar and potatoes. Chichawatni city is the headquarters of a Pakistani forest division. The local forested area is called Chichawatni Reserved Forest.

3.3.2 Kamalia

Kamalia falls in district Toba Tek Singh with an area of 1115 km2. It is located in sub-tropical, semi-arid region between 710-30/ to 730-45/ East longitude and 300-30/ to 320-30/ North latitude. It receives 350 mm rainfall per year, which mostly occurs in monsoon season (July-August). Its altitude is 164.47 meters above sea level Kamalia is prominent for its fertile agriculture lands, Sugar cane, Wheat, Rice and Cotton are common crops of this area. Now days this city is emerging due to its high tunnel's adaptation and off-season vegetable production which bring the interest of research for this study

3.4 Sample Size

Primary data is collected through well-structured questionnaires from farmers and pesticide applicators. After the pilot investigation. Questionnaire is refined considering the problems confronted during the pilot survey. Total purposely selected sample of 140 respondent farmers are taken for cost benefit analysis, and to access the health impact 140 sprayer's responses also been taken to conduct the study. A sample of 70 farmers are taken from Tehsil Chichawatni where farmers are using traditional methods of Tomato and Cucumber production and 70 farmers are taken as respondent from Tehsil Kamalia with tunnel farming adaptation for the productions of both vegetables.

To select the respondents, a purposive sampling procedure is employed. The respondents than asked about their pesticide usage practices types of pesticides used, problem associated with usage, effect on health, economic costs incurred due to health problems information about pesticides usage, under the workings of plant protection department.

Table 3.3 Data collection from Chichawatni and Kamalia

Tehsil	Farmers (Tunnels)	Farmers (Traditional)	Sprayers (Tunnels)	Sprayers (Traditional)
Kamalia	70	0	70	0
Chichawatni	0	70	0	70

3.5 Research Methodology

The unit of analyses in this study for the economic evaluation are farmers. While for the assessments of health impacts of pesticides unit of analysis are pesticide applicators or sprayers. To evaluate and analyze the health and economic effects of pesticides, there is a need to know two types of information. First one obviously to recognize the adverse health effects of pesticides on human health, second one is to know about the different health cost of illness maybe they are direct or indirect costs linked to pesticide usage in (monetary terms).

Three types of models are used in this study are: 1). Poisson regression model, 2). Environmental Impact Quotient, 3). 2 Stage Least Square Model, Poisson regression model is used to evaluate the adverse health impacts of pesticides on farmer's health, and to analyze the impacts of different elements of chances of getting ill. The EIQ calculator is used to calculate the quotient value for active ingredient present in pesticide sprayed by sprayer. The Two-Stage regression analysis is a statistical method that is used in the estimation of structural equation models. It is the extension of the

OLS method. It is used when the dependent variable's error terms are correlated with the independent variables. In structural equations, we use the maximum likelihood method to estimate the path coefficient.

3.5.1 Impact calculation on sprayer health

The common short-term diseases that appear due to pesticide exposure are skin irritation/itching, respiratory problem/difficulty in breathing, skin allergy, eye irritation and general sickness (Nausea, headache fever or weakness)(Langley & Mort, 2012). These symptoms added up for all the sprayers (involved in pesticide application and mixing) in each parcel to make a count variable both for tunnel fields and traditional fields of discussed vegetables. To investigate the health impacts of pesticide use, the Poisson or negative binomial regression model is implemented depending on the test statistic's nature. The Poisson distribution model is defined by (Cameron et al., 1988) (Eq.3.1).

$$Prob\left(Y_i = {}^{y_i}/_{x_i}\right) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} \quad (3.1)$$

Where Y_i is the dependent variable (frequency of sum of illness) and x_i is a vector of independent variables. λ_i is conditional mean and variance of dependent variable Y_i. The most common function form used for the variable having Poisson distribution is log-linear which can be written as below in (Eq.3.2).

$$D_i = \beta_i + \beta_i X_i + \epsilon_i \quad (3.2)$$

Where D_i is the frequency of symptoms due to pesticide's exposure and X_i is a vector of explanatory variables that include socioeconomic and demographic variables. Among the autonomous variables includes, the total number of sprayers working, the average age of the pesticide applicator, total education of worker involved in spray application, Field use EIQ value of the spray, total time spent in the farm, farm size, pesticide application in tunnel farms (dummy), In more detail complete empirical model can be written as.

$$D_i = \beta_0 + \beta_1 TNF_{di} + \beta_2 AGS_i + \beta_3 EDS_i + \beta_4 AVM_{di} + \beta_5 ETM_{di} + \beta_6 WSH_{di} + \beta_7 TRM_{di} + \beta_8 SMK_{di} + \beta_9 EIQ_{pi} \quad (3.3)$$

Were,

D_i: Frequency of illness to spraying applicator working in the farm of the i^{th} sprayer in last six month (Respiratory difficulty, eye irritation, skin allergy, skin irritation and general sickness[1]).

TNF_{di}: Dummy for the tunnel farming technology in which i^{th} sprayer applied the pesticide (1= sprayed in tunnel farms, otherwise= 0).

AGS_i: The average age of i^{th} sprayer (in years).

EDS_i: Education level of the i^{th} sprayer (in years).

AVM_{di}: Dummy for avertive measure (gloves, goggles, mask, cloths etc.), used by i^{th} sprayer (1 = for using the avertive measure, otherwise = 0).

[1] General sickness includes nausea, headache, vomiting, fever or weakness.

ETM_{di}: Dummy for eating meal or food after spray by i^{th} sprayer (1 = if eats something otherwise = 0).

WSH_{di}: Dummy for washing hand with sanitizers by i^{th} sprayer after the spray (1 = yes otherwise = 0).

TRM_{di}: Dummy for training and information provided by the companies to handle and mixing the sprays to i^{th} sprayer (1 = yes, 0 = no).

SMK_{di}: Dummy for smoking habit of i^{th} sprayer during spray or after spray (1 = yes, 0 = no).

EIQ_{pi}: Environmental impact quotient's value for specific ingredient present in spray applicated by i^{th} sprayer most of the time during season.

3.5.2 Field use EIQ calculation of pesticides

Pesticide ingredients are injurious for health and the environment. The EIQ evidenced to be a wide-ranging measure for evaluating pesticide hazards in agricultural systems. Before calculating Field use rating of pesticides, we have estimated the EIQ value of the active ingredients. The EIQ was developed by (Kovach et al., 1992) and encompasses three main apparatuses: farm worker, consumer and ecological effects (Figure 3.1).

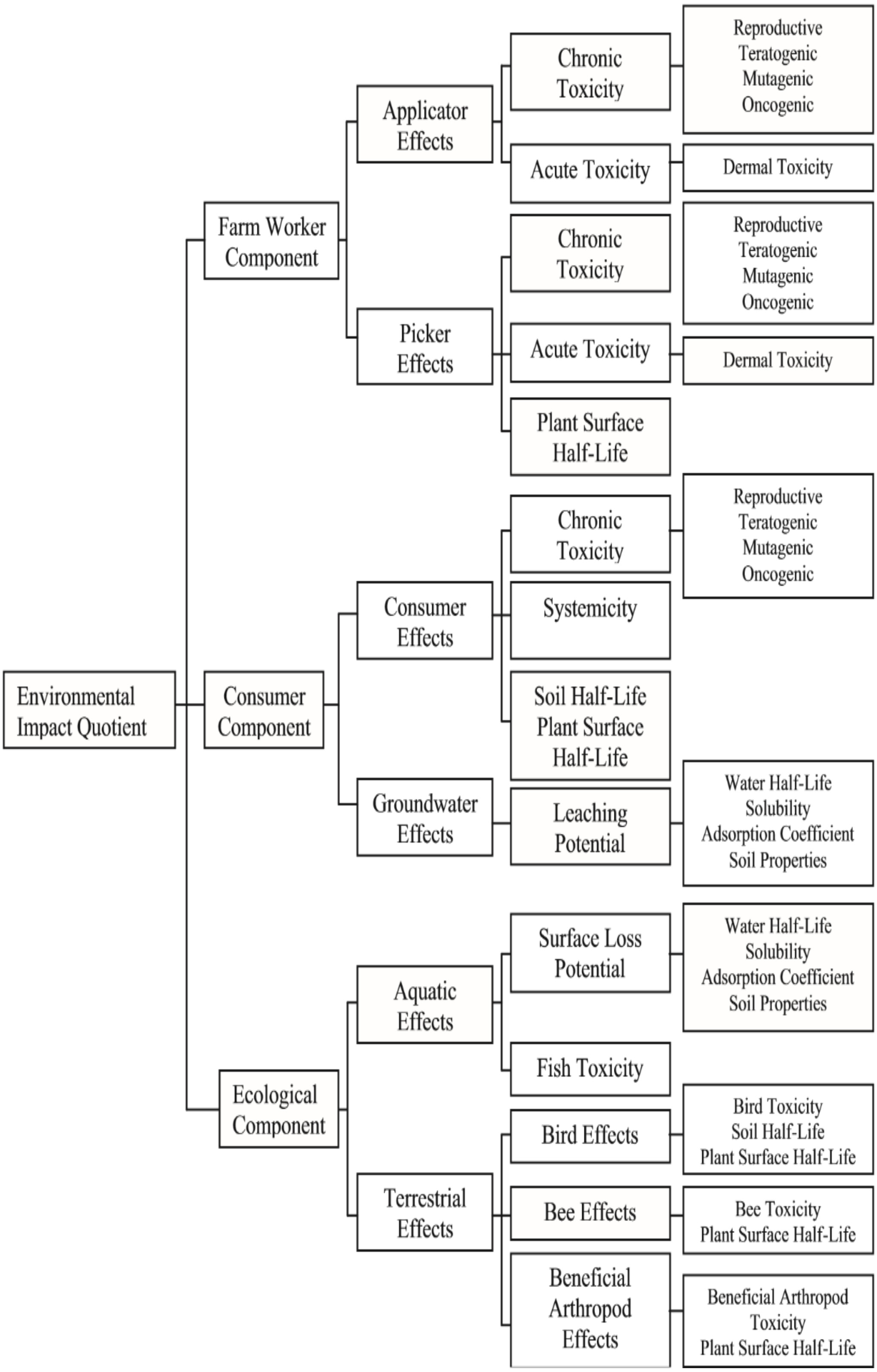

Figure 3.1: Individual environmental factors

The EIQ for each pesticide active ingredient is calculated as in (Eq. 3.4):

$$EIQ = \Big\{C[(DT \times 5) + (DT \times P)] + \Big[\Big(C \times \big({}^{(S+P)}/_{2}\big) \times SY\Big) + L\Big] + \Big[(F \times R)\Big(D \times \big({}^{(S+P)}/_{2}\big) \times 3\Big) + (Z \times X \times P) + (B \times P \times 5)\Big]\Big\}/3 \tag{3.4}$$

Here *C* is chronic toxicity, *DT*, is dermal toxicity, *P* is plant surface half-life, *S* is soil half-life, *SY* is systematicity, *L* is leaching potential, *F* is fish toxicity, *R* is surface loss potential, *D* is bird toxicity, *Z* is bee toxicity, and *B* is beneficial arthropod toxicity. Estimation of farm worker effects involves scoring the pesticides for chronic and dermal toxicity and for persistence on plant material (plant surface half-life). estimated chronic and dermal toxicity of each active ingredient of pesticides by taking the average of the ratings from various long-term laboratory tests conducted on small mammals (rabbits or rats).

Once EIQ values has been estimated for the active ingredients present in pesticide, then field used EIQ value is estimated. The dose (quantity used per acer), the formulation or active ingredient percentage present in pesticide (%age), frequency of application (number of sprays) need to be determined to develop a simple equation eq 3.5:

$$EIQ\ Field\ Use\ Rating = EIQ_{Calculated} \times \%\ active\ ingredient\ \times Rate \tag{3.5}$$

For our concern we have further simplified the formula as Field use EIQ rating is comprises of three main components Field use EIQ value for worker, Field Use EIQ value ecological and Field use EIQ value Consumer. Eq 3.6.

$$Field\ use\ EIQ = \frac{Worker_{EIQ} + Consumer_{EIQ} + Ecological_{EIQ}}{3} \qquad (3.6)$$

For this study we used Field use EIQ values of worker and ecological which is our concern and of the objective. Field use EIQ values for some pesticides have been calculated by adding values obtained from online EIQ calculator and then divided by 2 (table 3.4).

Table 3.4 List of pesticides used with EIQ rating

Insecticide Name	Active Ingredient	Dosage per acer	Price (PKR)	Field Use EIQ
Acelan 20SL	Acetamiprid 20%	250 ml	700	3
Admiral 10EC	Pyriproxyfen 10%	250 ml	1500	0.8
Coregan	Chlorantraniliprole 20%	50 ml	1000	0.4
Corvus 10EC	Novaluron 10%	300 ml	800	0.9
Voliam Flexi 300sc	Thiamethoxam (200g/L) + Chlorantraniliprole (100g/L)	80 ml	1000	1.4
Monex	Emamectin Benzoate (2.1%)	1000 ml	1800	1.2
Polytrin C	Profenofos (400g/L) + Cypermethrin (40g/L)	500 ml	950	25.4
Karate	Lambda-Cyhlothrin (25g/L)	200 ml	650	0.2
Plinum	Pymetrozine 50%	120 g	900	2.6

Polytrin C having highest 25.4 Field use EIQ value in current list calculated as EIQ value of *Profenofos* 40% adding in EIQ value of Cypermethrin 0.4% on 500 ml use per acer.

3.5.3 Health cost of illness due to pesticides

The health cost of illness of the farmers from pesticides experience is directly associated with the dose of total pesticide used in the field, the number of times when a farmer gets in touch with the pesticide [most toxic categories of pesticide], and some other personal behaviors of the farmers. The 2 stage least square model evaluates all types of costs in the second stage, whether they are direct or indirect (Atreya, 2013). Health cost comprises of numerous, tangible and intangible factors, we cannot compute all of them, but some of the factors have a weighty share in estimation of health cost. It depends upon the perception that cost can be averted by preventing illness. It measures all direct and indirect cost of the illness. The direct cost includes the medical expense, while indirect cost is the losses of working days due to ill health, time spent for treatment and loss of efficiency. This study collected data by frequency and severity of illness, and by assessing the costs in terms of doctor fee, medicines purchased, laboratory tests, transportation expenditures, hospital fee and dietary expenses.

The study also tried to gather the data on the losses occurred due to lost working days, poor work efficiency and productivity loss. Thus, the cost of sickness in this study is representing the direct cost of illness only because the respondents failed to report credible data for indirect cost of illness. The cost of illness is regressed on set of independent variables to get the factors influencing health costs, especially the influence of the pesticide usage. The first stage of 2 SLS is to generate the predicted value of dependent variable, the second stage is to simply substitute the independent variables for X and estimate the resulting equation using OLS. The trick to generating a predicted value of dependent variables from equation one is to find a variable that belongs in the second equation (the one predicting X1) but does not belong in the first equation (the one predicting Y) (dung, 1999). In this regression, the health cost of sprayer (in rupees) is taken as the dependent variable and variables affecting health cost are taken as explanatory variables and mathematically it can be written as.

$$HC_i = \beta_0 + ILLp_i + \beta_1 TNF_{di} + \beta_2 AGS_i + \beta_3 EDS_i + \beta_4 AVM_{di} + \beta_5 ETM_{di} + \beta_6 WSH_{di} + \beta_7 TRM_{di} + \beta_8 SMK_{di} + \beta_9 EIQ_{pi} \quad (3.7)$$

Here,

HC_i = Total health cost of illness faced by i^{th} sprayer during the last six months. It includes doctor fee, remedial expenditures, lab test expenditures, traveling expenses.

$ILLp_i$ = Predicted value of the total number of the illness estimated from first equation.

TNF_{di} = Dummy for the tunnel farming technology in which i^{th} sprayer applied the pesticides (1= sprayed in tunnel farms, otherwise= 0).

AGS_i = The average age of i^{th} sprayer (in years).

EDS_i = Education level of the i^{th} sprayer (in years).

AVM_{di} = Dummy for avertive measure (gloves, goggles, mask, cloths etc.), used by i^{th} sprayer (1 = for using the avertive measures, otherwise = 0).

ETM_{di} = Dummy for eating meal or food after spray by i^{th} sprayer (1 = if eats something otherwise = 0).

WSH_{di} = Dummy for washing hand with sanitizers by i^{th} sprayer after the spray (1 = yes otherwise = 0).

TRM_{di} = Dummy for training and information provided by the companies to handle and mixing the sprays to i_{th} sprayer (1 = yes, 0 = no).

SMK_{di} = Dummy for smoking habit of i^{th} sprayer during spray or after spray (1 = yes, 0 = no).

EIQ_{pi} = Environmental impact quotient's value for specific ingredient present in spray applicated by i^{th} sprayer most of the time during season.

3.5.4 Expected signs of Variables

Age: the expected signs of the age considered negative because as we know that when age increases experience increases and when experience increases farmer avoid risks.

EIQ: Expected sign of EIQ is positive because more EIQ means more health damages could occur and more usage means high risk (Abedullah et al., 2015).

Education: education means awareness when a farmer is aware from the adverse effects of pesticide there is less chances of risk. Negative sign is expected for education. In this study this variable gain information of the farmers. Whether they are educated or illiterate.

Avertive Gear: Application of the mitigation gears is effective tool for decreasing the adverse health impacts on the pesticide applicators(Nguyen & Tran, 1999)..

Washing Hands: Taking meal or drink some water or tea without washing hands and smoking are the worst bad habits of the pesticide workers in the field. These habits pose a serious threat on the workers' health. The expected sign is negative with illness.

Mixing: The expected sign of mixing the chemicals is positive. Workers mix up the pesticides with hands into other toxic pesticides to get more results that mixing is very harmful for the health of the workers(Prabhu, Cynthia, & Florencia, 1994).

3.5.5 Cost-benefit analysis

Cost-benefit analysis helps the choice maker to take a better decision in terms of financial gains for a future product. Researchers analyze the costs and benefits associated to project. After analyzing these facets of costs and benefits manger takes the decision whether this project is advantageous for them or not. According to our research objective we evaluated the decision of adopting tunnel technology for the production of Cucumber and Tomato, weather this adaptation is financially acceptable or not.

The standard procedure of project evaluation is implemented to study the feasibility of tunnel farming. The profit from the tunnel farm is estimated by using the basic formula of profit (revenue-costs). The project viability indicators such as benefit-cost ratio (BCR) and internal rate of return (IRR) are assessed, aspects are given below. The operational cost (labor cost, maintenance cost) and benefits are estimated for project life for period of 15 years which is converted into present value. The detail of costs and formula to estimate Net return is given below in Equation 3.8.

$$AII_{ij} = \sum_{j=1}^{2} APo_{ij}AYo_{ij} - APi_{ij}AYi_{ij} - AFc_{ij} \quad (3.8)$$

Here,

$A\Pi_{ij}$ = is the average profit gained of the i^th farmer for j^th production method[2] per annum.

$APo_{ij}APo_{ij}$ = are the price and quantity of the total output gained by i^th farmer by using j^th production method.

$APi_{ij}APi_{ij}$ = are the price and quantity of the total variable inputs used by the i^th farmer in j^th production method.

AFc_{ij} = is the average fixed cost incurred by the i^th farmer in j^th production method.

Our study first assessed the average net profit for the farmer using tunnel farming for Tomato and Cucumber and then for the farmers using traditional farming method for both crops. In our sample there are four types of farmers, implying that average net profit for each type of the farmer is estimated separately, and then total sample size is divided into two major groups, first group is of tunnel farmers and the other is of traditional farmers.

$$NPV_s = \sum_{t=0}^{15} \frac{AII_{st}}{(1+r)^t} \quad (3.9)$$

The net present value for the benefit analysis is estimated by the implementation of the *NPVs* equation (eq. 3.9). If the *NPVs* is equal to 0 then *r* is equal to the internal rate of return (IRR), that can be estimated by using the equation given above. The results of benefit-cost ratio indicate the return on each rupee of investment that is made to adopt the tunnel farming method for the production. The *BCR* (Benefit-Cost Ratio) is

[2] Production method is tunnel farming or traditional farming method for vegetable production.

estimated by using the present value of benefit and cost as in the below given equation (eq. 3.10).

$$BCR = \frac{Present\ value\ of\ benefits}{Present\ value\ of\ cost} \quad (3.10)$$

Present value of benefits means all cash inflows throughout the life of project discounted at a rate to get present value of benefits and its comparison with the present value of costs incur throughout the project. For discounting future values into present values, we use average interest of state bank of Pakistan from 1991 to 2020 which is 8 percent. If the cost-benefit ratio of project is greater than 1 then we accept the project but, in our scenario, we compared the *BCR* for tunnel farming and traditional farming to check which project is more beneficial.

CHAPTER 4

EMPIRICAL RESULTS AND DISCUSSION

4.1 Descriptive Statistic

Overall summary of the variables describes the mean values, minima and maxima of the observation for illness. We estimated mainly 5 short term symptoms for our study (skin irritation, skin allergy, eye irritation, difficulty in breathing and general sickness) faced by pesticides sprayers by direct pesticide exposure. The number of symptoms faced by each pesticide applicator is added to get the total number of illnesses, where mean value of the total number of illnesses is (0.82) with minimum value (0) and maximum value (4). Average age of the sprayer in our sample data is 31 years with minimum age of 18 years and maximum is 57 in our sample size, which reveals that young-aged persons are working more as sprayer in either farming system. Education of pesticides applicators found (5.3) as mean with 0 minimum level and 12 maximum level, which implies that most of the sprayers can write and read their name.

Only 47% of the sprayers are using avertive gear for prevention. About 53% of the sprayers eat meal after the spray as the mostly sprayers apply spray on fields in daytime. About 83% of the sprayers wash their hands with sanitizer or soap after the spray. Only 20% of the sprayers from the sample been provided training and information by pesticides company for mixing and handling of sprays this number is low as an assumption we can say that only multinational companies provide this, and small farmers do not use expensive pesticides they prefer local pesticides which impact more on health. About 62% of the respondents are smokers who use to smoke during pesticide application or after the spray with meal. Environmental impact quotient rate having (12.6) mean value with (1.5) minimum and (157.1) maximum value, more the value rise affects the human health adversely. Health cost incurred by the respondent in our study is 488 rupees as mean value and 3200 rupees as maximum during last six months. total number of sprays has mean value of (7.14) sprays per acer with minimum 4 sprays and maximum 12 sprays per season. Mean value of area under cultivation is (4.06) acers, minimum area cultivated is 1 acer and 50 acers are maximum. Further descriptions of our study are elaborated in the figure 4.1.

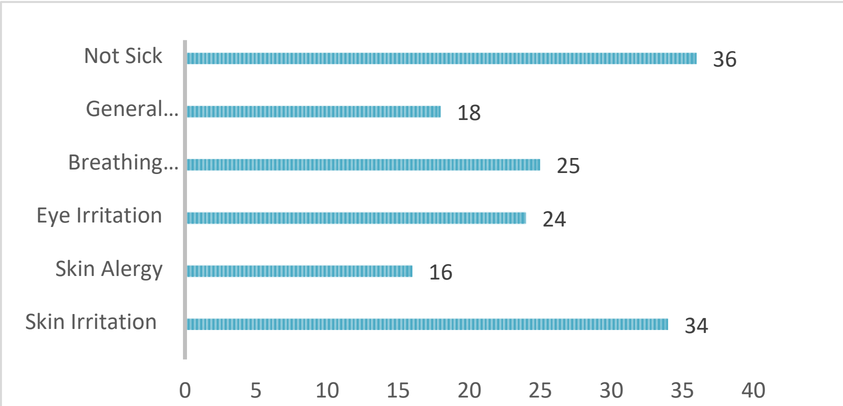

Figure 4.1: **Illness found among respondents**

Inclusively, we found 104 out 140 respondents faced by illness due to pesticides exposure, which indicates 74.3% illness rates among sprayers. In which general sickness faced by 15.7% of the respondents, breathing difficulty is faced by 21.7% respondents, eye irritation s faced by 21% of the respondents, skin allergy is faced by 14% of the respondents and skin irritation is faced by 30% of the respondents approximately.

4.2 Comparative Description

We compared the average value of different variables between two groups of sprayers applicating pesticide in tunnel farming and traditional farming for both crops (Tomato and Cucumber) from two different Tehsils Kamalia and Chichawatni respectively. Which make easy for us to compare two Tehsils and two farming systems simultaneously or side by side. We implemented the statistical t-test to compare the mean values of two groups. It is perceived that mean value (1.01) of total number of illnesses faced by pesticide sprayers applicating in traditional farming system significantly higher than sprayers working in tunnel farming having mean value (0.6). This implies that chance of getting short term health impacts is significantly higher for the pesticide sprayer working in traditional farming field than in tunnel farming and this supports to answer first objective of our study (Table 4.1).

Our descriptive statistic reveals in terms of the average age of sprayers of tunnel and traditional farming system no significant difference. The mean values of age of sprayers (30) in tunnel farming and (32) in traditional farming. Education level significantly high in tunnel sprayers with mean value (6) and 5 in counterpart. Which implies that tunnel farmer hires expert sprayers. The behavior of eating meal after the is commonly found (0.5) mean value but insignificant. The smoking habit is significantly higher in traditional sprayers with mean value (0.77), in tunnel farming system mean value for smoking is (0.47). This is because traditional sprayer remains in an open surrounding and maybe he thinks that it is less harmful to smoke in open environment (Table 4.1).

Total number of sprays is significantly high in Traditional farming as compared to the tunnel farming the mean values are (8.8) and (5.4) correspondingly. Its means that pesticide requirement is much higher in traditional farming system and its about half the number of spray of pesticides required in tunnels, as tunnel sheets itself protects the product from insect attack. It is also found that awareness about the hazardous effects of pesticides is significantly high in the tunnel farming sprayers than traditional farming sprayers, mean values are (0.73) and (0.53) respectively. Health cost incurred by the traditional sprayer is significantly higher than the tunnel farming sprayer mean values are recorded (684.9) and (429.7) respectively. (Table 4.1).

Table 4.1: Descriptive Comparison Tunnel farming and Traditional farming

Variables	Tunnel Farming	Traditional Farming
Illness	0.63	1.01***
Age of sprayer	32	30
Education of sprayer	6*	5
Use of avertive measures	0.52	0.43
Area under cultivation	5**	3.12
Eating meal after spray	0.5	0.5
Awareness about hazards (pesticide)	0.73**	0.53
Hand wash with soap	0.84	0.81
Smoking after spray	0.47	0.77***
Environmental Impact Quotient	13.34	12.36
Total no. of. Sprays	5.4	8.8***
Health cost incurred	429.7	684.9***

***, **, and * indicates the level of significance at 1%, 5% and 10% respectively.

We have also investigated the percentage of each disease among both groups by the simple mathematics of percentage, in both groups we have 70 respondents. In tunnel farming we found 38 people sick with asked diseases and 32 not sick, which indicated that 54.3% of the respondents faced by the illness due to exposure of pesticide, in which 28.9% of the ill respondents are faced by skin irritation, 13.2% skin allergy, 21.1% are face d by eye irritation, 34.2% are faced by breathing difficulty and 18.4% of the respondent of tunnel farming are faced by general sickness during last six month due to pesticide exposure. (Figure 4.2).

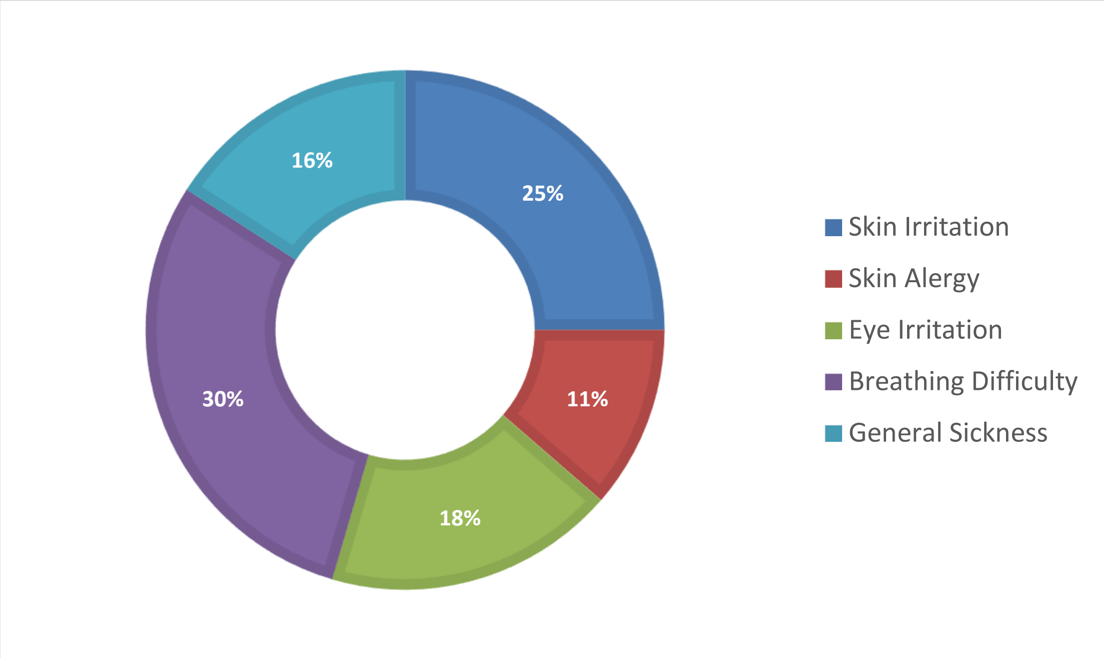

Figure 4.2: **Illness percentage in Tunnel Farming due to Pesticides**

In traditional farming we found 66 of the respondents with asked diseases and 4 not sick, which indicated 94.3% illness rate in traditional farming due to pesticides exposure, in which 32.4% of the ill respondents are faced by skin irritation, 15.5% are faced by skin allergy, 22.5% are faced buy eye irritation, 14.1% are faced by breathing difficulty and 15.5% of the ill respondents are faced by general sickness during last six months illness due to pesticides contact. (Figure 4.3).

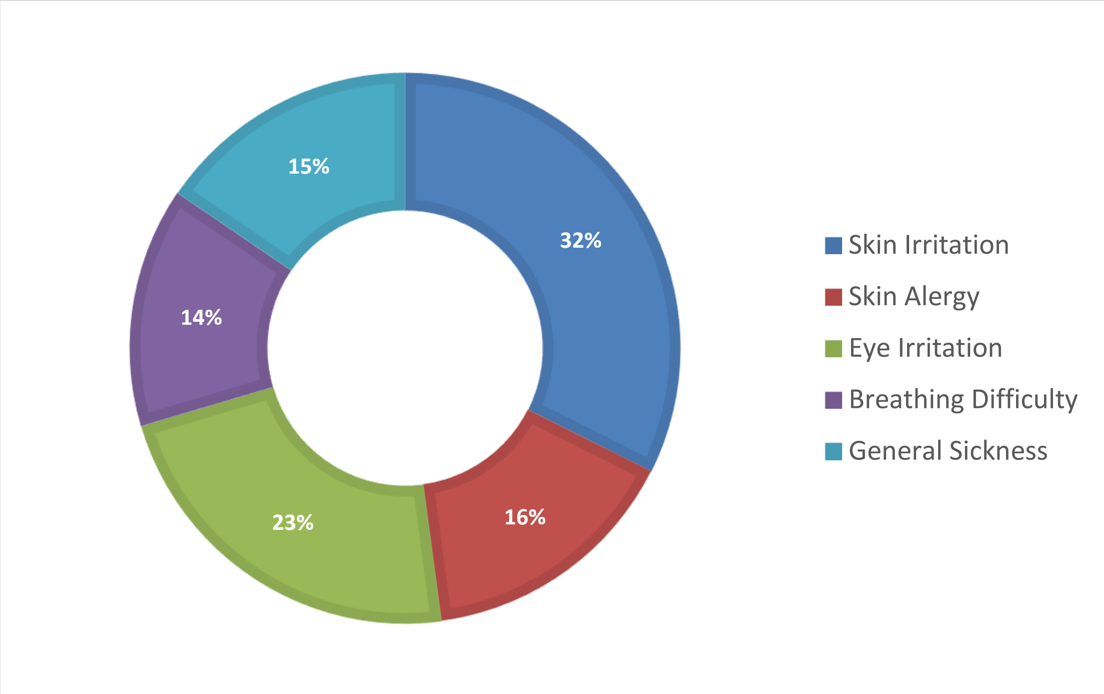

Figure 4.3: **Illness percentage in Traditional Farming due to Pesticides**

Table 4.2: Illness Comparison of the Tunnel farming and Traditional farming

Illness	Tunnel Farming (%)	Traditional Farming (%)
Skin Irritation	25	32.4
Skin Allergy	11.4	15.5
Eye Irritation	18.2	22.5
Breathing Difficulty	29.5	14.1
General Sickness	15.9	15.5

4.3 Results of Econometric Analysis

In this chapter we will discuss the outcomes of econometric models and their descriptions. Results and discussion section are divided into following three subsections: Section one deals the disease due to direct exposure of pesticides particularly on pesticide applicator health. Section two is elaborating the determinants of health cost faced by pesticide sprayers in tunnel farm fields and in traditional farm fields of Tomato and Cucumber. Section three is comprising of cost and benefit analysis of tunnel farming and traditional farming of both vegetables to evaluate the internal rate of return and payback period.

4.3.1 Pesticide impact on sprayer health

The study is endeavored to investigate the factors (Socioeconomic, physical and preventive measures) affecting the health symptoms (skin irritation, skin allergy, eye irritation, breathing difficulty, general sickness) faced by the sprayer either in tunnel farming or traditional farming. A large area of literature indicates that these symptoms are caused by the direct exposure of pesticides (Choudhury et al., 2013; Antleand & Pingali, 1994; Yasin, & Safi, 2002; Cocco, 2002; John et al. 1994; Khan, 2007; Abedullah et al., 2015).

The symptoms faced by each sprayer during the last six months are added up to make a count variable. Hypothesis of the study is given below.

H_0 = Dependent variable (count) is over dispersed.

H_1 = Dependent variable (count) is not over dispersed.

Results rejected the null hypothesis which indicates that our dependent variable is not over dispersed. By using the empirical model expressed in equation 3.1, a Poisson regression model is estimated. The empirical results of our Poisson regression model elaborate the highly significant difference in illness with regarding our dummy variable for tunnel farming system where we selected tunnel farming as 1 and traditional farming as 0, we can say with confidence level at 1 percent that logs of expected illness of sprayers is expected to be decrease by (0.56) units in tunnel farming than in traditional farming as we have a negative sign with our coefficient. It means that there are less chances of getting symptoms among sprayers of tunnel farming, one reason for this could be that number of sprays of pesticides is greater in traditional farming system, the open surrounding is more prone to insects, so there is more chance of getting exposure of pesticide (Table 4.3).

Ages of the sprayers have positive impact on the illness this relationship shows that there is vagueness regarding middle-aged farmer having greater chances of getting ill. Thus, age does not have a significant relationship with illness. It means that expected chance of getting illness by the pesticide's exposure are same for the young sprayers or elder sprayers or we also assume that a person could be ill by pesticides at any level of age. The regression results show that the education affect the log of expected illness negatively, as shown in the table 4.3 that education has negative but insignificant impact on illness, more knowledge about the pesticides results in a decrease (0.02) units log of illness. Here, in this study, education means ability to read the precautions about the pesticides mentioned on pesticide label (Table 4.3).

There are some factors like avertive measure or protective gear such as gloves, glasses, mask, etc. If a sprayer adopts these avertive measures during spray it reduces the chances of illness, in our empirical model the precautionary measure variable shows the negative sign with significant results at the 10% confidence interval. These results states that if the sprayer uses the precautionary gadgets the log of expected illness for sprayer is expected to be decrease by 0.42 units. It implies that sprayer should use the proper precautionary gadgets while spraying to reduce the hazardous impacts of pesticides, so the improper precautions result in more chances of illness (Table 4.3).

The probability of getting short term diseases is very prone to the personal and social attributes of the sprayers. The empirical result shows that the variable eating meal after the spray shows the positive sign ith our predicted variable at 5% confidence interval. So, with positive relationship it is estimated that the log expected illness for sprayer increase by 0.49 units due to 1 time meal consumption after the spray. The result estimated that the variable hand wash is insignificant but shows unexpectedly the positive sign with our predicted variable, its means that sprayers wash hands, but they do not wash their hands in a proper way or with sanitizer. Results also indicate that variables awareness about health hazards and training or information provided by the companies to handle, mix and use of pesticide are insignificant but expectedly shows negative impact on illness, implying that, awareness and training about the pesticides needs to impart in the study areas. This can help to reduce the disease percentage among our respondents (Table 4.3).

The chances of illness are very sensitive to the personal characteristic of the sprayers. The personal behavior like smoking during mixing spray, spraying on fields or after spraying. The results estimated that the smoking habit has the positive relationship with the illness, also having the significant impact on the illness at the 10% confidence interval, it means we can predict that due to smoking the log of expected illness increase 0.42 units significantly. This implies that sprayers should avoid the personal habit of smoking during field work to reduce the health damages.

The results of our model indicate that environmental impact quotient (EIQ) has highly significant impacting on illness with 1% confidence interval. It is estimated that 1 unit of EIQ increase the log of expected illness by 0.12 units. It implies that farmers should use the pesticides with the minimum value of EIQ to reduce the health impacts of pesticides on sprayers. (Table 4.3).

Table 4.3: Poisson regression results for illness

illness	Coef.	St. Err.	t-value	p-value	[95% cnf.	Interval]
Dummy tunnels	-.557***	.212	-2.63	.009	-.972	-.141
Ages	.002	.011	0.15	.879	-.019	.022
Education	-.024	.032	0.74	.459	-.039	.087
Av. Measures	-.424*	.233	-1.82	.069	-.88	.033
Eating meal.	.488**	.223	2.18	.029	.05	.925
Hand wash	.004	.238	0.02	.987	-.463	.471
Awareness	-.072	.201	-0.36	.722	-.466	.323
Training.	-.016	.247	-0.07	.947	-.501	.468
Smoking	.322*	.248	1.70	.088	-.063	.908
EIQ.	.124***	.003	3.53	.001	.005	.019
Constant	-.737	.546	-1.35	.178	-1.807	.334
Mean dependent var		0.821	SD dependent var			0.603
R-squared		0.161	Number of obs.			140
F-test		47.236	Prob > chi2			0.000
Akaike crit. (AIC)		268.265	Bayesian crit. (BIC)			300.623

***, **, and * indicate the level of significance at 1%, 5% and 10% respectively.

4.3.2 Health cost estimation

There are two types of treatment the first one is the clinical treatment and the second one is the self-treatment. Self-treatment mostly has low expenses but a visit to the clinic results different types of expenditures like doctor fee, medicinal cost, cost of loss of working hours, etc. similarly another cost that is related with the hospital treatment is the travelling cost, this study estimates the average travelling cost of Rs.175. Cost which is some time indirect is the cost of the loss of working hours, when the sprayer is getting ill then he is sacrificing his working days or hours due to illness. These all-costs merge into one cost that is total health cost, the average cost of health that farmers pay for their treatment is approximately 560 rupees per season. To estimate the determining factor of health cost ordinary least square method (OLS) is employed. All descriptive variables are identified through the literature review.

Our empirical results demonstrate that the 1% significant coefficient of the predicted value of the total number of illnesses among pesticide sprayers has indicated that 1 unit increase in health symptom leads to an increase in the health cost by RS. 438. The results are in line with the general considerate that the more you are ill, the more you go to the doctor for treatment. The empirical findings reveal that education has a negative impact on the health cost with 5 % significance level, and it implies that I unit of education leads to decrease the health cost by 14 Rs. The coefficients of age, dummy for washing hands, dummy for awareness about hazardous impacts of pesticides, and dummy for training or information provided by the companies are statistically insignificant but their signs are as per the expectations except dummy for hand wash.

Furthermore, our results reveal that tunnel farming adaptation has negative and significant impact on sprayer’s health cost, and there is Rs 383 less cost in tunnels farming than sprayers working traditional farming. The coefficient of avertive measure to avoid health hazards significantly indicates that the sprayers who uses preventive gear during spray and mixing are facing Rs.256 less cost than their counterparts. The health cost associated with short term diseases is very sensitive to the personal and social attributes of the sprayers. The empirical result shows that the variable eating meal after the spray shows the positive sign ith our predicted variable at 1% confidence interval. So, with positive relationship it is estimated that 1 unit of eating meal after the spray is causing cost of Rs.327 to the sprayer (Table 4.4).

The cost of illness is very prone to the personal characteristic of the sprayers. The personal actions like smoking during mixing spray, spraying on fields and after spraying. The results estimated that the smoking habit has the positive relationship with the illness, also having the significant impact on the illness at the 1% confidence interval, it means that its 1-unit increase cause the cost to increase by Rs. 176 to the pesticide sprayer. The results of health cost regression indicate that environmental impact quotient (EIQ) has highly significant impacting on cost with 1% confidence interval. It is estimated that 1 unit increase EIQ value cause the cost of Rs. 91 increases for the sprayer. (Table 4.4)

Table 4.4: Regression results for Health cost

Health cost	Coef.	St. Err.	t-value	p-value	[95%cnf.	Interval]
Illness predicted	437.6***	109.6	-3.99	.00	-654.6	-220.6
Dummy tunnels	-383.3***	53.9	-7.11	.00	-489.9	-276.7
Ages	-1.2	1.9	-0.62	.538	-5.1	2.7
Education	-14.6**	6.3	2.29	.023	2.0	27.3
Av. Measures	-256.3***	52.5	-4.88	.00	-360.3	-152.3
Eating meal.	326.8***	53.5	6.11	.00	220.8	432.6
Hand wash	47.8	50.6	0.94	.348	-52.4	148
Awareness	-8.3	43.7	0.19	.849	-78.	94.
Training.	-42.9	48.1	-0.89	.374	-138.2	52.2
Smoking	176.8***	48.8	3.62	.00	80.1	273.5
EIQ.	91.8***	2.7	10.91	.00	24.4	35.2
Constant	492.8**	119.7	4.11	.00	255.8	729.8
Mean dependent var		557.379	SD dependent var			488.400
R-squared		0.815	Number of obs			140
F-test		51.099	Prob > F			0.000
Akaike crit. (AIC)		1917.947	Bayesian crit. (BIC)			1953.247

***, **, and * indicate the level of significance at 1%, 5% and 10% respectively.

4.3.3 Cost-Benefit Analysis

To promote or invest in any project its economic evaluation is mandatory which creates an indication for policymakers, financers and private investors. There are different indicators of economic evaluation including CBR (cost benefit ratio analysis), NPV (net present value) and IRR (internal rate of return). We implemented cost-benefit analysis (CBA) to evaluate tunnel farming technology for Cucumber and Tomato production to provide maximum possible profit. We did the BCR for Tomato and Cucumber separately for tunnel farming and then for traditional farming for 1 acer of the land from each farmer to better understand the difference. Cost and benefit analysis for tunnel farming and traditional farming has been discussed in detail below.

I. Tunnel Farm for Cucumber

Assessing the cost benefit analysis for 1 acer Cucumber farm all the costs are elaborated in our cost benefit analysis. Basic thing required for the tunnel farm is iron rod according to the sample data on an average 290 rods used on 1 acer, average cost of the iron rods is Rs. 420600 per acer and it is our fixed cost, according to the literature average lasting of the iron rods is 10 to 12 years so we did the cost benefit analysis for 10 operational years (Nasir, 2017). As we have taken the tunnel farming sample from Kamalia, so we have taken the average land rent cost from Kamalia which is Rs. 65000 per acer per annum. Plastic sheets are used to cover the plants for the protection and to make the temperature feasible for the crop, it need to be replaced every time in each year so average variable cost of the plastic sheet is Rs. 68000 per acer per annum. Tunnels need to be installed and then uninstall for the crop rotation so, average cost for the installation and uninstallation of the tunnels is Rs 21000 per acer per annum. Plastic strings are used to hold the plant along with tunnel structure as per the data 2 to 3 rolls of plastic string used for 1 acer, average cost of plastic strings is Rs. 12900 per acer per annum.

Machinery and equipment required for different operation like land preparation, leveling and ridge making, average machinery cost for 1 acer is Rs. 18500 per annum.

Seed is also the basic part of the production according to our data sample all the respondents used hybrid and certified seed for their production, average seed cost of Cucumber for tunnel farm is Rs. 75000 per acer per annum. Irrigation required for Cucumber is after every 7 days and 15 to 18 irrigations are required for 1 season, data demonstrate in our study that canal water is available but time allowed for the irrigation is too short, on an average 1 farmer gets 20 to 30 minutes for the irrigation for this reason almost every farmer install tube well in their fields to properly irrigate their crops and this increase the irrigation cost ultimately, average irrigation cost for 1 acer is Rs. 20000 per acer per annum as it includes the electricity consumed to irrigate the fields by tube well and Abyana paid by the farmers.

Fertilizer requirement of the Cucumber is too high for tunnels as it require fertilizer on every irrigation, this increases the fertilizer cost. Average fertilizer cost for the Cucumber is Rs. 145000 per acer per annum. Farmyard manure is also used by the farmers, on an average 3 to 4 trolleys are required for 1 acer of Cucumber, average cost of the farmyard manure is Rs. 10500 per acer per annum. Pesticide requirement for the tunnel farm is less but fungicides requirement is high as Cucumber is very sensitive to humidity and temperature, so the attack of fungus is high which require more fungicides than traditional farming, average cost of all the chemicals used in tunnel farm is Rs.26000 per acer per annum. A huge number of labors is required to manage and to keep maintain the tunnel farm, average labor cost for Cucumber farm is Rs. 130000 per acer per annum. Transportation cost depends on the marketed city and total number of bags transported, average transportation cost for Cucumber farm is Rs. 160000 per acer per annum.

According to our sample data, a Cucumber farm owner can earn by selling total output, all season is divided into three segments based on harvest i.e., first harvest, middle harvest and last harvest with 1st price, 2nd price and 3rd price respectively. Average output from 1 acer Cucumber farm is Rs. 1640000 per annum.

The study further estimated the investment by engaging benefit-cost analysis and internal rate of return (IRR) tools of project valuation. The values of economic analysis of Cucumber tunnel farm are reported in appendix II (A). The present value of costs and benefits are evaluated by using the current market interest rate (8%) as reported in appendix II (A) due to space limitation. The cost and benefit of Cucumber tunnel farm is reported for 10 years (iron rod life life). According to our sample data tunnel farm generate profit from the very first year of the installation. After 10 years farm would be able to generate net profit of 10.4 million rupees. Benefit cost ratio indicate that if we spend Rs.1 on Cucumber tunnel farm then it generates Rs. 1.6 in return. The internal rate of return (IRR) from Cucumber farm is 85.75 percent (Appendix II). The values of IRR 85.8 percent clearly indicate that investment on Cucumber tunnel farm generates higher profit than the ongoing market interest rate, reflecting viability of the investment (Table 4.5).

II. Tunnel Farm for Tomato

To analyze cost and benefit for 1 acer Tomato farm all the costs and benefits are elaborated in our study. Basic thing required for the tunnel farm is iron rod according to the sample data on an average 295 rods used on 1 acer, average cost of the iron rods is Rs. 430700 per acer and it is our fixed cost, according to the literature average life span of the iron rods is 10 to 12 years so we did the cost benefit analysis for 10 operational years (Nasir, 2017). As we have taken the tunnel farming sample from Kamalia and Sahiwal due to unavailability of Tomato farmers in Kamalia, so we have taken the average land rent cost from Kamalia and Sahiwal which is Rs. 600000 per acer per annum. Plastic sheets are used to cover the plants for the protection and to make the temperature feasible for the crop, it need to be replaced every time in each year so average variable cost of the plastic sheet is Rs. 70000 per acer per annum. Tunnels need to be installed and then uninstall for the crop rotation so, average cost for the installation and uninstallation of the tunnels in 1 year is Rs 22000 per acer per annum. Plastic strings are used to hold the plant along with tunnel structure as per the data 2 to 3 rolls of plastic string used for 1 acer, average cost of plastic strings is Rs. 15000 per acer per annum.

Machinery and equipment required for different operation like land preparation, leveling and ridge making, average machinery cost for 1 acer is Rs. 20000 per annum. Seed is also the basic part of the production according to our data sample all of the respondents used hybrid and certified seed for their production, average seed cost of Tomato for tunnel farm is Rs. 50000 per acer per annum. Irrigation required for Tomato is after every 7 days and 35 to 40 irrigations are required for 1 season as 1 season for Tomato last for 8 months approximately, data demonstrate in our study that canal water is available but time allowed for the irrigation is too short on an average 1 farmer gets 25 to 30 minutes for the irrigation for this reason almost every farmer install tube well in their fields to properly irrigate their crops and this increase the irrigation cost ultimately, average irrigation cost for 1 acer is Rs. 25000 per acer per annum as it includes the electricity consumed to irrigate the fields by tube well and Abyana paid by the farmers.

Fertilizer requirement of the Tomato is high but its less than Cucumber farm, average fertilizer cost for the Tomato farm is Rs. 95000 per acer per annum. Farmyard manure is also used by the farmers on an average 2 to 3 trolleys are required for 1 acer of

Tomato farm, average cost of the farmyard manure is Rs. 7000 per acer per annum. Pesticide requirement for the tunnel farm is about 6 to 7 sprays while fungicides requirement is high about 12 to 14, average cost of all the chemicals used in tunnel farm is Rs. 35000 per acer per annum. A huge number of labors is required to manage and to keep maintain the tunnel farm, average labor cost for Cucumber farm is Rs. 212000 per acer per annum. According to our sample data, a Tomato farm owner can earn by selling total output, all season is divided into three segments based on harvest i.e., first harvest, middle harvest and last harvest with 1st price, 2nd price and 3rd price respectively. Average output from 1 acer Tomato farm is Rs. 1825000 per annum. Transportation cost depends on the marketed city and total number of bags transported, average transportation cost for Tomato tunnel farm is Rs. 81000 per acer per annum.

The study further estimated the investment by engaging benefit-cost analysis and internal rate of return (IRR) tools of project valuation. The values of economic analysis of Tomato tunnel farm are reported in appendix II (B). The present value of costs and benefits are evaluated by using the current market interest rate (8%) as reported in appendix II (B) due to space limitation. The cost and benefit of Tomato tunnel farm is reported for 10 years as per iron rod life span. According to our sample data tunnel farm generate profit from the very first year of the installation. After 10 years farm would be able to generate net profit of 28.1 million rupees. Benefit cost ratio indicate that if we spend Rs.1 on Tomato tunnel farm then it generates Rs. 1.8 in return. The internal rate of return (IRR) from Tomato farm is 104.9 percent (Appendix II). The values of IRR 104.9 percent clearly indicate that investment on Tomato tunnel farm generates much higher profit than the ongoing market interest rate, reflecting viability of the investment (Table 4.5).

III. Traditional Cucumber Production

For the Assessment of cost benefit analysis for 1 acer Cucumber production, all the costs are elaborated in our study. As we have taken the Traditional farming sample from Chichawatni, so we have taken the average land rent cost from Chichawatni which is Rs. 57000 per acer per annum. Machinery and equipment required for different operation like land preparation, leveling and ridge making, average machinery cost for 1 acer is Rs. 18000 per annum. Seed is the basic part of the production according to our data sample all of the respondents used hybrid and certified seed for their production, average seed cost of Cucumber for traditional production of Cucumber is Rs. 50000 per acer per annum.

Irrigation required for Cucumber is after every 7 days and 12 to 15 irrigations are required for 1 season as 1 season for traditional hybrid Cucumber last for 4 to 5 months approximately, data reveals in our study that canal water is available but time allowed for the irrigation is too short on an average 1 farmer gets 25 to 30 minutes for the irrigation for this reason almost every farmer install tube well in their fields to properly irrigate their crops and this increase the irrigation cost ultimately, average irrigation cost for 1 acer is Rs. 15000 per acer per annum as it includes the electricity consumed to irrigate the fields by tube well and Abyana paid by the farmers.

Fertilizer requirement of the Cucumber is high, average fertilizer cost for the conventional Cucumber production is Rs. 1025000 per acer per annum. Farmyard manure is also used by the farmers on an average 2 to 3 trolleys are required for 1 acer of Cucumber farm, average cost of the farmyard manure is Rs. 10000 per acer per annum. Pesticide requirement for the traditional production is about 8 to 10 sprays while fungicides requirement is low about 4 to 5, average cost of all the chemicals used in Cucumber production is Rs. 20000 per acer per annum. A huge number of labors is required to manage and to keep maintain the Cucumber field, average labor cost for Cucumber production is Rs. 110000 per acer per annum. According to our sample data, a conventional Cucumber farmer can earn by selling total output, all season is divided into three segments based on harvest i.e., first harvest, middle harvest and last harvest with 1st price, 2nd price and 3rd price respectively. Average output from 1 acer Cucumber sown is Rs. 625000 per annum. Transportation cost depends on the marketed city and total number of bags transported, average transportation cost for Traditional Cucumber is Rs. 95000 per acer per annum.

The study further estimated the investment by engaging benefit-cost analysis and internal rate of return (IRR) tools of project valuation. The values of economic analysis of Cucumber production are reported in appendix II (C). The present value of costs and benefits are evaluated by using the current market interest rate (8%) as reported in appendix II (C) due to space limitation. The cost and benefit of Cucumber production farm is reported for 10 years as compared the results with Cumber tunnel farm. According to our sample data traditional Cucumber production generate profit from the very first year. After 10 years farm would be able to generate net profit of 211715 rupees per acer per annum. Benefit cost ratio indicate that if we spend Rs.1 on traditional Tomato production then it generates Rs. 1.2 in return. The internal rate of return (IRR) from traditional Tomato production is 25.8 percent (Appendix II). The values of IRR 25.8 percent clearly indicate that investment on traditional Tomato production generates higher profit than the ongoing market interest rate, reflecting viability of the investment (Table 4.5).

IV. Traditional Tomato Production

To assess the cost benefit analysis for 1 acer Tomato production all the costs are elaborated in our cost benefit analysis. As we have taken the Traditional farming sample from Chichawatni, so we have taken the average land rent cost from Chichawatni which is Rs. 57000 per acer per annum. Machinery and equipment required for different operation like land preparation, leveling and ridge making, average machinery cost for 1 acer is Rs. 18000 per annum. Seed is the basic part of the production according to our data sample all the respondents used hybrid and certified seed for their production, average seed cost of Tomato for traditional production of Tomato is Rs. 25000 per acer per annum.

Irrigation required for Tomato is after every 7 days and 12 to 15 irrigations are required for 1 season as 1 season for traditional hybrid Tomato last for 4 to 5 months approximately, data validate in our study that canal water is available but time allowed for the irrigation is too short, on an average 1 farmer gets 25 to 30 minutes for the irrigation for this reason almost every farmer install tube well in their fields to properly irrigate their crops and this increase the irrigation cost ultimately, average irrigation cost for 1 acer is Rs. 15000 per acer per annum as it includes the electricity consumed to irrigate the fields by tube well and Abyana paid by the farmers.

Fertilizer requirement of the Tomato is high, average fertilizer cost for the conventional Tomato production is Rs. 57000 per acer per annum. Farmyard manure is also used by the farmers on an average 1 to 2 trolleys are required for 1 acer of Tomato farm, average cost of the farmyards manure is Rs. 6000 per acer per annum. Pesticide requirement for the traditional farm is about 10 to 12 sprays while fungicides requirement is low about 4 to 6, average cost of all the chemicals used in traditional Tomato production is Rs. 19000 per acer per annum. A huge number of labors is required to manage and to keep maintain the Tomato field, average labor cost for Tomato production is Rs. 75000 per acer per annum. According to our sample data, a conventional Tomato farmer can earn by selling total output, complete season is divided into three segments on the basis of harvest i.e., first harvest, middle harvest and last harvest with 1st price, 2nd price and 3rd price respectively. Average output from 1 acer Tomato farm is Rs. 1825000 per annum. Transportation cost depends on the marketed city and total number of bags transported, average transportation cost for traditional Tomato production is Rs. 48000 per acer per annum.

The study further estimated the investment by engaging benefit-cost analysis and internal rate of return (IRR) tools of project valuation. The values of economic analysis of Tomato production are reported in appendix II (D). The present value of costs and benefits are evaluated by using the current market interest rate (8%) as reported in appendix II (D) due to space limitation. The cost and benefit of Tomato production farm is reported for 10 years as compared the results with Tomato tunnel farm. According to our sample data traditional Tomato production generate profit from the very first year. After 10 years farm would be able to generate net profit of 58834 rupees per acer per annum. Benefit cost ratio indicate that if we spend Rs.1 on traditional Tomato production then it generates Rs. 1.1 in return. The internal rate of return (IRR) from traditional Tomato production is 15.7 percent (Appendix II). The values of IRR 15.7 percent clearly indicate that investment on Tomato tunnel farm generates higher profit than the ongoing market interest rate, reflecting viability of the investment (Table 4.5).

Table 4.5: Comparison of cost benefit analysis

	Tomato (Tunnel)	**Cucumber (Tunnel)**	**Tomato (Traditional)**	**Cucumber (Traditional)**	**Tunnel (Combined)**	**Conventional (Combined)**
BCR	1.9	1.6	1.1	1.2	1.7	1.2
IRR	104.5%	85.7%	15.4%	25.8%	95.1%	21%

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATION

5.1 Conclusion

Technological adoption for value added crop production in Pakistan is making progress with the introduction of tunnel technology, it is one of the most important modifications in advanced farming techniques. In this race of sustainability and high productivity use of pesticides play a very vital role, but pesticides possess unavoidable risk to its direct exposure. Insecure use of pesticide results in short term hazardous health impacts such as headache, nausea, skin irritation, skin allergy, eye irritation, and breathing difficulty.

This study surveys the perilous impact of pesticide exposure on sprayer's health (breathing stress, skin irritation, skin allergy, eye irritation and general sickness including fever, nausea, headache etc.) comparatively between two Tehsils Kamalia and Chichawatni, in which one area is implemented tunnel technology and the other is practicing traditional techniques for production of Tomato and Cucumber. This dissertation also evaluates comparative health cost incurred by pesticide applicators among two Tehsils and feasibility of tunnel farming adaptation by employing primary data, which was collected through a well-structured questionnaire from 140 farmers and sprayers.

Statistical test reveals that 104 out 140 respondents faced by illness due to pesticides exposure, which indicates 74.3% illness rates among sprayers. In which general sickness faced by 15.7% of the total respondents. Where, breathing difficulty is faced by 21.7% respondents, eye irritation s faced by 21% of the respondents, skin allergy is faced by 14% of the respondents and skin irritation is faced by 30% of the respondents approximately. Furthermore, only 47% of the sprayers were using avertive gear for prevention. About 53% of the sprayers eat meal after the spray as the mostly sprayers apply spray on fields in daytime. About 83% of the sprayers wash their hands with sanitizer or soap after the spray. Only 20% of the sprayers from the sample had been provided training and information by pesticides companies for mixing and handling of sprays which indicates that extensions workers are not being called for the inspection of the fields farmers doing it on its own they just ask the pesticide dealers which guide them about wrong spray and unspecified dose of pesticide which results that farmer in our survey using Polytrin-C which used on cotton crops.

Our exploration is based on three different models. The first model is estimating the health impacts among pesticide sprayers of both categories, where we employed the Poisson regression model. The second model is about to calculate the sprayers health cost. The second model is investigated by employing OLS regression. The third model is about the cost and benefit analysis of tunnel farming.

In our first model, the dependent variable is the number of illnesses facing by pesticide applicators. We attempted to estimate the determinants of health bearings by employing the Poisson regression model. Our results reveal that there is highly significant difference in illness with regarding our dummy variable for tunnel farming system, which implies that logs of expected illness of sprayers is expected to be decrease by (0.56) units in tunnel farming than in traditional farming. Avertive measure's variable shows the negative sign with significant results stating that if the sprayer uses 1 unit if the precautionary gadgets the log of expected illness for sprayer is expected to be decrease by 0.42 units. The empirical result demonstrates that the variable habit of eating meal after the spray shows the positive sign with our predicted variable at 5% confidence interval. So, with positive relationship it is estimated that the log of expected illness for sprayer increase by 0.49 units due to 1 unit meal consumption after the spray.

The chances of illness are very sensitive to the personal characteristic of the sprayers. The personal attribute like smoking during mixing spray, spraying on fields or after spraying. The results estimated that the smoking habit has the positive relationship with the illness, also having the significant impact on the illness at the 10% confidence interval, it means we can predict that due to smoking the log of expected illness increase 0.42 units significantly. The results of our model indicate that environmental impact quotient (EIQ) has highly significant impacting on illness with 1% confidence interval. It is estimated that 1 unit of EIQ increase the log of expected illness by 0.12 units.

The second model is evaluating the factors of health cost faced by the pesticide sprayers. We employed two-stage ordinary least square (OLS) regression because our dependent variable is continuous and one of the independent variables (total number of diseases) is found to be endogenous. The results of the first stage exposed that Dummy for the tunnels and use of avertive measures during spray both lead to decrease the health illness. The results of the second stage reveal that the predicted value of the total number of diseases contributes to increasing the health cost by Rs. 437. Adaptation of the tunnel technology helps to reduce health cost by Rs. 383. Eating meal after the spray cause an increase in health cost by Rs. 327. Education of the sprayers helps in reduction of health cost by Rs. 14. Personal habit like smoking cause an increase of Rs. 177 in total health cost of sprayer. Environmental impact quotient (EIQ) is causing an increase of Rs. 91 in total health cost.

The third model is to evaluate the cost and benefits of Tunnel farming and traditional farming. Analysis shows that average fixed cost for tunnel farming is Rs. 470000 and for traditional farming it is zero. Average variable cost for the tunnel farming is Rs. 670000 including operational cost, seed cost, irrigation cost, fertilizer cost, farmyard manure, spray cost, labor cost, health cost, workday loss and transportation cost. While for the traditional farming average variable cost including all input, cost is Rs. 40000.

We applied different tools for project evaluation to investigate the economic feasibility of investment in Tunnel farming. The BCR ratio for Tunnel farming is 1.7 with a very high IRR rate of 95.2%. These values are high enough and reasonable to attract investment in this segment. There is a need to stimulate private nominees to consider this as a business prospect.

5.2 Policy Recommendation

In the light of above discussion following policy proposition can be done.

- As our cost benefit analysis revealed that tunnel farming is profitable but the initial cost is large so government can assist in promoting tunnel farming by providing specific loans for tunnel farming as it can be return after first year. Sprayers should be helped financially by the government to cope with health cost and trade off.
- It is clear from the regression results of illness avertive gear reduce the health impact significantly, we can propose that farmers should be advised to be strict about spray SOPs for the humanitarian reasons to protect their employees.
- As proved from this study, people who do not have adequate information about pesticides, dose calculation, threshold value of prevalence and their formulation, normally do presumption work in their spraying activity. Which is increasing cost of production. Therefore, it is recommended to the extension department to pay visit and consultation to the farmers to reduce the indiscriminate use of agro-chemicals.

- administrative control department need to be more responsive and should ban the import of various hazardous chemicals which are having high EIQ values and high impacts on health.

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APPENDIX. I

FARMER'S QUESTIONNAIRE

TITTLE: ECONOMIC COMPARISON OF TUNNEL AND TRADITIONAL FARMING SYSTEM: A CASE STUDY OF TEHSIL CHICHAWATNI AND TEHSIL KAMALIA

I am M Phil Research student department of Environmental Economics at Pakistan Institute of Development Economics (PIDE) Islamabad. The title of my M.Phil. thesis is "Economic Comparison of Tunnel and traditional farming system: A Case Study of Tehsil Chichawatni and Tehsil Kamalia". For this purpose, I am collecting data from farmers to make comparison that how tunnel farming is beneficial for them. Your cooperation and information given you will be very useful. Therefore, I would request you to kindly respond to the questions without any fear because I do not belong to government institute.

I would like to assure you that the information given by you will be kept strictly confidential and will be used for research purpose only.

I am hopeful to receive your co-operation.

Date: __________________ Interviewer Name: __________________________________

1. Personnel information:

1.1 Respondent Name: ______________________S/O ______________________Age _______ (Years)

1.2 NICNo. _____________________________________1.3 Cell No. ___________________________

1.4 Village Name: _____________________ Tehsil: ________________District: __________________

1.5 Family type ______________________ (Nuclear/Joint/Other)

1.6 Total family members ________________Working members in the family ___________________

1.7 Education of the Respondent (Years): _____ No. of children: _____ Male______ Female________

1.8 Experience in farming (Years): ____

1.9 Vegetables growing experience (Years) ____

1.10 Tenancy status (Owner / Tenant / Owner-cum-tenant): _________________________________

1.11 Area owned: _______ (acres) Area rented-in: ________ (acres) Area rented-out: ______ (acres)

1.12 Area allocated to vegetables____________ (acres)

2. Rent related information:

Rent per acre (Rs)/Annum	
Distance of field from irrigation source (Km)	
Distance of field from waste-water source (Km)	
Distance from output market (Km)	
Distance from input market (Km)	
Duration of contract (months)	
Distance from developed road (Km)	
Availability of electricity	**Yes/No**
Quality of soil	**Excellent, very good, good, medium, bad, very bad, worst**
Quality of tube well water	**Excellent, very good, good, medium, bad, very bad, worst**

3. Tunnel Specification:

Material	**Quantity**	**Price**	**Cost/acre**
Iron Rod/acre			
Plastic/acre			
Labor days/acre			
Dimensions	**Description**		
Hight			
Width			
Length			
No. of Tunnels per acre			

4. Standard of work of different operations in vegetable production:

Parcel/Crop name	Area sown (acres)	Planting time	First harvest time	Operation	No.	Total Tractor (hr/acre)	Total Cost of Tractor
P_1=				Ploughing			
				Planking			
				Leveling			
P_2=				Ploughing			
				Planking			
				Leveling			

5. Seed related information:

Vegetable Name	Seed Source [a]	Quantity (Grams or Kg/acre)	Total Price (Rs/kg)
P_1=			
P_2=			

a. Description of seed source, 1=certified from market, 2. Uncertified from home, 3.
   Uncertified from market, others=4

6. Sowing method:

Operation	*Name of vegetable on each parcel*	
	P_1=	P_2=
Nursery cost		
a) Seed treatment cost		
b) Labor Cost (treatment)		
Method of sowing		
i) Broadcast		
ii) Dibbling		
iii) Transplanting		

7. What type of water are you using? _______________ (Canal/Tube well water/Mix)

*(Canal water = 1, Tube well water = 2, Mix water = 3)

8. Who irrigates the field? ____________________ (Yourself/Hired labor)

9. What is your allotted time for irrigation by Govt. (warabandi)? ___________ minutes/acre

10. Tax (mamla) for canal irrigation: _____________________ (Rs/acre/six months)

11. No. of tube wells installed at your farm: Peter engine _______ Electricity driven ______,

12. Size of the pipe: Peter engine ______________Electricity driven___________________

13. Total area being irrigated by tube well (acres)_______________________________

14. Irrigation related information:

vegetable	Source of irrigation	Total number of irrigations	Duration b/w. irrigations (Days)	Irrigation time(hr/acre)	Total irrigation cost of tub well (Rs/acre)	Irrigation cost of wastewater (Rs/acre/six month)
P_1 =	**i. Canal**				-	-
	ii. Tube well					-
	iii. Mixed					-
	iv. wastewater				-	
P_2 =	**i. Canal**					
	ii. Tube well					
	iii. Mixed					
	iv. wastewater					

15. Farmyard manure:

	No. of trolleys per acre		Quantity/trolley (Maunds)	Size of trolley	Price/trolley (Rs)
	P_1=	**P_2=**			
Home					
Purchased					

16. Chemical fertilizers:

Parcel	Quantity and price	Brand name					
		Urea	**DAP**	**Nitrophos**	**SSP**	**NPK**	**Micro-nutrient**
P_1=	Bags used						
	Price/bag						
	Method[a]						

P$_2$=	Bags						
	Price/bag						
	Method[b]						

b. **Method of application: 1.** Broadcast, **2**. Placement**, 3.** Fertigation**, 4.** Foliar

17. Information about pesticide use:

Parcel	Type of pesticide	Average gap (days) between sprays	Intensity of attack	Name of pesticide used	Total number of sprays	Amount used per spray (grams or liter/acre)	Product price (Rs/acre/spray)
P$_1$=	**1**		S/M/L				
	2		S/M/L				
	3		S/M/L				
	4		S/M/L				
	5		S/M/L				
	6		S/M/L				
	7		S/M/L				
	8		S/M/L				
P$_2$=	**1**		S/M/L				
	2		S/M/L				
	3		S/M/L				
	4		S/M/L				
	5		S/M/L				
	6		S/M/L				
	7		S/M/L				
	8		S/M/L				

S=Severe M=Medium L=Low

17.1. Who sprays pesticides? __________________ (Yourself/Hired labor)

17.2. If self, did you wear protective clothing during spraying? (Yes/No)

18. Information about weedicide use

Parcel	No.	Days after sowing	Intensity of attack	Name of weedicide used	Amount used (grams or liter/acre)	Product price (Rs/acre/sray)
P_1=	1		S/M/L			
	2		S/M/L			
	3		S/M/L			
	4		S/M/L			
	5		S/M/L			
P_2=	1		S/M/L			
	2		S/M/L			
	3		S/M/L			
	4		S/M/L			
	5		S/M/L			

S=Severe M=Medium L=Low

18.1. Who sprays weedicides? __________________ (Yourself/Hired labor)

19. Did you spray vegetables after harvesting? ________________ (Yes/No)

20. Did you sell the standing crop? ___________________ (Yes/No)

21. If yes, then at what stage? ___________________ (Ready/not yet ready/at any other stage)

22. Information about output per acreage:

Parcel	Total No. of bags (Pallies/acre)	1st price/bag (Rs)	No. of bags sold at 1st price	Mid-price (Rs)	No. of bags sold at mid-price	Last price (Rs)	No. of bags sold at last price	Total Revenue (Rs/acre)
P_1=								
P_2=								

Size of one bag of Parcel 1 = _______________ kg Size of one bag of Parcel 2= _______________kg

23. Farm labor in days:

Operation	**P_1=**							**P_2=**						
	Family labor		**Hired labor**					**Family labor**		**Hired labor**				
	No	**hrs/acre**	**No**	**hrs/acre**	**Daily wages (Rs/day)**	**Contract payment (Rs)**	**Exchange labor (hrs)**	**No**	**hrs/acre**	**No**	**hrs/acre**	**Daily wages (Rs/day)**	**Contract payment (Rs)**	**Exchange labor (hrs/acre)**
Sowing														
Ridge														
Hoeing														
Irrigation														
Fertilizer														
Pesticide														
Picking														
Others, (specify)														

24. Are you a smoker? _______________ (Yes/No)

24.1. If yes, then since how many years? ____________________

24.2. Do you smoke while spraying? _______________ (Yes/No)

Type of brand	**No.of packets used per day**	**Price per packet (Rs)**	**Total cost per day (Rs)**	**Monthly cost (Rs)**

25. Average working hours per day in the field ___________________________ (hours/day)

26. Name the insecticide that you mostly use to control pests _____________________

27. What is the price of this insecticide? _____________ (Rs/bottle or container)

28. What is the method of mixing insecticide in water? ____________________________

29. Do you eat meal after spraying in the field? _______________ (Yes/No)

30. Do you wash your hands with a sanitizer before eating? _______________ (Yes/No)

31. Are you aware of the harms posed by pesticide use? _______________ (Yes/No)

32. Do companies provide you information and training to effectively handle pesticides?

________________ (Yes/No)

33. Health related information (due to pesticide exposure):

If health problems with spraying were experienced, please specify the types of problems (*tick one or more of the following options*)

Health impairment	**Frequency of illness (No. per crop season)**	**Workdays, fully lost due to the illness (per crop season)**	**Number of times you sought treatment for illness. (per crop season)**		**Cost of medicine (Rs/ crop season)**		**Fee paid to Physician (Rs/visit)**	**Travel cost to meet Physician (Rs/visit)**
			Self	**Physician**	**Self**	**Physician**		
1. Skin irritation								
2. Nausea								
3. Stomach pain								
4. Diarrhea								
5. Asthma								
6. Coughing								
7. Other respiratory problems								
8. Eye irritation								
9. General weakness								
10. Fever								
11. Sleeplessness								
12. Others(specify)								

APPENDIX. II

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Illness	140	.821	.603	0	4
Dummy for tunnels	140	.5	.502	0	1
Ages	140	31.036	9.764	18	57
Education	140	5.664	3.284	0	14
Avertive measures	140	.479	.501	0	1
Eating meal	140	.514	.502	0	1
Hand wash	140	.829	.378	0	1
Awareness	140	.629	.485	0	1
Training	140	.2	.401	0	1
Smoke	140	.621	.487	0	1
EIQ	140	12.855	16.701	1.5	157.1
Health cost	140	557.379	488.4	0	3200
Skin Irritation	140	.229	.421	0	1
Skin allergy	140	.1	.301	0	1
Eye irritation	140	.164	.372	0	1
Difficulty in breathing	140	.179	.384	0	1
General sickness	140	.15	.358	0	1

APPENDIX II(A)

Cost Benefit Analysis

Cucumber Production (Tunnels)

COST	PKR
Average cost of Tunnels per acer (Fixed Cost)	462600
Average cost of plastic sheet per season	68049
Average cost of machinery per acer per season	18457
Average Seed cost per acer per season	74484
Average irrigation cost per acer per season	20286
Average cost of farm yard manure per acer per season	10886
Average cost of chemical fertilizer per acer per season	143331
Average spray cost per acer per season	18078
Average transportation cost per acer per season	161629
Average land rent per acer per season	32544
Average labor cost per acer per season	133950
Average health cost per acer per season	402
Average work day loss per acer per season	1800
Present market intrest rate pecentage per annum	8
BENEFIT	PKR
Average benefits per acer	1637929

Years	0	1	2	3	4	5	6	7	8	9	10
Average fixed tunnel cost per acer (PKR)	462600										
Average variable cost of production per annum (PKR)	683896	615847	615847	615847	615847	615847	615847	615847	615847	615847	615847
Total cost per acer per annum (PKR)	1146495.5	615846.5	615846.5	615846.5	615846.5	615846.5	615846.5	615846.5	615846.5	615846.5	615846.5
Present value of total cost (PKR)	1146496	570228	527989	488879	452666	419135	388088	359341	332723	308077	285256
Present value of total cost with each adding year (PKR)	1146496	1716724	1674485	1635374	1599161	1565630	1534583	1505836	1479218	1454572	1431752
Total benefits per acer per annum (PKR)	1637929	1637929	1637929	1637929	1637929	1637929	1637929	1637929	1637929	1637929	1637929
Present value of total benefits (PKR	1637929	1516601	1404260	1300241	1203926	1114747	1032173	955716	884922	819372	758678
Present value of total benefits with each adding year (PKR	1637929	3154529	3042188	2938169	2841855	2752675	2670101	2593644	2522850	2457301	2396606
Net return	491433	1437805	1367704	1302795	1242694	1187045	1135518	1087808	1043632	1002729	964855
BCR	1.6										
IRR	85.8 %										

APPENDIX II(B)

Cost Benefit Analysis

Tomato Production (Tunnel)

COST	PKR
Average cost of Tunnels per acer (Fixed Cost)	477384
Average cost of plastic sheet per season	70000
Average cost of machinery per acer per season	18457
Average Seed cost per acer per season	49138
Average irrigation cost per acer per season	25000
Average cost of farm yard manure per acer per season	6771
Average cost of chemical fertilizer per acer per season	95291
Average spray cost per acer per season	35000
Average transportation cost per acer per season	80831
Average land rent per acer per season	57000
Average labor cost per acer per season	212257
Average health cost per acer per season	2054
Average work day loss per acer per season	5000
Present market intrest rate pecentage per annum	8
BENEFIT	PKR
Average benefits per acer	1824431

Years	0	1	2	3	4	5	6	7	8	9	10
Average fixed tunnel cost per acer (PKR)	477384										
Average variable cost of production per annum (PKR)	656799	656799	656799	656799	656799	656799	656799	656799	656799	656799	656799
Total cost per acer per annum (PKR)	1134183	656799	656799	656799	656799	656799	656799	656799	656799	656799	656799
Present value of total cost (PKR)	1134183	608147	563099	521388	482767	447006	413895	383236	354848	328563	304225
Present value of total cost with each adding year (PKR)	1134183	1742330	1697282	1655571	1616950	1581189	1548078	1517419	1489031	1462746	1438408
Total benefits per acer per annum (PKR)	1824431	1824431	1824431	1824431	1824431	1824431	1824431	1824431	1824431	1824431	1824431
Present value of total benefits (PKR	1824431	1689288	1564156	1448292	1341011	1241677	1149701	1064538	985683	912670	845065
Present value of total benefits with each adding year (PKR	1824431	3513719	3388587	3272723	3165442	3066108	2974132	2888969	2810114	2737101	2669496
Net return	690248	1771389	1691304	1617152	1548492	1484919	1426054	1371550	1321083	1274355	1231088
BCR	1.8										
IRR	104.5 %										

APPENDIX II(C)

Cost Benefit Analysis

Cucumber Production (Tradiitonal)

COST	PKR
Average cost of machinery per acer per season	18457
Average Seed cost per acer per season	50175
Average irrigation cost per acer per season	15600
Average cost of farm yard manure per acer per season	10286
Average cost of chemical fertilizer per acer per season	102846
Average spray cost per acer per season	20749
Average transportation cost per acer per season	95381
Average land rent per acer per season	57000
Average labor cost per acer per season	111210
Average health cost per acer per season	651
Average work day loss per acer per season	2604
Present market intrest rate pecentage per annum	7
BENEFIT	PKR
Average benefits per acer	625321

Years	0	1	2	3	4	5	6	7	8	9	10
Average variable cost of production per annum (PKR)	484959	484959	484959	484959	484959	484959	484959	484959	484959	484959	484959
Total cost per acer per annum (PKR)	484959	484959	484959	484959	484959	484959	484959	484959	484959	484959	484959
Present value of total cost (PKR)	484959	453233	423582	395871	369973	345769	323149	302008	282251	263786	246529
Present value of total cost with each adding year (PKR)	484959	938192	908541	880830	854932	830728	808108	786967	767210	748745	731488
Total benefits per acer per annum (PKR)	625321	625321	625321	625321	625321	625321	625321	625321	625321	625321	625321
Present value of total benefits (PKR	625321	584412	546180	510448	477054	445845	416678	389418	363943	340133	317881
Present value of total benefits with each adding year (PKR	625321	1209733	1171501	1135769	1102375	1071166	1041999	1014739	989264	965454	943202
Net return	140362	271541	262960	254939	247443	240438	233891	227772	222054	216710	211715
BCR	1.3										
IRR	25.8 %										

APPENDIX II(D)

Cost Benefit Analysis

Tomato Production (Traditional)

COST	PKR
Average cost of machinery per acer per season	18457
Average Seed cost per acer per season	20144
Average irrigation cost per acer per season	15000
Average cost of farm yard manure per acer per season	6557
Average cost of chemical fertilizer per acer per season	57176
Average spray cost per acer per season	19019
Average transportation cost per acer per season	47776
Average land rent per acer per season	57000
Average labor cost per acer per season	73714
Average health cost per acer per season	966
Average work day loss per acer per season	1500
Present market intrest rate pecentage per annum	8
BENEFIT	PKR
Average benefits per acer	357518

Years	0	1	2	3	4	5	6	7	8	9	10
Average variable cost of production per annum (PKR)	317309	317309	317309	317309	317309	317309	317309	317309	317309	317309	317309
Total cost per acer per annum (PKR)	317309	317309	317309	317309	317309	317309	317309	317309	317309	317309	317309
Present value of total cost (PKR)	317309	293805	272041	251890	233232	215955	199958	185147	171432	158733	146975
Present value of total cost with each adding year (PKR)	317309	611114	589350	569199	550541	533264	517267	502456	488741	476042	464284
Total benefits per acer per annum (PKR)	357518	357518	357518	357518	357518	357518	357518	357518	357518	357518	357518
Present value of total benefits (PKR	357518	331035	306514	283809	262786	243321	225297	208608	193156	178848	165600
Present value of total benefits with each adding year (PKR	357518	688553	664032	641327	620304	600839	582815	566126	550674	536366	523118
Net return	40209	77440	74682	72128	69764	67575	65547	63671	61933	60324	58834
BCR	1.1										
IRR	15.7 %										

APPENDIX III

Insecticides Used in Production (Cucumber + Tomato)

Insects	Insecticide Name	Active Ingridient	Dosage per acer	Price (PKR)	Field Use EIQ
White Fly	Acelan 20SL	Acetamiprid 20%	250 ml	700	3
Leaf Minor	Admiral 10EC	Pyriproxyfen 10%	250 ml	1500	0.8
Army Worm	Coregan	Chlorantraniliprole 20%	50 ml	1000	0.4
Aphid, Jassid	Corvus 10EC	Novaluron 10%	300 ml	800	0.9
Fruit fly	Voliam Flexi 300sc	Thiamethoxam (200g/L) + Chlorantraniliprole (100g/L)	80 ml	1000	1.4
Thrips	Monex	Emamectin Benzoate (2.1%)	1000 ml	1800	1.2
	Polytrin C	Profenofos (400g/L) + Cypermethrin (40g/L)	500 ml	950	25.4
	Karate	Lambda-Cyhlothrin (25g/L)	200 ml	650	0.2
	Plinum	Pymetrozine 50%	120 g	900	2.6

Fungicides used in Production (Cucumber + Tomato)

Deseases	Fungicide Name	Active Ingridient	Dosage per acer	Price (PKR)	Field Use EIQ
Leaf Blight	Cobox	Copper Oxychloride 50%	1000 g	1950	36.6
Bacterial Blight	Cabrio Top 60WDG	Pyraclostrobin5% + Metiram 55%	600 g	2300	31.3
Early Blight	Acrobat MZ 90/600 WP	Dimethomorph + Mancozeb	250 g	950	8.6
Late Blight	Topas	Penconazole 41.8% (Propiconazole)	250 ml	1300	3.1
Downy Mildew	Folio Gold	Chlorothalonil 33.11% + Mefanoxam 3.31%	1000 ml	850	27.5
Powdery Mildew	Kumulus 80DF	Sulphur 80%	500 g	500	28.8
	Miravs Duo	Pydiflumetofen 6.9% + DFZ 11.5%	200 ml	1300	