T.R.
KAHRAMANMARAŞ SÜTÇÜ İMAM UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE

ECONOMIC ANALYSIS OF POTATO PRODUCTION IN DOHUK PROVINCE, NORTHERN REGION OF IRAQ

QASIM MOHAMMED IBRAHIM

MASTER THESIS

DEPARTMENT OF BIOENGINEERING AND SCIENCES

KAHRAMANMARAŞ TURKEY - 2017

T.R.
KAHRAMANMARAŞ SÜTÇÜ İMAM UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE

ECONOMIC ANALYSIS OF POTATO PRODUCTION IN DOHUK PROVINCE, NORTHERN REGION OF IRAQ

QASIM MOHAMMED IBRAHIM

this thesis submitted in candidature for the degree of
MASTER OF SCIENCE
at the Department of Bioengineering and Sciences

KAHRAMANMARAŞ, TURKEY - 2017

M.Sc. Thesis entitled “Economic Analysis of Potato Production in Dohuk Province, Northern Region of Iraq” and prepared by Qasim Mohammed Ibrahim, who is a student at Bioengineering and Sciences Department, Graduate School of Natural and Applied Sciences, Kahramanmaraş Sütçü İmam University, was certified by all the jury members, whose signatures are given below at the date of 24 /08 / 2017.

Prof. Dr. Cuma AKBAY (Supervisor) ……

Department of Agricultural Economics

Kahramanmaraş Sütçü İmam University

Assist. Prof. Mithat DİREK (Member) ……..……..……

Department of Agricultural Economics

Selçuk University

Assist. Prof. Mücahit PAKSOY (Member) ...…….

Department of Agricultural Economics

Kahramanmaraş Sütçü İmam University

I approve that the above signatures related to the members.

Assoc. Prof. Mustafa ŞEKKELİ …….…….

Director of Graduate School of Natural and Applied Science

Kahramanmaraş Sütçü İmam University

DECLARATION

I hereby declare that all information in the thesis has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all materials and results that are not original to this work.

QASIM MOHAMMED IBRAHIM

Note: The original and other sources used in this thesis, the declaration, tables, figures and photographs showing the use of resources, subject to the provisions of Law No. 5846 on Intellectual and Artistic Works.

KUZEY IRAK BÖLGESİ DOHUK İLİNDE PATATES ÜRETİMİNİN EKONOMİK ANALİZİ

(YÜKSEK LİSANS TEZİ)

QASIM MOHAMMED IBRAHIM

ÖZET

Bu çalışmada Kuzey Irak'ta yer alan Duhok ilinde patates üretiminde kaynak kullanım verimliliği incelenmiştir. Çalışmanın ana amacı patatesi üretimindeki mevcut durumunun ortaya konulması, bölgesel patates üretim fonksiyonunun ve verim üzerine etkili olan faktörlerin analiz edilmesidir. Çalışmanın ana materyalinin tesadüfi örnekleme yöntemi ile belirlenen 220 üretici ile yapılan anket verileri oluşturmaktadır. Tohum, gübreleme, sulama, ilaç kullanımı, iş gücü, makine kullanımı gibi çeşitli girdilerin etkilerini değerlendirmek için Cobb-Douglas üretim fonksiyonu kullanılmıştır. Analiz sonuçlarına göre, tohum miktarı, gübreleme, sulama ve ilaçlamanın patates üretimi üzerine istatistiksel olarak anlamlı ve pozitif bir etkisi vardır. Çalışma alanında üreticilerin finansman kaynağı bulmada zorluk çekme, tesislerin yetersizliği, düşük ürün fiyatları ve yüksek tohum fiyatları gibi sorunlarla yüzleştikleri tespit edilmiştir. Araştırma yüksek kaliteli tohum kullanılarak üretimde verimliliğin arttırılabileceğini göstermiştir. Bölgede tohum üretim projeleri desteklenmeli, patates üretimine uygun sulama suyunun ve toprağın modern laboratuar yöntemleri ile analizleri yapılmalıdır.

Anahtar Kelimeler: Patates, sosyo-demografik faktörler, üretim fonksiyonu, Dohuk, Irak

Kahramanmaraş Sütçü İmam Üniversitesi
Fen Bilimleri Enstitüsü
Biyomühendislik Anabilim Dalı, 25 Ağustos / 2017

Danışman: Prof. Dr. Cuma AKBAY
Sayfa Numarası:73

ECONOMIC ANALAYSIS OF POTATO PRODUCTION IN DOHUK PROVINCE, NORTHERN REGION OF IRAQ

(M.Sc. THESIS)

QASIM MOHAMMED IBRAHIM

ABSTRACT

The study examines the resource use efficiency in potato production in Dohuk, Iraq. The main objective of this study is reflecting the reality of the production of the potato crop, analyze the production function of the local potato crop and the effects of inputs use on yields. The primary data were collected from 220 farmers and questionnaires were distributed randomly to farmers in all districts and aspects. The Cobb-Douglas production function is used to evaluate the effects of various inputs such as seed, fertilizer, irrigation, pesticide, human labor, machinery, diesel fuel and harvesting. According to results, amount of seed, fertilizer, irrigation, and pesticide had statistically significant and positive effects on potato production. Farmers in the study area are faced with difficulties such as lack of access to finance, poor storage, facilities, low domestic production prices, and the high cost of seeds parents. The researcher recommended to increase the productivity of farmers through high-quality seeds, to support the production of seed projects locally, especially on soil and its suitability for potato production and using modern laboratory analyses of soil and water.

Key Words: Potato, Socio demographic factors, production function, Duhok district, Iraq.

Kahramanmaraş Sütçü Imam University
Graduated School of Natural and Applied Science
Department of Bioengineering and Sciences, August 25 / 2017

Supervisor: Prof. Dr. Cuma AKBAY

Page number: 73

ACKNOWLEDGEMENTS

I would like to thank everyone who has given me support and encouragement over the year in completing this thesis. First of all, thanks to my supervisor, Prof. Dr. Cuma AKBAY, whose knowledge and technical expertise has made this study an amazing learning opportunity, for his guidance and encouragement through the various stages of the M.Sc.

I am very grateful and thankful to my dear father, my mother, my wife, my brothers, and my sisters, for their support and impeccable understanding allowing me to accomplish this thesis during my study.

I would like to express my deepest appreciation to my other friends and all those who provided me with assistance to complete this thesis.

Finally, special thanks are due to farmers and the district administration in the study area, for their cooperation and provision of information essential for this study.

QASIM MOHAMMED IBRAHIM

TABLE OF CONTENTS

Page No

LIST OF TABLES

Page No

LIST OF FIGURES

Pages No

LIST OF ACRONYMS AND ABBREVIATIONS

HU : Human Cost

L : The Labor Used in the Production Process

FOA : Food and Agricultural Organization

H : Hectare

IQD : Iraqi Dinar

R : Wage

C : Cost Machine

Kg : Kilogram(s)

M : Machinery Used in the Production Process

Lt : Liter(s)

H : Number Hour Working Machine

D : Cost Diesel fuel

NL : Number of Liters

P : Price of Liter

F : Cost of Chemical fertilizers

W : Weight of Quantity Fertilizer

PCF : Price of Chemical fertilizers

CS : Cost Seeds

CP : Cost Pesticide

QP : Quantity of pesticide

CR : Cost of Rent Land

ND : Number of Dunam

T I : Total Input

T S : Sum Input

TO : Total Output

ER : Net Returns

TP : Total Production

K : labor Input

CM : Cost of Farmyard Manure

BCR : Benefit Cost Ratio

1. INTRODUCTION

1.1. Preface

The potato (*Solanum tuberosum*) belongs to the family Solanaceae, which includes tomato, eggplant and peppers (Noonari et al., 2016). Potatoes family occupy a prominent position among vegetable planted in the world. Potatoes are an important food source, and consist of 205 solid matters and has 80% of the high-nutrient waters. Starch constitutes about 85% of the bloc and the rest is protein. Potatoes also provide vitamins, including thiamine, riboflavin, niacin and vitamin C. It also contains sulfur, phosphorus, sodium, minerals, calcium, iron, potassium and magnesium. The potato crop as one of the important vegetable crops in many countries of the world, including Iraq because of its nutritional economic importance, occupies an important position in international trade (Taha and Farouk, 2007).

The potatoes are used in many ways: the skin or hulled, whole or cut up, with or without spices. The only requirement involves cooking the starch granules swell. Most are served hot potato dishes, but some are cooked first, then served cold, especially the potato salad and potato chips/crisps. Potatoes are also a major component, such as fast food, where they are fried and served with sauce (FAOSTAT, 2017).

Potatoes are one of the high nutritive value of crops grown in most of the world. Potatoes have originated in Peru and Bolivia (South America), spread to all other parts of the world successfully and became the main crop. It is generally believed that the Portuguese potatoes in India, Pakistan, the sub-continent and the British encouraged its cultivation in this area (PHDEB, 2010).

Potato is one of the most important high nutritive value crop grown in the world. It comes in the forefront of tuber crops and occupies the fourth position after wheat, sorghum, and rice, as an edible consumed crop in the world. While there are nearly 4,000 different varieties of potatoes, each of which has special agricultural attributes or cooking.

The commercial production of the potato crop began in 1917 in North America, where it was moved by the Scottish and Irish immigrants (Musleh et al., 1989). In 2013, many potato productions come from industrial countries; China, Russia, India, and United States of America with production of 72, 63, 23 and 20 million tons/annum, respectively.

In the world, it’s grown on 18360000 hectares with a total production of 327620000 tons (FAOSTAT, 2017).

Potatoes is one of the main cash crops for farmers, as well as between the goods of the exportable horticultural major of the countries. Therefore, the development of potato crop farms increases foreign income exchange earnings (EPB, 2008).

Potatoes are an important crop in many developing countries because of their proven potential to raise farm incomes, rural employment, and food consumption (Scott et al., 2000). The United Nations called 2008 as "The International year of the potato" to boost its plantation which has a significant role in decreasing hunger of people all over the world (Zangeneh et al., 2010). Potato production and marketing is unique in the sense that the market the price of potatoes actuates significantly during the season, from year to year and must be consumed within a relatively short period (Pedersen et al., 2005).

Based on FAO statistics, 350 million tons of potatoes were consumed worldwide each year. Although the total potato production and consumption continue to increase (Pule et al., 2015), there is a concern in world potato-producing community about its ability to compete in a globalized the market, especially with frozen potato products become Rolling global commodities. Competitiveness can be enhanced by improving the use of land, water, energy, labor, machinery, fertilizer, pesticides, electronic and risk reduction resources. The potato crop is exposed to many risks is vital and vitality, which affect the sustainability of production. Events related to the rainfall that poses a threat to the potatoes are excessive rain during the tuber growth leads to water logging and crops rotting in the soil due to suffocation, or heavy rains at harvest time provide harvest impossible (Van der Waals et al., 2016).

The 1960 potato crop dates to Iraq with large areas and commercial fields that date back to the date of entry into many countries of the world. Potato crop tops the list of tuber crops in terms of nutritional importance and the third rank after cotton and maize production in irrigated crops.

Potato’s popularly known as ‘The king of vegetables’, has emerged as a fourth most important food crop in Iraq after rice and wheat. Iraq's vegetable basket isn’t complete without potatoes. Being short duration crop, the largest amount of dry matter, energy, food, protein food, produced in a period of less time compared with grains such as

rice and wheat. Thus, the potato crop is important to achieve food security for the nation (Ahmed et al., 2013).

The potato is included in the list of the strategic food basket, and its production continues to meet the requirements of Iraqi market reserves. Which reached 204.6 thousand tons in 2010 and the import shortage is compensated from the Arab and international markets (Majhol, 2010).

Iraq's vast agricultural resources at the expense of fertile land and irrigated plains well, extreme weather fluctuations and the centuries-old tradition of agriculture. Because of the pivotal importance in the economy, the government determined agriculture as one of the four main drivers for growth (Sarah and Mohsen, 2015). The cost per hectare to produce potatoes vary depending on the total area of the field where the larger area of the field and the lower the cost of mechanization (Arkan and Yassen, 2011).

Table 1.1 shows that the quantity of production was increasing until 2005. The conditions were very favorable for example the large rainfall for the region, the adoption of an agricultural sector on this type of crops, and the stability of the region in terms of wars. Production decreased once again in 2006- 2010 and the quantity of production was 794000 tons in 2006 and decreased to 204597 tons in 2010. This is due to the lack of concern about urbanization, trade and the large importation of crops from outside countries. After 2010 production has increased until 2013. After 2013, instability of the region because of the terrorism and wars, once again and leave the agricultural area quantity of production for the year 2014 to 25745 hectare and 402302 tons (Table 1.1).

Table 1.1. Potato cultivated area and production in Iraq (2005 - 2014)

Year	Area (ha)	Production (tons)	Yield (tons /ha)
2005	51000	808000	15.84
2006	45000	794000	17.64
2007	33300	598000	17.96
2008	33000	348773	10.57
2009	19694	223147	11.33
2010	13017	204597	15.72
2011	40444	557401	13.78
2012	43500	586000	13.47
2013	37945	647337	17.06
2014	25745	402302	15.63

Source: FAOSTAT, 2017

1.2. Research Problem

The researcher believes that this is the problem of farmers in the cultivation of most crops, including the potato crop in the province of Dohuk, failure to achieve optimal production levels in the unit area. It is normal that the social and economic characteristics of farmers will impact on the production of potato in Dohuk.

The phenomenon of crop propagation and competition for other crops was not uniform among the different regions of the country because of variability of land productivity due to the distance between the north and the south of the governorate. One of the reason for low acre productivity is the irrational use of agricultural resources due to the poor relationship between the area and the size of these resources which negatively affects their relationship with the productivity of the crop. Producers of potatoes suffer from high production costs due to the high prices of imported inputs, which affect the efficiency of the use of these resources, reflected in the profitability of producers and which burdens the farmers.

This requires studying the economic efficiency of farmers, the factors affecting the production of the production unit, the resources and conditions needed to connect to the required productive efficiency.

1.3. Research Methodology

The focus of this study was to determine the effects of the cost on potato production in Dohuk governorate, and collect the data in two ways:

1. Describe the socio-demographic characteristics of potato farmers,

2-Using the standard model of the Cobb-Douglas production function to estimate potato production function,

For this purpose, the effect of independent variables on potato production is analyzed using cross-sectional data from farmers in Dohuk governorate as a model.

1.4. Research Hypothesis

The researcher assumes that there is a systematic relationship between productivity and farm size of potato farms in Dohuk governorate. Recall that the level of production achieved isn't close to the optimum production volume under the use of traditional production methods. Farmers weren't able to achieve customization efficiency, because of high costs and especially the cost of seeds for their dependence on their purchases on traders.

The main factors affecting potato production are supposed to be seed, irrigation, chemical fertilizers, pesticide, human labor, diesel fuel, farmyard manure, machinery and harvesting.

1.5. Objective of the Research

The objectives of this research are as follows:

- ✓ Review the current situation of potato production in Dohuk governorate.
- ✓ Study the economics of production and marketing of potatoes in the province of Dohuk, Iraq.
- ✓ Investigation of social and economic characteristics of farmers that effect the production potato in the province of Dohuk
- ✓ Calculate the level of production that determines the optimal behavior of farmers in the short term.

2. LITERATURE REVIEW

2.1. International literature

Ahmad et al. (1999) conducted a study to compared rice and potato production and profitability. In total 60 farmers of which 30 rice growers and 30 potato growers were selected randomly from four villages of Guipure Upazila, Mymensingh district in Bangladesh during 2009. The Cobb-Douglas production function was used to determine the effects of individual inputs on rice and potato production. The most important results of the study that rice and potato cultivation was profitable from the point of view of farmers. The per hectare yield of the rice and potato were 83,320.00 Tk. and 2,62,625.22 Tk. respectively. The total cost of rice and potato cultivation were 54,202.74 Tk. and 1,20,221.71 Tk. respectively. Once again, a net return of Boro rice and potato were 24,117.26 Tk and 1,42,403.51 respectively. The Cost Benefit Ratio was 1.41 and 2.18 respectively for rice and potato production. The results showed that the production of potato was more profitable than rice production.

Tripathi et al. (2005) analyzed the superiority of contract farming over the non-contract farming system in potato production. The study is based on the primary data collected from 54 respondents in North Haryana during the year 2003-2004. The results established the fact that human labor, fertilizers under contract farming, irrigation, plant protection under non-contract farming have quite visible and favorable impact on the gross return from the crop. At the existing pattern of resource use and production technology adopted by the farmers for potato production. The contracting agency procured the produce on the fixed price, as agreed by both the producer and the purchaser in advance. As per the contract, the whole produce was purchased by the contracting agency, and the farmers were also bound to sell their produce to the agency at the prefixed rate. The price uncertainty the ratio was 0.48 for the non-contract farms, as there was much variation in the price of potato in the market depending on its quality, quantity marketed, place location of sale, means of transportation and communication.

Pedersen et al. (2005) analyzed the use of the per organic project is to enhance the use of various organic fertilizers in farming systems, develop new management strategies to improve the water and nitrogen application. All costs are defined according to the same guidelines and principles although it’s obvious that there are cultivation practices that may differ between the various countries. Findings from this study show that potato cropping practices vary significantly among the various countries with major differences in yield

and costs. In Portugal and Italy, irrigation is a common practice due to limited precipitation. In Denmark, irrigation is a common practice as well, whereas most of the east and central European countries do not irrigate. This gross margin analysis is based on average costs in typical potato producing regions. In this respect, they don't represent an average estimate for each country. However, the study provides a good indication of cropping practices and economic performance in varies different regions of Europe. Based on these findings the implementation of new technology must be adapted to local conditions regarding field size, farm practice, animal production, access to organic farmyard manure and climatic conditions.

Mudombi (2007) analyzed the sweet potato project aimed at increasing sweet potato production, utilization, and marketing, which was to be achieved through production, distribution, and marketing. The study used both primary and secondary sources of data. Primary data was sourced from the farmers, while secondary data was sourced from organizations such as Zimbabwe Farmers Union. Data collection was conducted from February to May 2007 and it coincided well with the cropping season in the area. The improved sweet potato into the smallholder farming system resulted in welfare gains for the households under the various scenarios considered and resulted from sweet potato's contribution to food security and income. The study found that there were significant differences in terms of a human, physical, social capital between adopting and non-adopting households with adopters having more capital than non-adopters. Socio-economic factors that were found to significantly discriminate between adopting and non-adopting households were: sex and age of household head. Socio-economic factors that influenced use intensities and adoption probabilities are farmer training (for use intensity only); participation in on-farm trials; irrigation use; farmer to farmer input exchange and extension. significant factors on use intensity and adoption probability had positive relationships.

Mohammadi et al. (2008) analyzed to determine energy consumption of input and output used in potato production and making an economic analysis in Ardabil, Iran. The data were collected from 100 potato farms in Ardabil, Iran. Farms were selected based on random sampling method. The results indicated that total energy inputs were 81624.96 MJ ha^{-1}. About 40% of this was generated by chemical fertilizers, and 20% from diesel oil and machinery. About 82% of the total energy inputs used in potato production was indirect (seeds, fertilizers, manure, chemicals, machinery) and 18% was direct (human

labor, diesel). Mean potato yield was about 28453.61 kg ha^{-1}, it obtained under normal conditions of irrigated farming, considering the energy value of the seed, the net energy, energy productivity value was estimated to be 20808.03 MJ ha^{-1} and 0.35, respectively, the ratio of energy outputs to energy inputs was found to be 1.25. This indicated an intensive use of inputs in potato production not accompanied by an increase in the final product. Cost analysis revealed that total cost of production for one hectare of potato production was 3267.17 $. Benefit–cost ratio was calculated as 1.88.

Dupreé (2008) analyzed the effect of different rates of organic, USDA National Organic Program certified fertilizer, compared to a control with no fertilizer application and a treatment of fish emulsion as the sole source of fertilizer, on plant growth and yield. The data collected fall 2006 /2007 growing seasons USDA guidelines, data were subjected to an analysis of variance and mean separated using Tukey's test at $P > 0.05$. The results of the study suggest that via organic potato production in Louisiana is profitable. If compared, commercial organic fertilizer is more expensive than conventional fertilizer, as are labor costs, but due to price premiums $20/50 lb. Sack of conventional fresh market potatoes and $35/50 lb. Sack of organic fresh market potatoes, the organic production systems had potentially 2 to 3 times higher gross and net benefits when compared to a conventional production system. In this study, the use of a fish emulsion as the sole fertilizer was one of the most costly but profitable production systems, as yields, gross and net benefits were highest. The fish emulsion may have a beneficial association with plant growth regulators.

Zangeneh et al. (2010) analyzed to determine the amount of input–output energy used in potato production and make an economic analysis of potato production in Hamadan province, Iran. Data were collected from 100 producers by using a face to face questionnaire method and economic analysis of potato production was investigated by two groups. Group, I consisted of 68 farmers (owner of machinery and high level of farming technology) and Group II of 32 farmers (non-owner of machinery and low level of farming technology). The results revealed that 153071.40 MJ ha^{-1} energy consumed by Group I and 157151.12 MJ ha^{-1} energy consumed by Group II. The energy ratio, energy productivity, specific energy, net energy gain, and energy intensiveness were calculated. The net energy of potato production in Group I and Group II was 4110.95 MJ ha^{-1} and 21744.67 MJ ha^{-1}, respectively. Cost analysis showed that total cost of potato production in Groups I and II were 4784.68 and 4172.64 $ ha^{-1}, respectively. The corresponding, benefit to cost ratio from potato production in the surveyed groups were 1.09 and 0.96, respectively. It was

concluded that extension activities are needed to improve the efficiency of energy consumption in potato production.

Gbigbi (2011) identifies and analyses factors that influence the economic efficiency of smallholder sweet potato producers in Delta State by drawing on data from random sample of 100 smallholder farmers from Ughelli South Local Government Area. The study employed stochastic frontier and Tobit model to measure the level of economic efficiency and its determinants in sweet potato production. Empirical results show decreasing returns to scale in production. The mean economic efficiency is 0.61 with a range of 0.13 to 0.99. Education, access to extension, access to credit and membership of farmer's cooperative positively and significantly influence economic efficiency. Innovative institutional arrangements that enhance extension and farmer training accompanied with improved access to credit is likely to enhance sweet potato production efficiency.

Bhajantri (2011) analyzed production processing, marketing of potato in Karnataka area production and productivity. Potato in the state examine the channels involved in the marketing of potato 30 farmers including small farmers, marginal and large farmers were selected. Thirty consumers were also selected randomly. Besides 15 market intermediaries were selected randomly. In this study calculated using regression analysis software to translate the respondent's response relative importance values or utilities. In this resulted production (0.40%) and productivity (9.22%) in the district during the last 5 years has shown insignificant growth rate. In Belgaum district potato production and productivity has increased with a growth rate of 5.23 and 10.26 percent which is significant. The potato processing industry is growing significantly in Belgaum and Hassan districts with a growth rate of (1.97%) and (3.82%) indicating potential opportunity for the establishment of small-scale potato processing industries in these districts. Reveals that clear majority of farmers (64%) are selling directly to commission agents/Wholesalers in regulated markets. The producer who sold potato through producer - Wholesaler - Retailer - consumer realized the highest share (65%) in consumer rupee compared to other channels indicating the efficiency of this channel.

Meliko et al. (2012) evaluate the efficiency of the small-scale farmers for the production year 2006/2007 in Limpopo province. Using policy analysis matrix, a total of 12 production systems were selected. Result shows that all were profitable under market condition with existing policies, all except dry land maize had comparative advantage suggesting efficiency in the systems. Ranking the systems in term of PRC, DRC, irrigated

vegetables like potatoes, cabbages and tomatoes had higher profitability. Comparative advantages than field crops like both dry and irrigated maize, peanut and Beans. Despite completeness in all and comparative advantage in most systems, these wasn't due to policy intervention as incentive indicators, e.g. shows that all production systems are being taxed indicating little motivation from policies for small scale farmers to production.

Reyes et al. (2012) analyzed uses a double hurdle regression analysis to estimate the factors influencing marketing decisions among potato growers in the central highlands of Angola, focusing on the gender of household head, productive asset ownership, and transaction costs. The study's main objective is generated information about the factors affecting smallholder farmers' marketing decision. Data collected in this study came from the cross-sectional household- and village-level survey implemented by World Vision's prerender project in Angola in 2009. Although the results suggest that the quantity produced is exogenous in the models for market participation and for quantity sold. The methodology used provides a framework for others to follow when endogeneity is suspected in one and more variables. Suggests that potato growers, potato sellers, and male heads are richer than their counterparts. The linear regression results on quantity produced suggest that female-headed households produce less than their male counterparts. Thus, providing technical assistance to female-headed households may be necessary to help them obtain higher production. Moreover, all production-related variables were affecting production in an expected way. As well as suggest that farmers who use fertilizer produce more than farmers who don't apply fertilizer to their fields. Surprisingly, there was no statistically significant effect of using local varieties and using improved varieties on production. The results of the double hurdle analysis suggest that male-headed households are more likely to sell potatoes. However, once the market participation decision has been made, and the conditional quantity sold is gender neutral.

Scott et al. (2012) then analyze average annual compound growth rates in potato production, area harvested, and yields in the developing countries of Asia over early the last half century. The aim of this at flushing out the flow of potatoes and potato products from the major producing provinces in Chin at more distant urban markets. The collected data first utilizes FAO times-series data for these key in dictators first to calculate annual averages for the beginning 1961 -1963 the end 2008-2010 of the period, and then to calculate the saver then tire period. Result in this study new technology, improvements in production, postharvest infrastructure, and government policy along with the inherent traits

of the crop itself all contributed to these trends. A shift toward more diverse diets and the cash income derived from potato production played and equally if not more important role.

Mutai et al. (2013) investigated the factors that determine farmers' shift in market participation from village to regional market in Vihiga County. Market participation has a potential to increase farmers' rural incomes and employment opportunities especially if farmers concentrate on production and marketing of local crops requiring low inputs such as sweet potatoes. Cross-sectional data was collected and a multinomial logit model was used for the analysis. Participation in local town market rather than village market was influenced by total income, transport mode to market, access to extension services, age, value addition done and the quantity of sweet potatoes supplied, while; transport mode, land size, quantity potatoes and gender determined participation for the regional option. It's recommended that the local and national government should: Increase its support in the establishment of sweet potato market; improve the rural road networks to cut down transport costs, and increase support to farmer groups.

Mukunda et al. (2013) analyzed the effectiveness of collective action in enhancing market participation engagement among smallholder sweet potato producers in Home Bay County, Kenya. The analysis in this study obtain a sample of non-members of producer groups, locations were then selected randomly and proportionate random sampling method was used to draw a sample of households in each of the sampled location. Data collected was conducted in Archegonia district, Home-Bay County, in Southwest Kenya. This study investigates the role of collective action in smallholder market participation using a sample of 150 sweet potatoes producing households in Southwest Kenya. Results in this study suggest that market participation is predominantly determined by the resource base of a household where by the size of land owned is a fundamental factor. Furthermore, the results provide supportive evidence that participation in collective action has the potential to strengthen market participation among the poor and marginalized smallholder producers.

Olagunju et al. (2013) examined the socio-economic characteristics of the sweet potato farmers, gender levels of potato production, the efficiency estimates of the farmers and factors that determine outputs in the study area. The data were analyzed using descriptive statistics and Cobb Douglas production function. The result suggests that land clearing, preparation, riding were found to be done by 90%, 87.5% ,93.8% of the male, 12.5%, 35.0% and 10.0% of the females, respectively. The analysis of the mean output in

kg/h of the male and female farmers shows the difference in the mean output. The efficiency distribution shows that male operate at the efficiency range lower than that of the females. The study reveals that women are more interested and committed to potato farming. Farm size, the quantity of input, depreciation, age, education, farming experience and care economy were found to affect the output of all the respondents.

Sgroi et al. (2014) evaluate sustainability and profitability of the crop the economic sustainability of farming enterprises growing early potatoes in a Mediterranean setting. The collected data was conducted in south-eastern Sicily, an island in the center of the Mediterranean. The results underscore their modest profitability, mainly due to a lack of entrepreneurial strategies aimed at enhancing production. This situation leads to short comings in terms of the economic viability of the considered activities and which according to economic theory underlie an ultimate impoverishment of the territory.

Jwanya et al. (2014) examined the economics of irrigated Irish potato production in Plateau State. Data were collected through administration of pre-tested structured questionnaires to the 120 randomly selected farmers. Primary data were collected based on 2012 cropping season on the respondents socio-economic and production variables. In this study, descriptive statistics in addition to gross margin was employed in analyzing the data. Results reveal that majority of the farmers were educated (64.17%) adults (58.33%) with long years (97%) of experience in Irish potato irrigation farming and owned an average of 0.7 hectares of irrigated farmland. Cost and return analysis revealed that costs of seeds, labor, and chemical fertilizers made up the highest (89.40%) portion of the average total variable cost of production. Results also revealed that irrigation is a profitable lucrative enterprise with a robust economic viability as shown by values of gross margin (N655,637.88), benefit–cost ratio (2.64) and sensitivity analysis ratio (2.16). The study recommends expansion in irrigated Irish potato farmlands and to adoption of technologies that will minimize the cost of seeds and labor.

Asci et al. (2014) analyzed risks in potato production, fertilizer, water, and producers' decision making. This study focuses on the challenge of developing fertilizer best management practices for agricultural producers that would both optimize the crop production and minimize water quality impacts from agricultural operations. The analysis of this data the effect of economic factors on fertilizer use decisions, this study develops a comprehensive model that integrates various production and risk analysis methods. The objective is to develop recommendations to improve development process by allowing for

a more comprehensive consideration of production and marketing risks affecting farmers' production choices. The land area, per acre yield and prices specifically for Hastings potato production in each of TCAA counties were obtained from potato statistics published by USDA – NASS for 1949 to 2006. Data for additional years (2007-2010) were obtained from USDA potato annual summary reports. Specifically, they use linear stochastic plateau production function to evaluate risks associated with the alternative levels of fertilizer application and prices for Florida potato production. Such analysis helps to determine under what conditions alternative fertilizer recommendations can be too restrictive and how likely these conditions to occur.

Duruyurek et al. (2015) examined the production of bioethanol from waste potato. The study aimed to produce bioethanol from Solanum tuberous by using the yeast Saccharomyces cerevisiae. The data divided in the study shown that the best ethanol production was in group 11 in period 2015. Result in this study over 280 million in the whole world and Turkey is 6th potato producer. Turkey produces 5250000 tons of potatoes. Approximately 20% of potatoes are a waste in Niğde. The study aimed to produce bioethanol from Solanum tuberous by using the yeast Saccharomyces cerevisiae. As a result, renewable energy sources can be produced from natural wastes.

Tolno et al. (2016) analyzed determinants of the quantity of potato produced and marketed by smallholder farmers in Guinea. The aim of this study increasing production and improving marketing efficiency has the potential for raising incomes of the farming households. Using by a multi-stage sampling technique, data was collected from a sample of 90 potato producers in Middle Guinea. Results of the Cobb-Douglas production function showed that potato area, improved seed and fertilizer, positively influenced the potato output and while production losses are negatively associated with the potato output. Also, results that none of the relevant production inputs used by the sample farmers were efficiently allocated and utilized. Constraints to potato production supply include lack of funds, poor irrigation, pest disease, the high cost of transportation, and lack of storage facilities among others. Findings, suggest that government, development stakeholders should encourage, support farmer organizations, develop agricultural, marketing infrastructures, to boost agricultural production and farmers' market access.

Noonari et al. (2016) analyzed economic of potato production in Khairpur district Sindh. To achieve objectives of the study planned strategy was undertaken considering the specific area type and several respondents used the respondent selection from the study

area in Sindh, and the sample of 60 potato growers which equally distributed among the different area of farms in Sindh. Primary data was collected through a wall structured questionnaire to get the information related to the potato production. The result of each potato grower obtained per acre 183.00 in Meds on an average. Each selected potato growers in Sindh area on revenue per acre earned of 140390.00 Rs that obtained by the grower of potato. An average per acre earned during the study, 63473.00 Rs on net income, 140390.00 Rs on gross income and 76917.13 Rs on total expenditure in the study area. An average per acre gross income is 140390.00 Rs. and total expenditure is 76917.00 Rs in Sindh area.

Thorne et al. (2016) used an experimental auction methodology that facilitates positive and negative bids to provide a complete revelation of preferences. Regression analysis was used to investigate the relationship between socioeconomic variables and the initial bids to exchange conventional for GM potatoes. Data collated from the experimental auction sessions. Results show that most participants preferred conventional potatoes to GM potatoes. Favorable information about GM increased subjects' evaluations of GM potatoes. After being informed about potential economic and health benefits, up to two-thirds of our subjects indicated that they would choose GM potatoes at a 20% price discount, while 14% of subjects would still reject GM potatoes at any price. Higher levels of education, greater familiarity with GM, and the presence of children in the household were associated with the lower valuation of the GM product.

2.2. Literature from Iraq

Iman et al. (2011) analyzed potato crop in area of Talkaff in Nineveh Governorate in Iraq. Data collected from 50 farmers. The total cost function was estimated and the average cost function was derived to calculate the optimal size that achieves economic efficiency. The optimal size of the potato crop is 23.54, while the actual size of the research sample is 15.06 tons. Therefore, the farmers of this sample produce only 63% of the economies of scale. The optimum area that can be exploited for optimal size is 13 dunums.

Arkan and Yaseen. (2011) analyzed the status of the economies of potato production in the province Nineveh, Iraq, the production costs and living costs generated by mechanized systems in different areas. The total cost of imports and exports for all operations area according to method depended on the law by Hassan (1991). Data collected in the Spring loop of three different agricultural areas of Nineveh Governorate Iraq, which

specialized in potato cultivation with different systems in terms of cultivated areas (5, 17.5 and 25 ha) the costs of workers, equipment, and machinery for the total agricultural operations of the potato crop. The cost per hectare of potato production varies according to the total area of the field, where the larger the area of the field and the lower the cost of mechanization. The main components of the cost potato production are the rent of irrigation, transportation, labor costs and fuel consumption for the beneficiaries. The total cost of production is 12,741,310 dinars for the first area (5 hectares), 54.917.351 dinars, for the second area (17.5 hectares) and 77.718.894 dinars for the area third (25 hectares). While the net return of the first area of 11.268.689 dinars, while 22,187,648 dinars for the second area, and 79,781.105 dinars for the third area.

Imad (2011) analyzed importance of the biological potato crop in the basket of food consumption of the Iraqi family. Among the reasons for the low productivity of the dunums is the poor relationship between the area and the size of the resources. The aim of the research was to ensure that there is a relational, relationship between the productivity and the optimal size of the farm, which shows the capacity savings achieved. Data collected for this study was conducted on a random sample of 205 farms of potato farms in Anbar Province, Iraq, and two agricultural seasons in 2010, 2011. Resulted in this study of the characteristics of the sample community varied in their positive effect on local productivity, with a weak effect on family work, farmers' experience production, human labor, and the impact of capital on productivity. The optimal level of production prices covering variable costs and fixed costs were identified in the short term. It was recommended that the small and medium-sized farms within the area of capacity savings, representing 92.7% of the farms, and should be integrated into the area of capacity savings (654) tons/ dunum for a farm of 23.79 dunums. Sample, to reach the optimum size to take advantage of the advantages of mass production.

Farhan and Ali. (2015) analyzed economic performance of potato farmers in Baghdad province. Using Data Envelopment Analysis; the potato growers harvest through a personal interview for 260 farms in season of 2013 – 2014. Result of the study included a number measurement of economic efficiency and components has been shown that the technical efficiency under variable returns to scale amounted to about cut 73.2%. While in the light of the stability of earnings capacity amounted to about 43.6%, and capacity efficiency amounted to about %61.7. As well as the results showed that the average allocative and economic efficiency under variable returns to scale producers of potatoes are

30.5,23.5 respectively. Moreover, that the reason for the low efficiency allocative high resource prices, as well as the presence of a waste of resources, this marital re-exploitation of resources is optimized, pay attention to the ways in high productivity and methods at a reasonable price. In addition to the on agricultural extension to provide its services to the farmers for increasing the production quantity and quality at low cost all this leads to the achievement of efficiency. In addition to the need rational exploitation, optimization of inputs used and make it close or equal to the quantities of inputs achieve economic efficiency while maintaining the same level of production.

3. MATERIAL AND METHOD

3.1. Study Area

The study was conducted in Dohuk City in the Northern Territory Government of Iraq. Dohuk is one of the Iraqi provinces located in the far north of the country. It is strategically located at the crossroads of Iraq, Turkey, and Syria. Duhok is the middle of valleys, hills, and mountains. It's somewhat irregular rectangular shape, east 43 passes through the city center and divides the province into two halves. The province itself lies in the northern temperature zone between the eastern meridian of 'E' and 44 '10' 43 10 E and the northern latitudes of 'N' and 37 '20' 36 40 N. In the circumstances surrounding the emergence of the city of Duhok, we see that it initially appeared at the foot of the White Mountain and on the Dohuk Strait. It has a distinct location between different regions of production, which provides the development of the city to facilitate the process of commodity exchange (Radar, 2009).

The city of Dohuk is 10715 km^2. It's administratively divided into areas including many of Dohuk, Sheikhan district, Ismail district, Zakho district, Amadiyah district, and Aqra district. The most important aspects in the city of Dohuk are Sersank and Zawaita, as well as enjoying the city's important tourist destinations for tourists from everywhere in Iraq and the world. The city of Duhok is also known for many famous orchids and vineyards and has now seen a large urban development city in the southern, eastern and exotic suburbs (Radar, 2009).

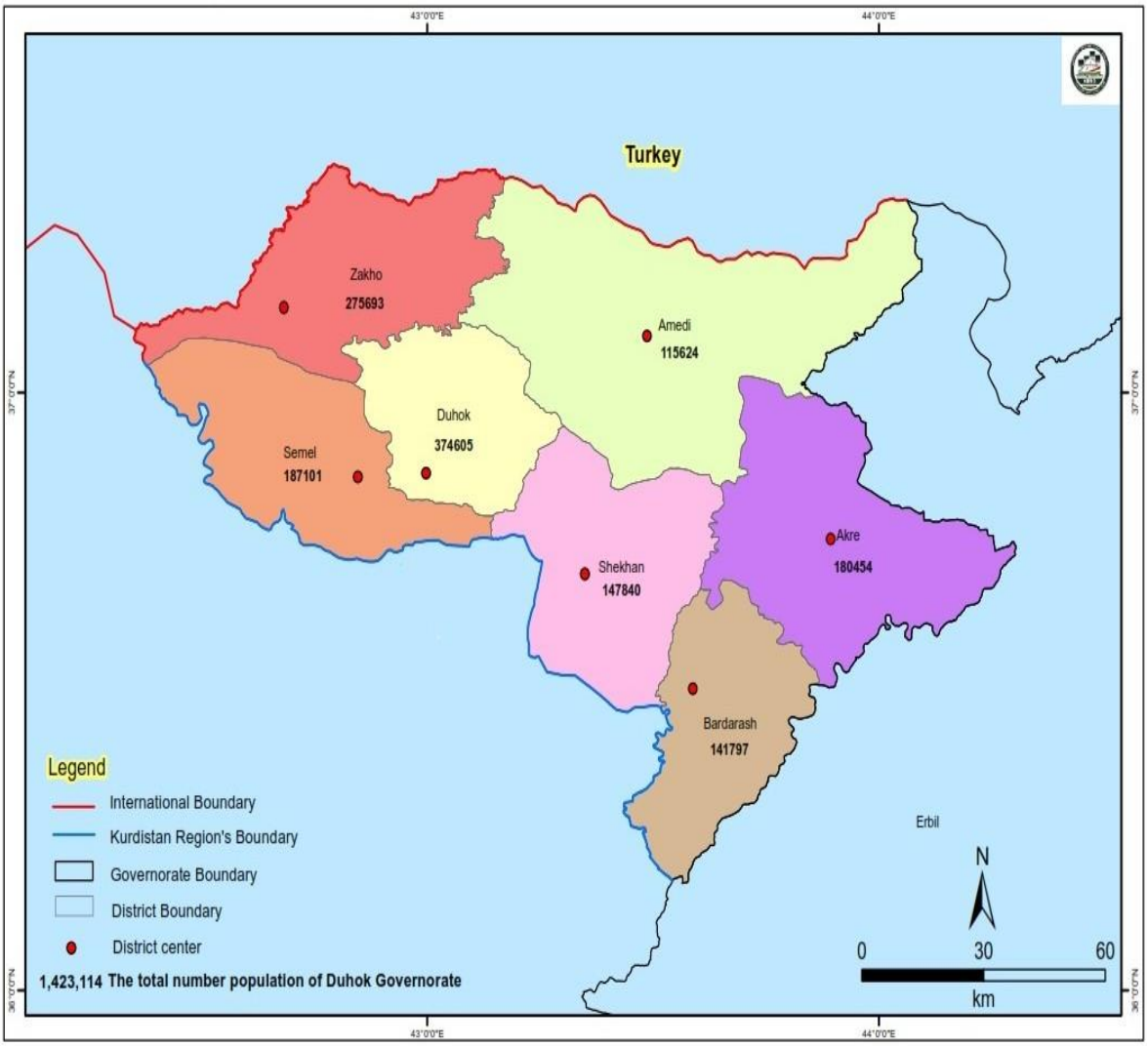

Figure 3.1. Map of Dohuk District in Iraq

Primary and secondary data were used for this study. Primary data collected during 2015- 2016 production year and includes social and economic characteristics of farmers such as the age of farmers, family size, education level, agricultural experience, production objectives, land ownership structure and farm size, as well as the membership of the farmers' organization and the pattern of crop cultivation reasons for adopting agricultural pattern. Data also includes the amount of potato production (kg), quantity, cost of inputs used such as seed, fertilizer and fuel. Because of changes in the prices of agricultural inputs and outputs during the planting seasons, the weighted average prices used in the study.

A questionnaire was distributed to a random sample of 20% potato farmers in Duhok governorate, passing through most districts and aspect shows. The number of farmers was 220. The questionnaires were distributed randomly to the farmers and producers of the potato during the 2015-2016 production year (Table 3.1).

Table 3.1. Numbers of sample by district

District	Semel	Dohuk	Zakho	Bardarash	Shexan	Akre	Total
Number of samples	56	6	58	29	46	25	220
The ratio	25.45	2.72	26.36	13.18	20.90	11.36	100.00

Data includes socio-demographic characteristics of the farmers such as age of farmers, the level of education, year of experience, family work, farm size and land tenure, potato production amount and value, cost of production includes the cost of seed, irrigation, chemical fertilizers, pesticide, human labor, diesel fuel, farmyard manure, machinery and harvesting.

3.2. Data Analysis

3.2.1. Complaint of the Cost and income of potato production

To estimate the Seeds quantity (potato mother) cost of potatoes (CS) in sample farms, the following formula was used.

CS= $Q * DO * P$**…….…..(1)**

Where;

CS= seed cost (potato mother) (IQD)

Q =weight of quantity seeds (potato mother) (kg)

DO= quantity of seeds (potato mother) per one dunam equal to 4.

P=price of seeds (potato mother). (IQD/Kg)

The irrigation cost of potatoes (I).

I= $E * F * P$**……. (2)**

Where;

E= average power learned from the engine (50).

F= average fuel consumption (liters / hour) (3).

P=price of one liter (500 IQD)

The chemical fertilizers cost of potatoes (F):

F= $W * PCF$**……(3)**

Where;

W=weight of quantity fertilizer (kg)

PCF=price of chemical fertilizers (IQD/Kg)

The pesticide cost of potatoes (CP):

$CP = QP * P$**……..……(4)**

Where;

QP= quantity of pesticide (Weight or liquid) (Lt)

P=price of pesticide (IQD/Lt)

The human labor cost of potatoes (HU):

$HU = L * R$**…….…… (5)**

Where;

L=the labor used in the production process.

R= wage of labor

The Diesel fuel cost of potatoes (D):

D = N * NL * P ……. (6)

Where;

NL=number of hour

L= Amount of liter (Lt)

P=price of liter (IQD/Lt)

The farmyard manure cost of potatoes (CM):

CM= $Q * R$**……..…..(7)**

Where;

Q =weight of quantity farmyard manure (Kg)

R= wage of machine transfer (IQD/Kg)

The machinery cost of potatoes (C):

$$C = M * H \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Where;

M= machinery used in the production process (Rent wage) (h)

H =number hour working machine (IQD/h)

To estimate the harvesting cost of potatoes in sample farms, the following formulas were used.

$$C = H * R \ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Where;

C=cost of machine used for harvesting (IQD)

H =number hour (h)

R=wage of machine (IQD/h)

$$S = H * R \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

Where;

S==cost of harvesting (IQD)

H =number hour (h)

R= wage of human labor for day (IQD/h)

Total income of potatoes (TO):

$$TO = N * P \ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

Where;

N= potato production. (kg)

P=price of potato production (IQD/Kg)

Gross profit (GR):

$$GR = TO - TI \ldots\ldots\ldots\ldots\ldots \quad (12)$$

Where;

TO= total output (IQD)

TI= total input (IQD)

The cost of rented land (CR-fixed cost):

$$CR = R * N \ldots\ldots\ldots\ldots\ldots \quad (13)$$

Where;

R= wage land planted. (N.IQD)

N=number of acre. (N)

Net returns (ER):

$$ER = GR - CR \text{..... (14)}$$

Where;

GR= gross profit (IQD)

CR=cost of rent land (IQD)

Benefit cost ratio (BCR):

BCR=TRC/TC…… (15)

Where;

TRC =total income (IQD)

TC =total cost (IQD)

Gross profit ratio (GPR):

GPR=TC/TRC…… (16)

Where;

TC =total cost. (IQD)

TRC =total income. (IQD)

Return per IQD (NRR):

NRR=NR/TC……. (17)

Where;

NR = net returns (IQD)

TC =total cost (IQD)

Expense structure ratio (ESR):

ESR=TFC/TC…… (18)

Where;

TFC =total foxed cost (IQD)

TC =total cost (IQD)

Descriptive statistics were used to analyze three objectives of the study. They have been captured through quantitative and qualitative variables important in understanding the socio-economic characteristics of potato growers. Mean, frequencies and standard deviations of different variables were obtained. Also, ANOVA (F-test) used to compare more than two groups. In addition, an exploratory data analysis tool such as tables and frequencies were used to make the necessary graphic illustration of the data.

3.2.2. Estimation of production function

The Cobb–Douglas production function is a particular functional form of the production function, widely used to represent the technological relationship between the amounts of two or more inputs, particularly physical capital, labor and the amount of output that can be produced by those inputs.

They considered a simplified view of the economy in which production output is determined by the amount of labor involved and the amount of capital invested. While there are many other factors affecting economic performance and their model provide to be remarkably accurate.

Cobb-Douglas production function has been used in most agricultural researchers because of its simplicity. It was first used in 1928 in an empirical study to calculate the productivity of capital and labor in the United States (Tan, 2008).

The Cobb-Douglas type of production function was used in this study as most widely used in the agricultural research and is convenient for the comparison of the partial elasticity coefficient (Prajneshu, 2008). The equation used to estimate production function was

$$TP(L, K) = bL^{\alpha}K^{\beta} \quad \text{……(19)}$$

where TP is total production (the monetary value of all goods produced in a year), L is labor input (the total number of person-hours worked in a year), K is capital input (the monetary worth of all machinery, equipment, and buildings), b, α and β are the estimated parameters. b is total factor productivity related to the technology used, α and β are the output elasticities of labor and capital, respectively. Output elasticity measures the responsiveness of output to a change in levels of either labor or capital used in production and ceteris paribus (Stewart, 2008).

Further, in Cobb-Douglas production function, $\alpha + \beta$ express the return to scale effect. According to this;

If $\alpha+\beta = 1$**,** the production function has constant returns to scale.

If $\alpha+\beta < 1$**,** the production function has decreasing returns to scale.

If $\alpha+\beta > 1$, the production function has increasing returns to scale.

There are several function forms for estimating the physical relationship between input and output. Since the Cobb-Douglas functional is the preferable to other forms if there are three or more independent variables in the model (Hanley and Spash, 1993), the Cobb-Douglas production function with several inputs was applied in this study. Data is analyzed by using Cobb-Douglas production function that provides a plausible structure

for the technical relationship between average potato yields and input use such as human labor, irrigation, seed parent, fertilizer, machine, diesel fuel, herbicide, harvesting costs.

By developing the function in terms of the number of inputs, the function will be transformed to:

$$\mathbf{Y = AX_1^{b1}X_2^{b2}X_3^{b3} \ldots, X_n^{bn}} \quad \text{.. (20)}$$

This type of function with any number of inputs may be changed to a logarithmic equation. In the function above, Y is the yield, Xi the production inputs of (i =1, 2, ..., n) with positive values, A is the intercept and b_i are the inputs elasticities. The above-mentioned function has nonlinear form and its logarithmic form as shown below was used to make it linear.

Therefore, the static frontier production function of potato production based on Cobb-Douglass production function is defined as followed:

$$\mathbf{LnY = \beta_0 + \sum_{i=1}^{n} Ln\beta_i X_i + \varepsilon} \quad \text{.. (21)}$$

$$\mathbf{LnY = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \ldots\ldots \beta n\ LnXn + \varepsilon}$$

Where, Ln is the natural logarithm, Y is potato production (IQD), β_0 is constant, β_i is the parameter to be estimated each input, X_1 , X_2 , X_3,……., X_n are independent variables such as such as human labor, irrigation, seed parent, fertilizer, machine, diesel fuel, herbicide and harvesting cost, $\varepsilon^{\varepsilon}$ is error term.

4. RESULTS AND DISCUSSION

4.1. Socio-demographic Characteristics of Farmers

The study showed that the technological, social and economic characteristics of farmers play a very important role in determining the levels of agriculture. In addition to general as well as specific characteristics of farms and their operators shape overall levels of production and productivity, generating differential returns to farming endeavors. Such characteristics as farm size, use of conservation practices, irrigation and water availability, land tenure, as well as household demographics and assets, have all been shown to exert some influence over farms and technology choice, input use and market participation.

The age distribution of farmers and their average age are shown in Table 4.1. Most agricultural operations require potato cultivation, such as land preparation, soil tillage, weeding, harvesting and energy. Consequently, these farmers who are within the productive age group of 36-45 years are likely to have the necessary strength to carry out these operations. The age of farmers was divided into three groups. First, the share of the farmers aged less than 36 years old was 25.5% (small farmers), the second group of farmers (middle-aged) is between 36 - 45 years old (60%), and finally, the third group of farmers (near-elders) is more than 45 years old (14.5%). The average age of all farmers is 49.17. Most farmers are young people who are still strong and full of energy. This finding indicates all operation of agriculture need the energy to make a significant impact on agricultural production, meaning that the age of the farmer includes the ability to make decisions about their farms and technology.

Table 4.1. Age distribution of the farmers

Age groups	Frequency	Percentage
25-35	56	25.5
36-45	132	60.0
46-70	32	14.5
Total	220	100.0
Average age of farmers	49.17	

There is no doubt that the size of work in any society determined by the two main elements, the first one is number of individuals able to work, taking into consideration the age level (the population pyramid) and their distribution by sex, the customs, traditions and values of society, menu in the field of operation and so on. Secondly, the efficiency of the productivity is depending on the level of technical, professional and staff, the availability of tools and the like. Household size distribution of farmers in the study area showed that the average household size was 8.29. According to household size groups 23.6% of farmers have less than seven members, 58.6% of farmers have between 7-10, and 17.7% have more than ten members on the family.

Table 4.2. Household size distribution of farmers

Household size (Number of persons)	Frequency	Percentage
3-6	52	23.6
7-10	129	58.6
11-14	39	17.7
Total	220	100.0
Average household size	8.29	

All farms produce potatoes made of males in the study area. In all agricultural process, the proportion of men's participation is greater than women, because the reasons such as difficulty of work, needs great energy, the time of the beginning of the planting season even harvesting, every day needs energy great efforts to works on a farm and daily needs. In Figure 4.1, the result shows that the percentage of married farmers is around 96% and the percentage of single is 4%.

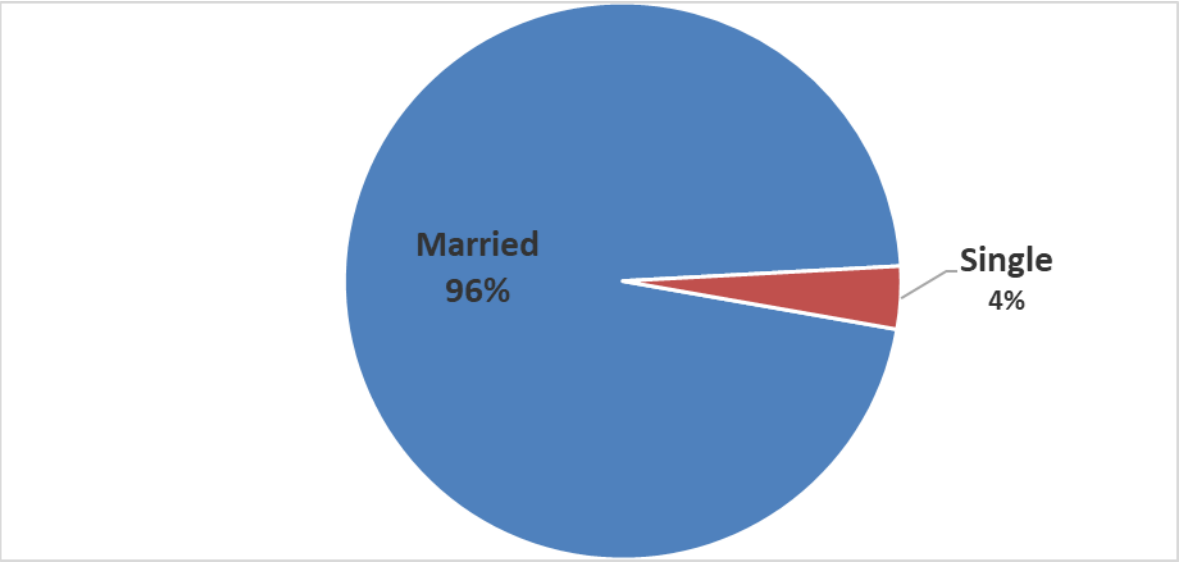

Figure 4.1. Marital status of farmers

Farmers were classified according to their academic attainment into three categories. The result in Figure 4.2 shows that the percentage of illiterate is 21%, the percentage of primary to high school is 56%, and the percentage of the academic level is 23%. Most of the farmer degree holder between primary to high school through the study area. One will have the opportunity to study detailed agricultural markets, technical and planning techniques, to overcome the problems and turn the weaknesses into a force that benefits humanity. They will learn how to be a pioneer in this area, how to use different creative ideas to increase productivity and ways to raise quality levels of products related to the agricultural field, and linking them to different industrial fields.

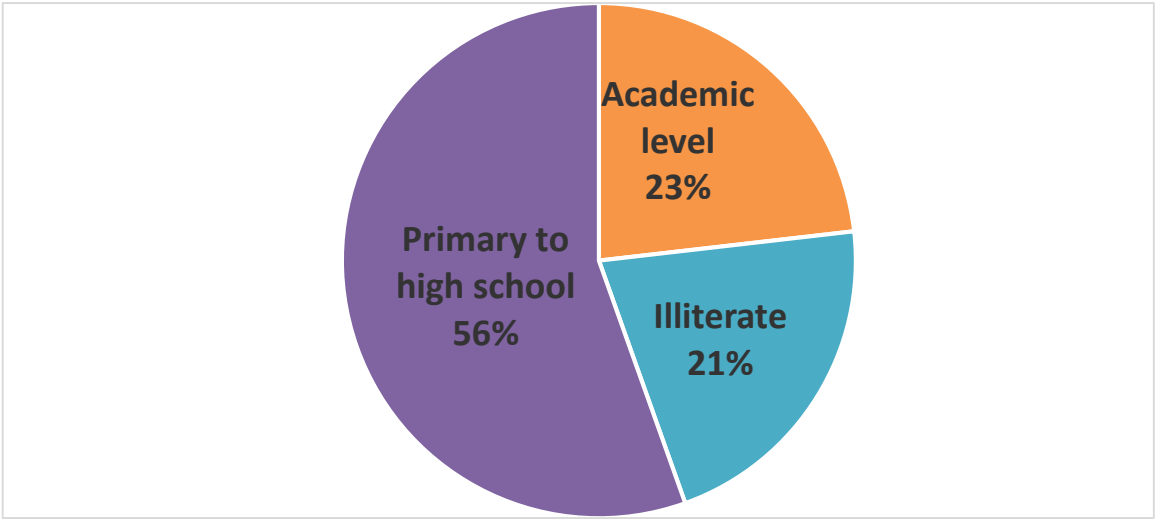

Figure 4.2. Educational status of farmers

Agriculture is one of the oldest known professions practiced by the human element since ancient times. The historical books proved that the primitive man first knew the profession of agriculture in the eighth millennium by during the middle stone age, moved from the life of solution and migration in search of food, water to the life of stability and residence in place, moved from the life of collecting food and hunting animals to food production rather than being consumed by it. Farmers have classified three categories shown in Table 4.3. The first one is the experience having farming experience less than 10 years (44.5%). Secondly, between 11-15 years of potato farming experience had 28.2 %, and final category is more than 15 years of farming experience possessed 27.3 % of potato farming. Farmers with more than 30 years of farming experience had 20.00% of potato farming. In the study area, the average farming experiences of potato farmers is 12 years.

Table 4.3. Experiences of farmers

Experiences of farmers (years)	Frequency	Percentage
<10	98	44.5
11-15	62	28.2
>15	60	27.3
Total	220	100
Average experiences (years)	12.31	

4.2. Land Use and Cultivated Area

Land tenure is a critical factor affecting potato cultivation. Figure 4.3 shows that the majority (77%) of the respondents are the types of potato farms owned by the landowner. The proportion of potato producers who rented their farmland in the study area is about 21% and cultivated of farmer by quotas is only 2%.

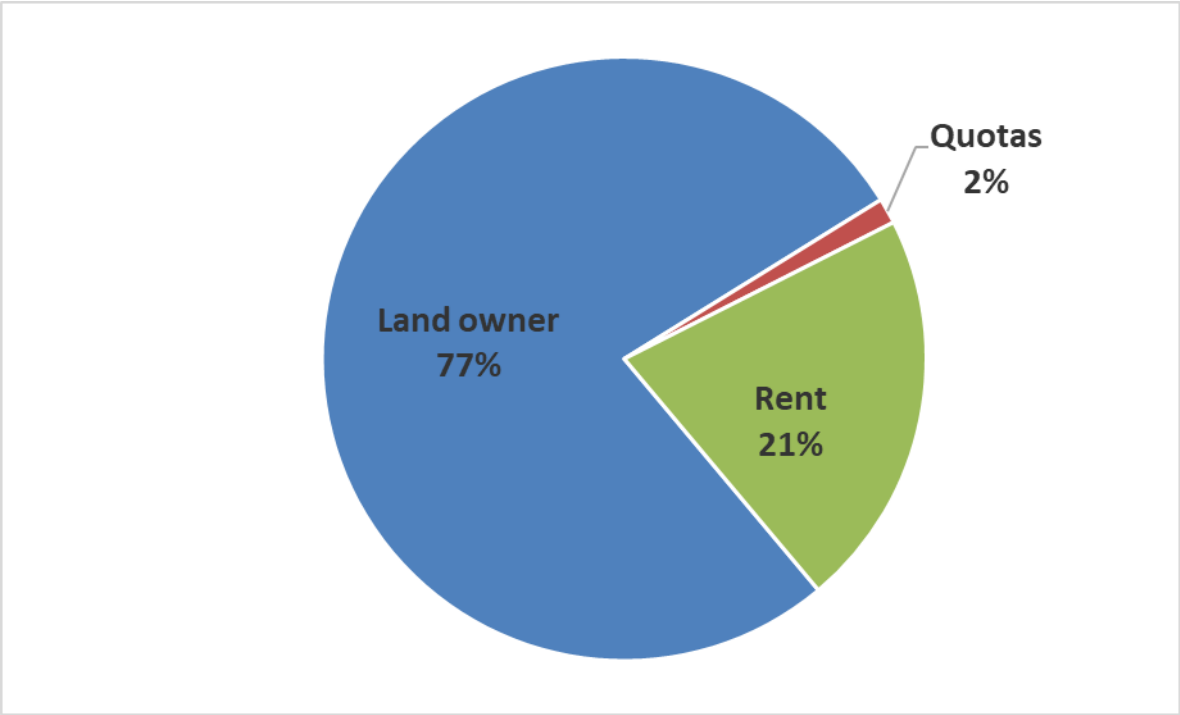

Figure 4.3. Land tenure of farmer

There are some farms producing potatoes with other products such as wheat, corn, potatoes and some other crops. According to Table 4.4, 39.5% of farmers cultivated less than 30 acres, 44.1% cultivated between 31-65 acres and 16.4% cultivated more than 65 acres in production season.

Table 4.4. Total cultivated area

Cultivated area groups (Acres)	Frequency	Percentage
8-30	87	39.5
31-65	97	44.1
66-100	36	16.4
Total	220	100.0
Average total area cultivated	43.45	

* 1 Acres = 2500 m^2

Water sources for irrigation are very valuable and significant for agriculture especially for potato cultivation, since water sources can directly affect potato production. The survey has indicated that all respondents have been using one of two resources of

water, as shown in Figure 4.4. The results explained that the main form of origin was used in rivers with 75% and the artesian was also used by the 25% of producers.

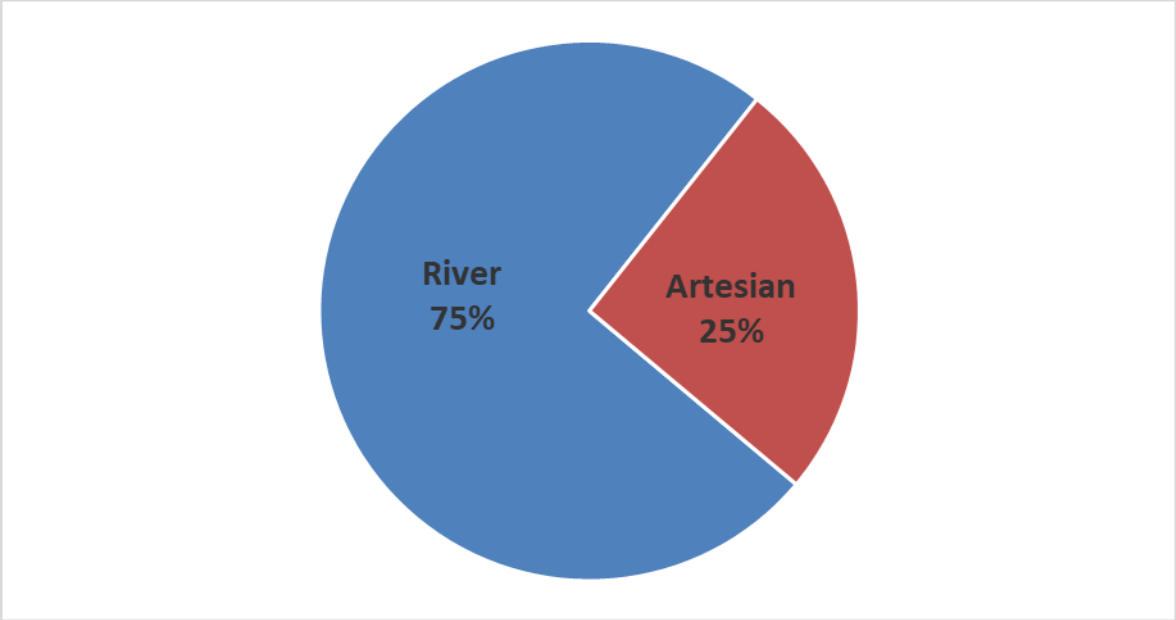

Figure 4.4. Water sources

According to survey results, there is a strong relationship between the extension department of agriculture and farmers in Dohuk governorate. Most of the farmers are in the agricultural rooms comprising (69%), cooperatives (19%), associations (4%), and others not tied to any hand equal (8%), as shown in Figure 4.5.

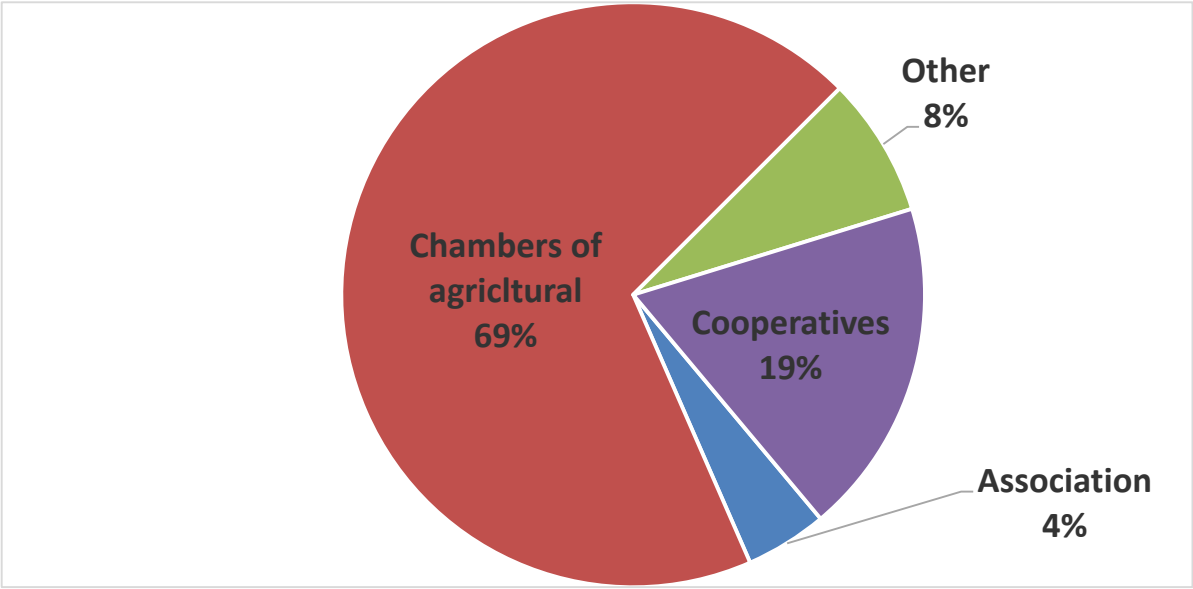

Figure 4.5. Membership in organizations

4.3. Potato Production and Cultivated Area

Potato farmers in the research area are classified into three categories according to than potato cultivated area. The first category represents land cultivated area less than 20 acres with sharing 38.6% of the farmers. Second category includes farmers have potatoes area between 21-40 acres with percentage of 39.5%. And final category of farmers cultivates more than 40 acres represent 21.8% of farmers. The average of all farmers' cultivated area is 31.08 acres.

Table 4.5. The size of potato cultivated area

Potato Cultivated area (acres)	Frequency	Percentage
6-20	85	38.6
21-40	87	39.5
41-85	48	21.8
>85	220	Total
Average Potato cultivated area	31.08	

* 1 Acres = 2500 m^2

In the climatic conditions of Iraq, especially in the province of Dohuk, there are many types of hybrid tubers imported from outside of Iraq such as Netherlands, Turkey and France. But the price for these varieties is very high started from 1300 to 1700 dollars for per ton. Farmers depend on these varieties because it’s early maturity, productive and also resistance to diseases. When the farmers planting one ton of hybrid varieties which produces at least 10 tones, these types are most common, preferred by consumers for taste and texture. There are some cultivars most using in Duhok such as Salvana (23%), Unviresa (21%), Sevran (10%), Colimban (8%). As well as Alaska or Sfire (7%), Losena or Belene (6%), Akterzas (4%), Vibeola or Severi (3%), and Dedon (2%), as shown in Figure 4.6.

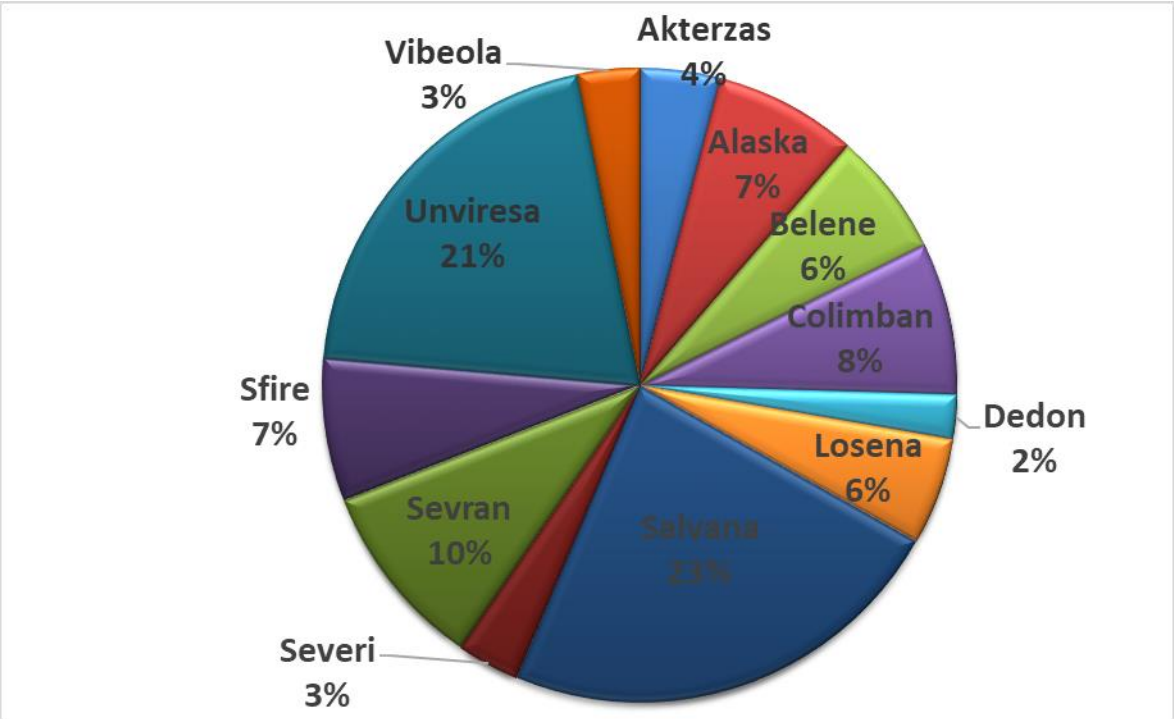

Figure 4.6. Potato varieties used for planting

In this study, the largest number of potato producers in the study area indicates that there is a strong relationship between farms and circular agriculture. The Figure 4.7 shows 68% of farmers get advice from agricultural engineers, technicians or from other agricultural department officers. On the other hands, 27% of farmers use his/her experience about potato farming. As well as 3% of farmers get information from neighbor or relatives' experiences, and 2% indicated that they try to get information from all sources.

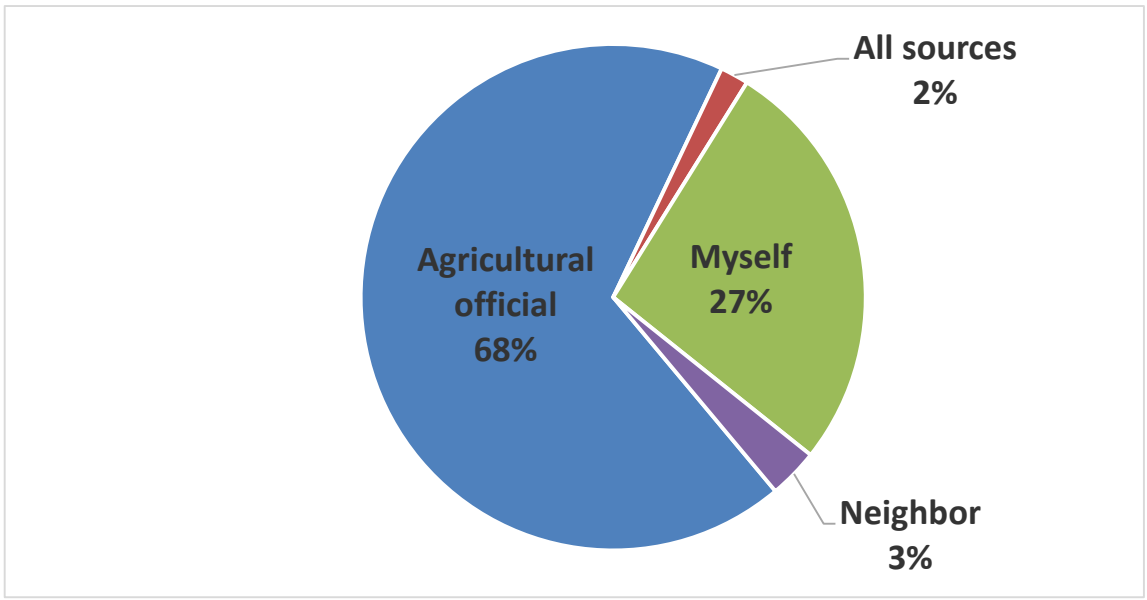

Figure 4.7. Information about potato production

4.4. Agricultural Contracts

The contract is the consent of two or more persons to have a legal effect on the establishment of an obligation, modification or termination of the legislator, whether it's a financial, real estate, and agricultural or commercial contract. The most important agricultural contracts covering several aspects such as corporate contracts, land contracts, government contracts and others (Hart, 1995).

This research discussed confidence between farms and government banks or private banks. According to results, in the research area, 55% of farmers do not trust the government banks. However, 45% of farmers are certainty with the banks (Figure 4.8).

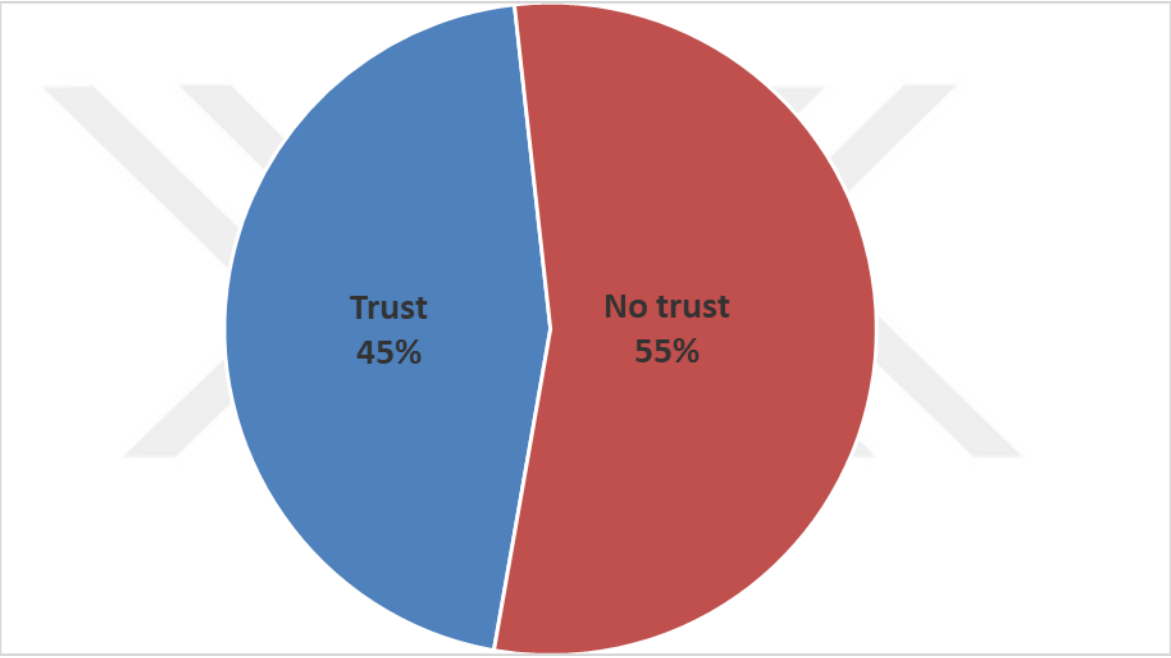

Figure 4.8. Trust to government banks

For using agricultural contract, farmers are divided into three groups according to research. The first group (44%), don't have any agricultural contract. Secondly, 28% have an agricultural contract for potato crop in some years, and 11% of farmers believed that it is necessary for the agricultural cycle.

Agricultural interdependence is very important in the agriculture sector. But in Iraq, there is no contract between farmers especially producers of potato crops and government through this study period. Most of the agricultural lands in the Dohuk area belongs to the owners of the land. However, few farms have an agricultural contract (13%), and much of farmers have no contract represent 87% of total producers.

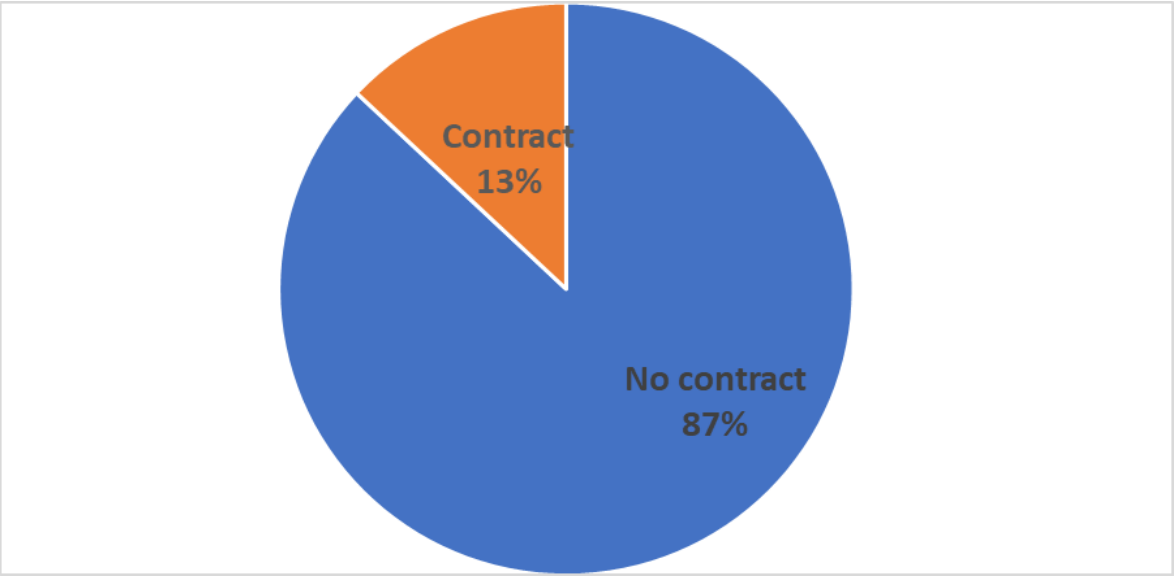

Figure 4.9. Agricultural contracts for farmers

In these research, the relationship between potato and wheat crops in the cultivated areas at 2015 for same lands also invested. Most farmers prefer wheat production compared to the potato crop because of price and cost. On the other hand, the potato crop needs a large agricultural process such as irrigation, harvesting, and others. According to results, 76% of farmers stated that their wheat production area more than potato production because of less cost and easy production. However, 24% of farmers agree the production of potato is better than wheat because it's used in the food industries quickly and its demand is increasing (Figure 4.10).

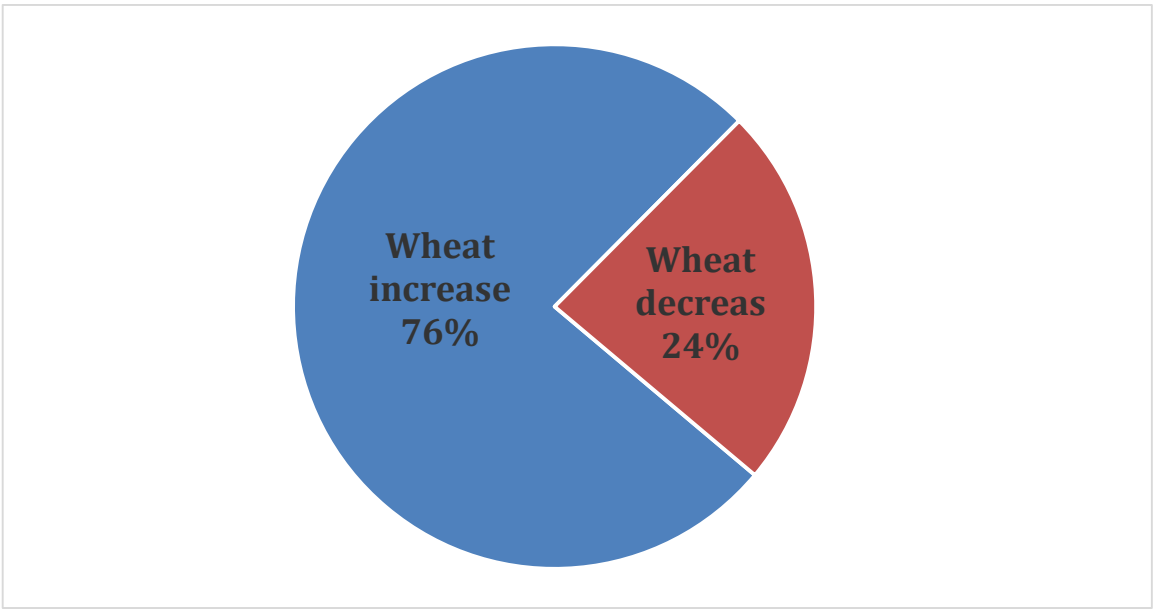

Figure 4.10. Compare land exploitation between past and present

In addition, the production of wheat is higher than the rate of potato production. For this reason, wheat is preferred to cultivation because one-meter square of wheat produces more than 1-1.5 kg, either with the same area of land for growing potatoes we have production rate 1-1.3 kg per acre. The other reason is that the price of wheat is higher than the price of potatoes. For example, the sale price of per kg of wheat between 500- 700 IQD, while the sale price of per kg of potatoes between 400-550 IQD per acre.

There are many successful models in the applications of contract farming and the establishment of agricultural projects. For this reason, most farmers tend to select the appropriate contractual model depending on three main factors. (A) farms support most effective contracting based on the price and sales guarantee (69%). (B) for receipt of cash money (22%) and (C) contribution to modern techniques (9%), as shown in Figure 4.11.

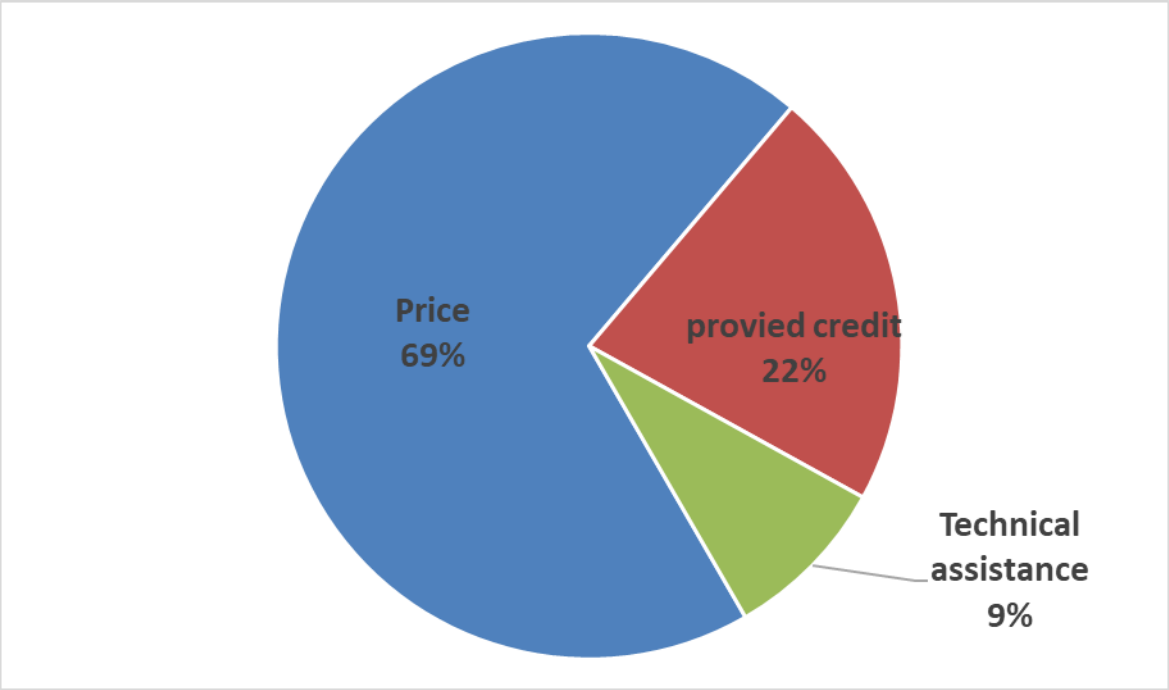

Figure 4.11. Attract farmers to potato crop

In the field of research area, many commercial companies related to the agricultural materials provided of all things related to the cultivation of potatoes such as fertilizer, tubers, etc. Most farmers for the potato cultivate have no relationship with the companies. In general, about 94% of farmers are non-subsidized farmers and 6% of the farmers get some support, as shown in Figure 4.12.

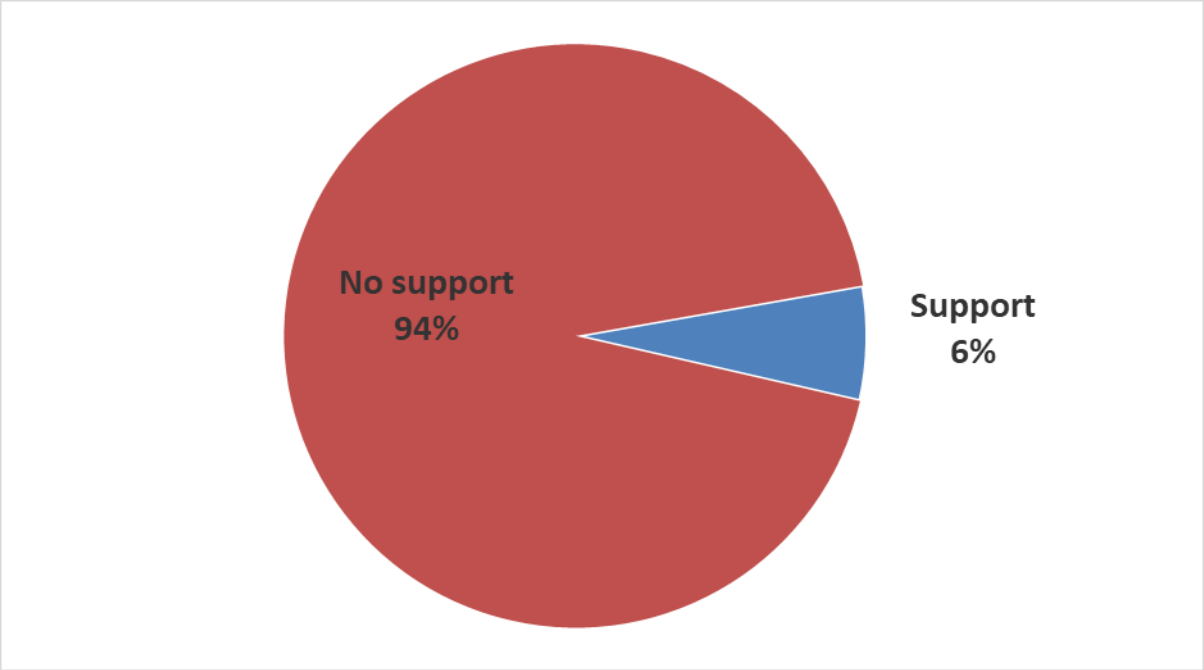

Figure 4.12. Maximize the benefits between producers and companies

Contractual agriculture doesn't depend only on equity capital but also depends on the experience of farmers and provision of employment opportunities in terms of social. Most of the farmers (78%) have certainly experience on contractual agriculture, while 22% have no experience (Figure 4.13).

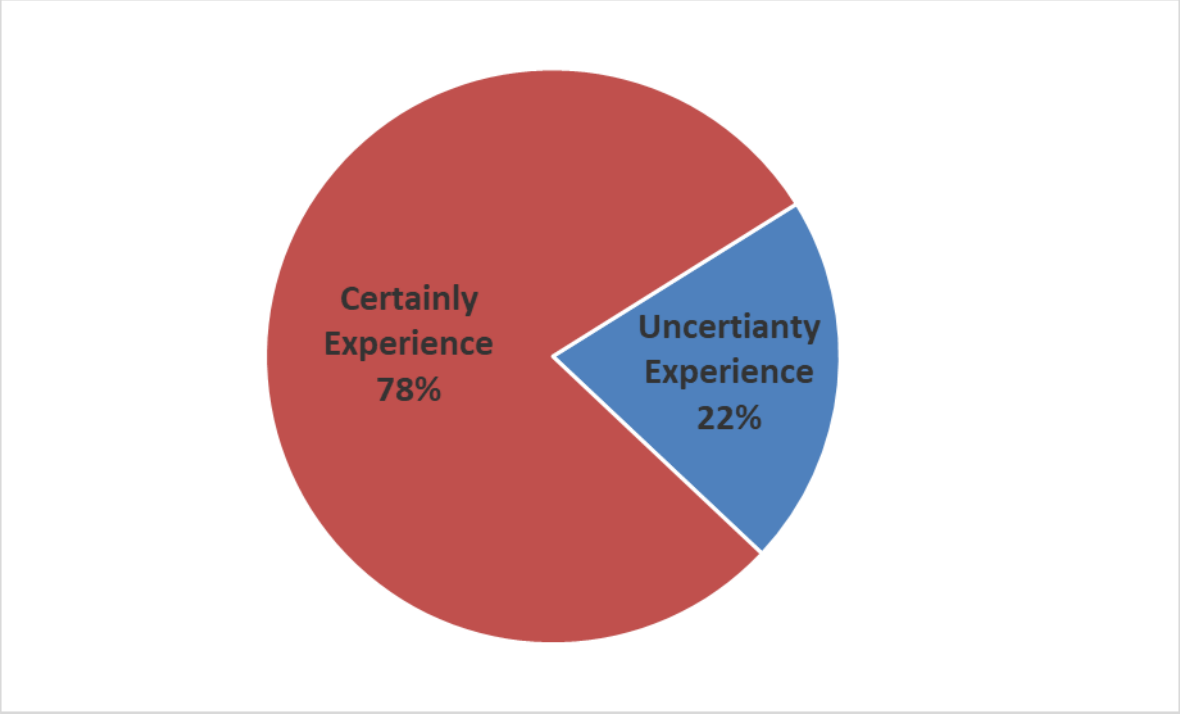

Figure 4.13. Role of farmer experience in contractual agriculture

Most of the farmers do not read contract or they don't understand contents of the contract. According to survey results, there are three reasons for not reading agricultural contract: 47% of the potato producers do not read contract because they are mostly illiterate, 42% of farmers do not understand the conditions of the contract or they stated that it is unclear, and 11% of farmers stated that the terms of the contract (such as economic condition) are very difficult for the farmers to understand (Figure 4.14).

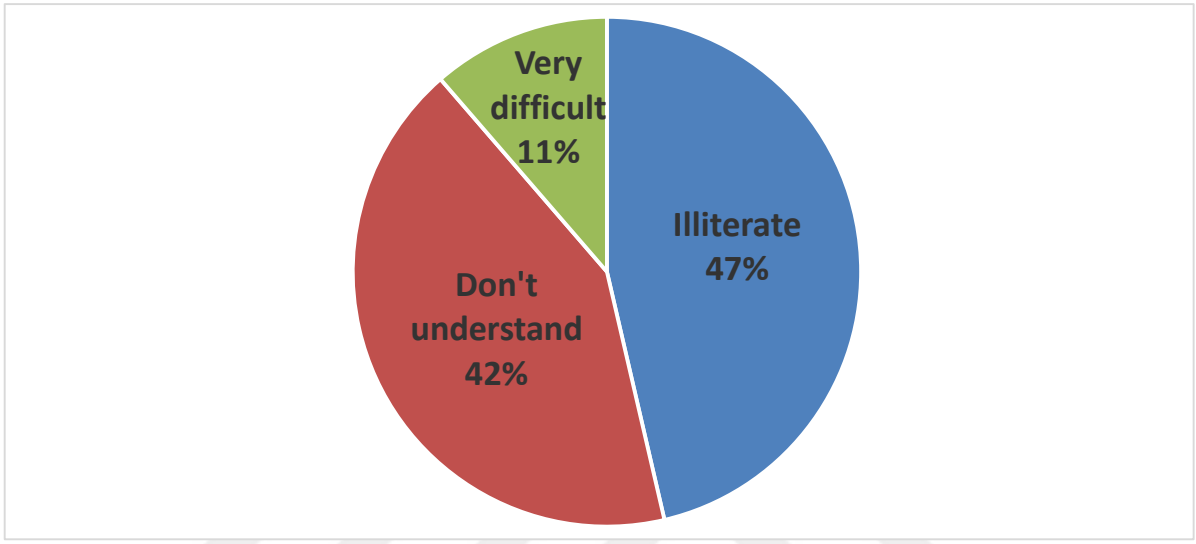

Figure 4.14. Reading content of contract

Farmers have no control on the agricultural contracts in study area because the of the commercial zone. Most of the farmers (98%) does not have agricultural insurance in research area while only 2% have agricultural insurance depends on the contract (Figure 4.15).

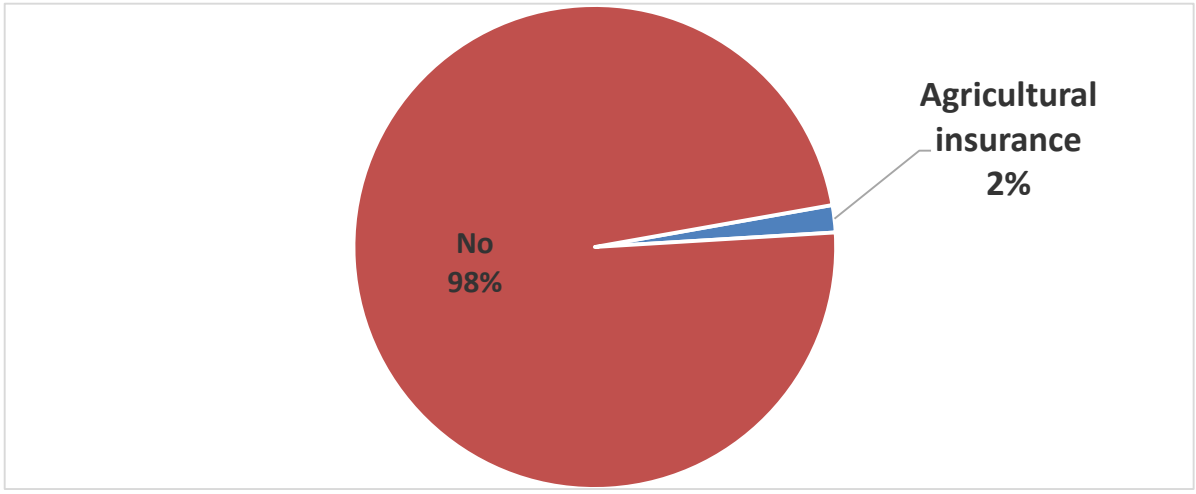

Figure 4.15. The role of agricultural insured for contracts

In many cases, there are unexpected problems such as seasonal floods, unstable climatic conditions, rainfall, low production prices and agricultural pests. 96% of farmers said that, there is no any support from the private or governmental sectors and 4% reflected that get support from government (Figure 4.16).

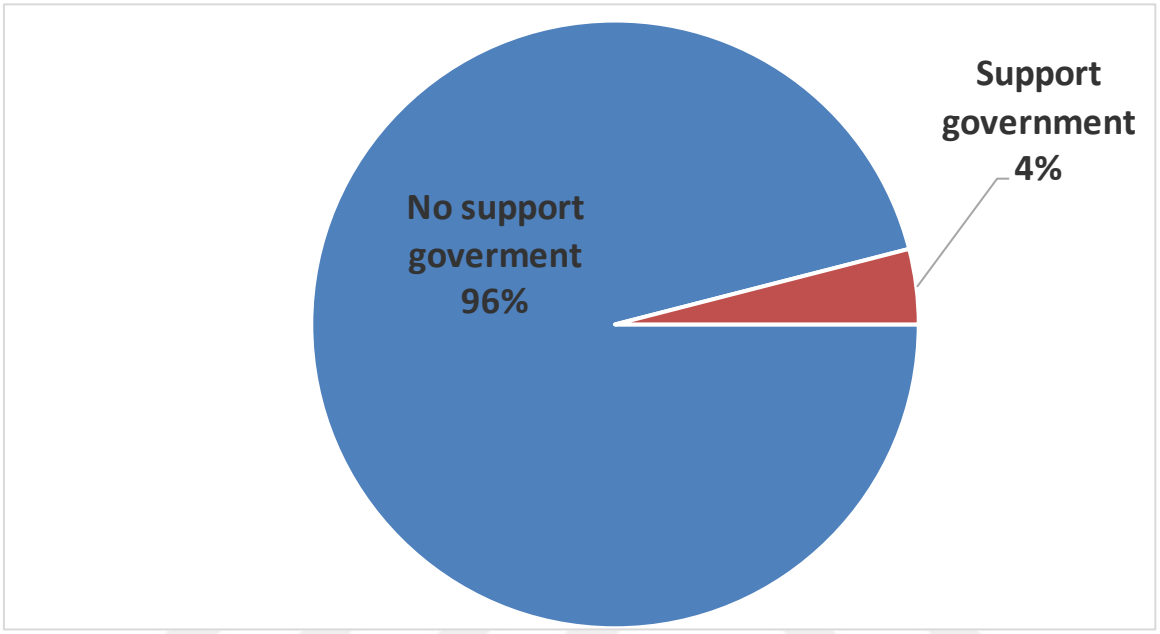

Figure 4.16. Disability factors

The acquisition of technological knowledge is an important input for the competitive advantage of industrial enterprises, especially if such knowledge can be used in the manufacture and development of production technology. This leads to a clear reduction in operating costs, enhancing efficiency, ensuring product quality and cost reduction. The question about using information technology or not is divided into three categories; firstly, 49% dependent on themselves. Secondly, 43% dependent on agricultural official and finally, 8% depends on old farmers with experience, as shown in the Figure 4.17.

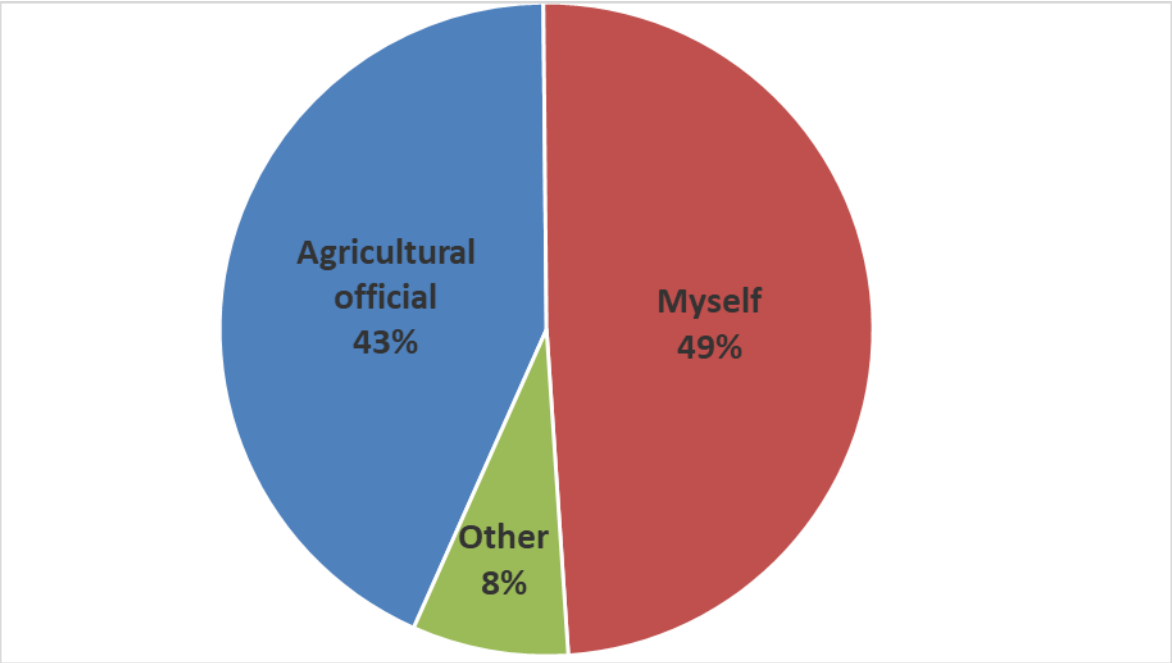

Figure 4.17. Process technology for potato crop

The Figure 4.18 showed that 54% of farmers have no problems in dealing with companies especially for the potato producers and 46% have difficulty dealing with these companies.

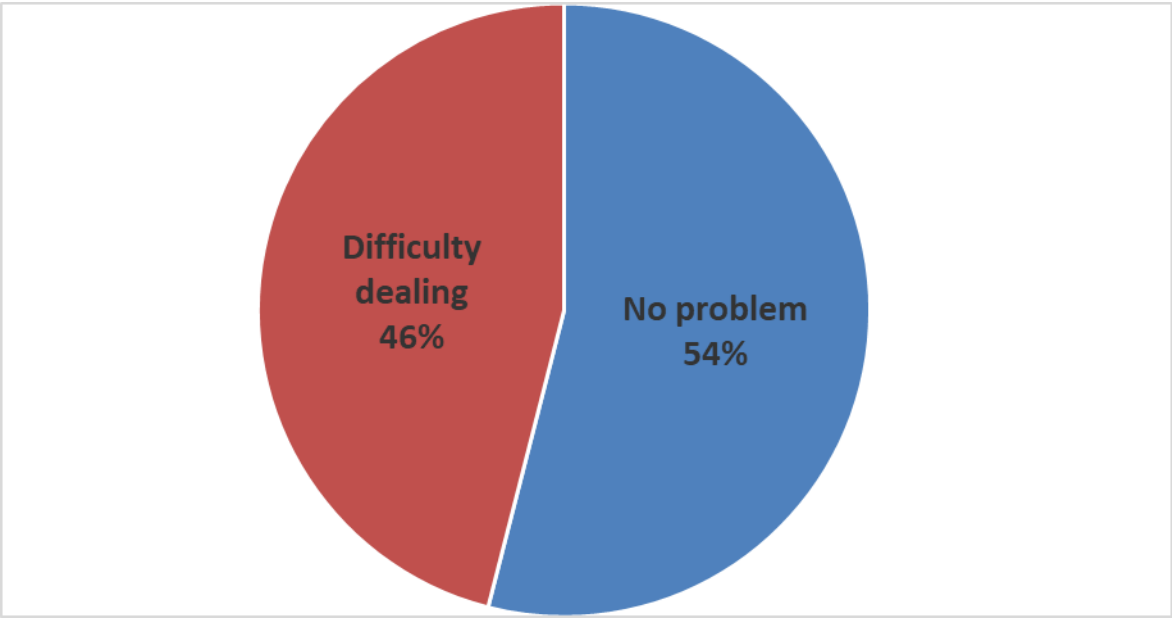

Figure 4.18. Demonstration of disability between companies and farmers

Companies committed to contracts towards farms. About 63% of farmers do not agree with the terms of the contract, 36% agree with the part of the contract and 1% accept the contract in general (Figure 4.19).

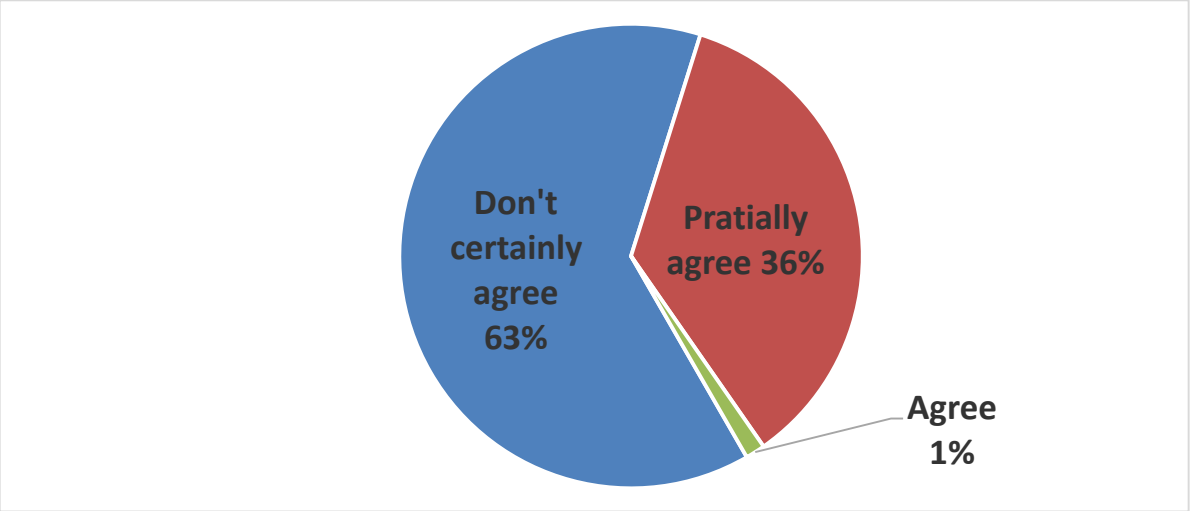

Figure 4.19. Conditions of companies in the agricultural contract

At the beginning of the planting season, the agricultural extension or circular organization quantity of potato tubers is distributed to farmers in the region at a price that is 20% less than market. However, a limited quantity of tubers is distributed and this isn't sufficient for farmers' needs. Therefore, many farmers buy potato tubers also from another market because of more cultivated area. Although most farmers support this support policy by forming circular (83%), some others (17%) do not support it because it supports a small amount of cultivated area (Figure 4.20).

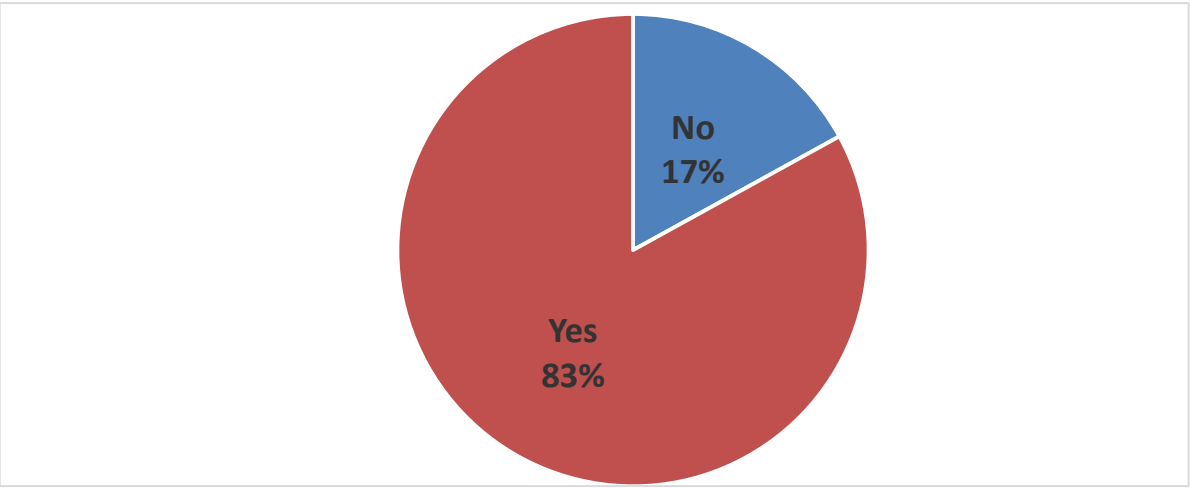

Figure 4.20. Supporting government and companies' tuber distribution policy

The agricultural directorate distributed the agricultural contracts to distinguished farmers (a member at the department of agriculture) to produce a potato crop. According to results, 96% of farmers indicated that they have from the contract, but 4% mention that they do not have any benefit from these contracts (Figure 4.21).

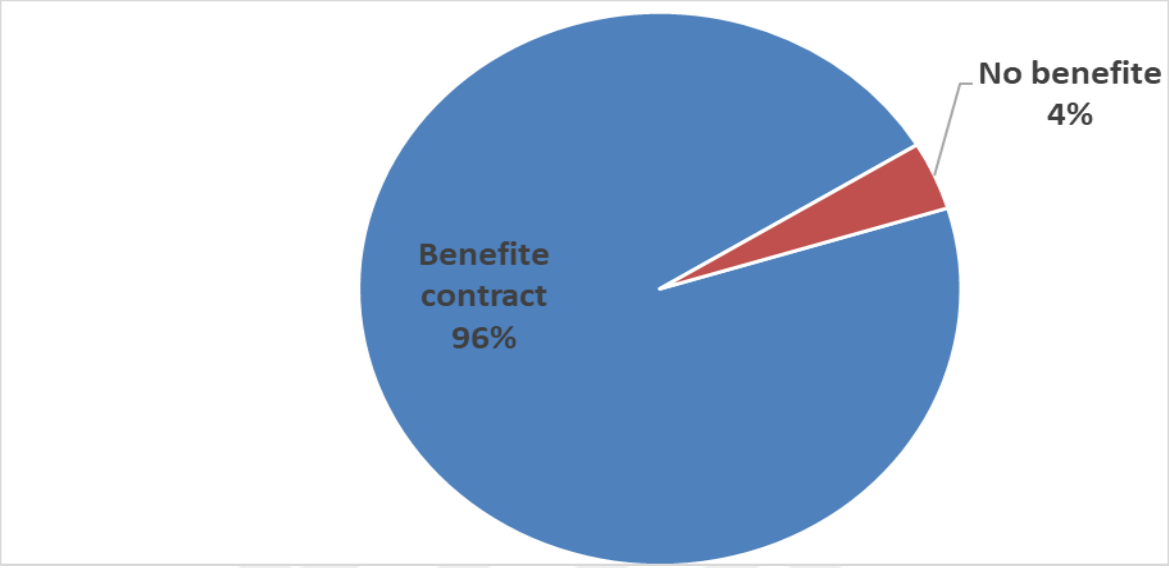

Figure 4.21. Benefited contract

Contract farming rarely encourages farmers to upgrade their activities in experience and move to general steps, such as packaging, manufacturing or marketing their products by government or companies. This study shows that 87% of the contract farming does not encourages farmers to upgrade their activities in experience and 13% reflect this view (Figure 4.22).

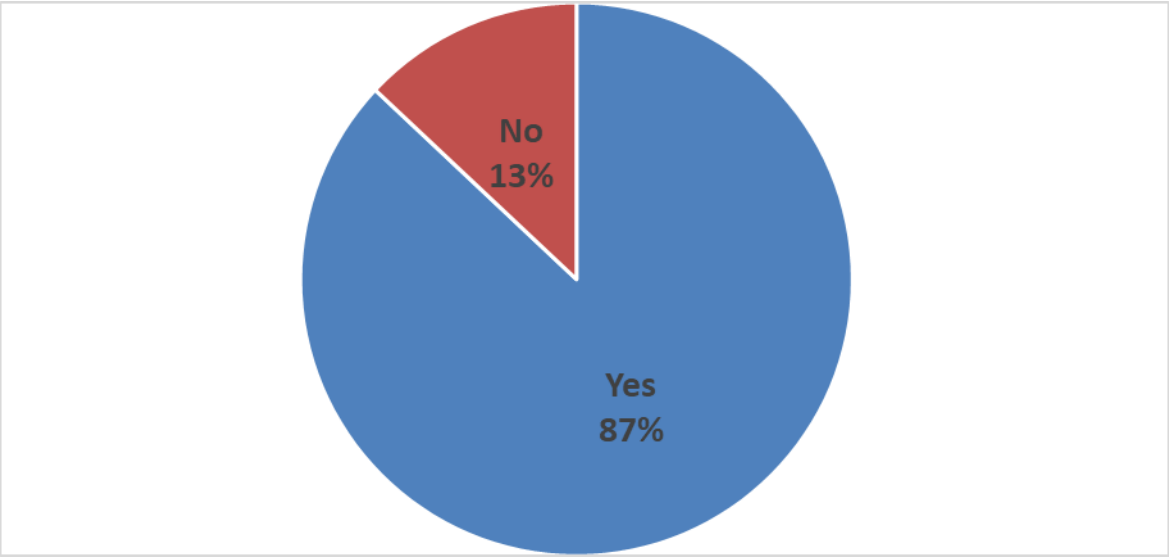

Figure 4.22. The encourages of contract farming

The period is not limited to potato tubers due the free market has goods with non-controlling variety prices. 85% of farmers said according to types, and 15% indicated that price of some seed is different according to time, as shown in the Figure 4.23.

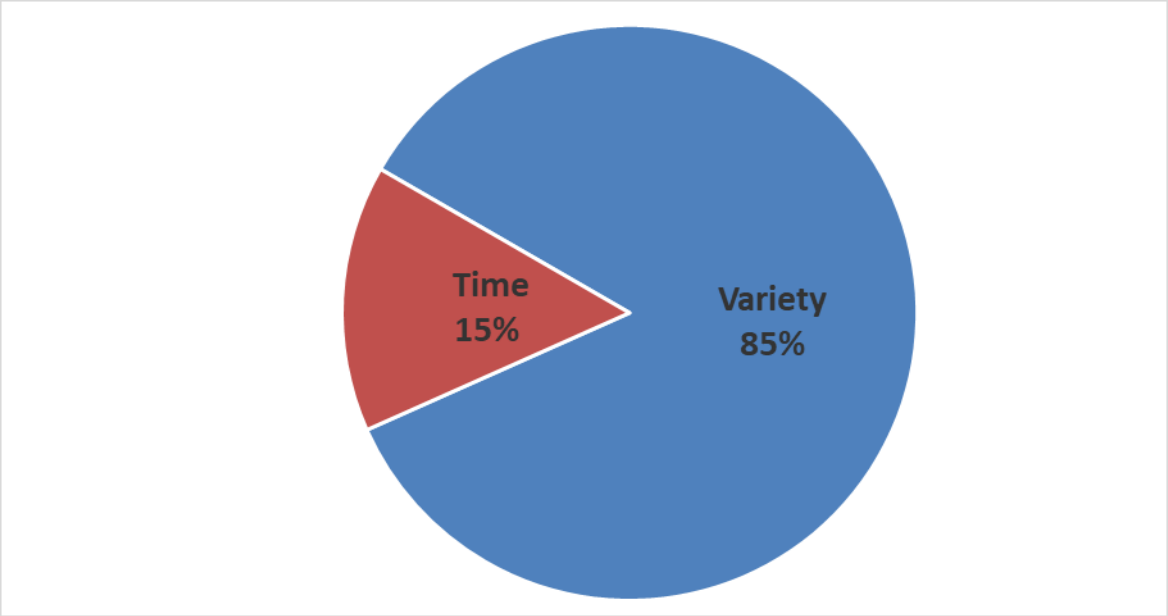

Figure 4.23. Price tuber seed parent

The most companies imported hybrid tubers from outside. It's dedicated to possessing high genetic traits of production, disease resistance, and rapid growth. 39% of farmers depend on this type of imported seed and other (61%) farmers used local seed and don't depend on imported tubers because of the high cost (Figure 4.24).

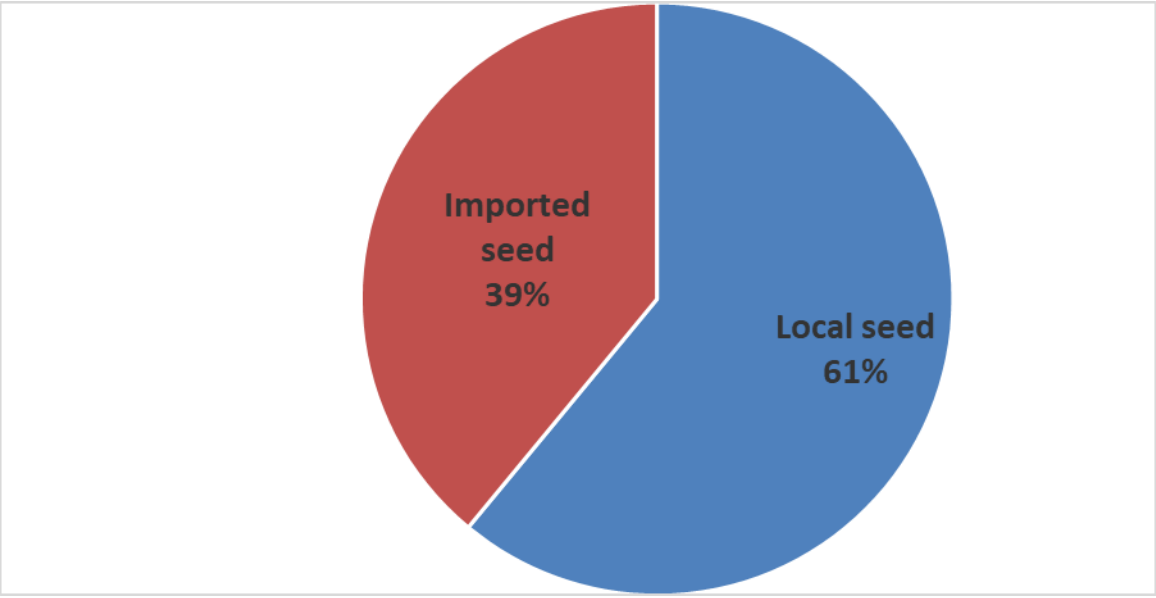

Figure 4.24. Sources of seed

Transfer of agricultural crop is one of the important points of the farmer, especially in harvest time like the big trucks to transfer the production from the field to the market or storage area. According to results, 97% of farmers have a problem to transfer as well as the prices of local production are very low especially the time of harvest, while other farmers (3%) transfer production direct to storage but spend a lot of money when providing cold storage leased (Figure 4.25).

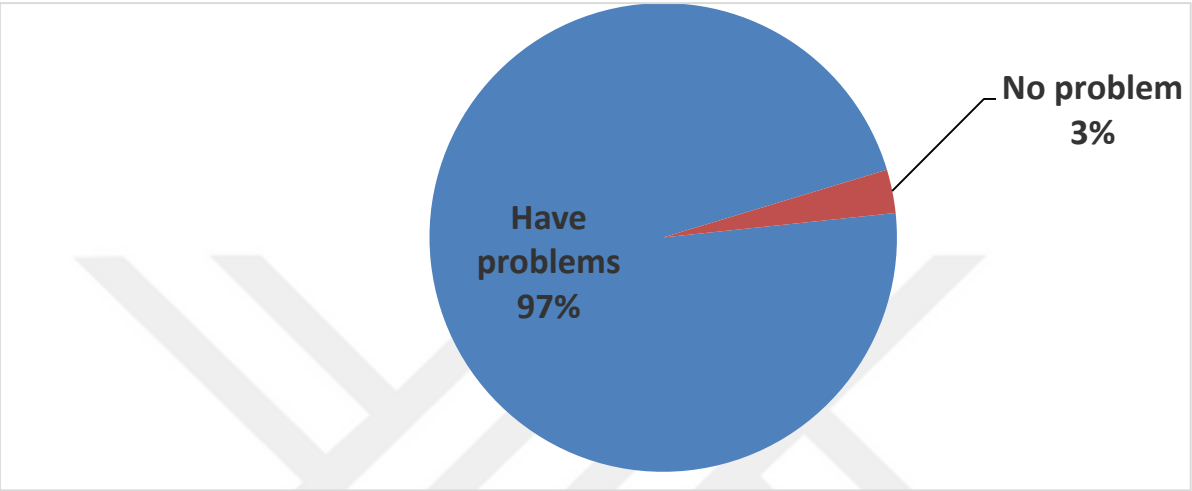

Figure 4.25. Transfer the product at harvest time

The role of packaging is very important to know the packaging and delivery of production materials in cooperation with companies, because it's the art of marketing. In research area, 85% of farmers indicated that there is no type of companies to do packaging, but 15% of farmers want these agricultural services (Figure 4.26).

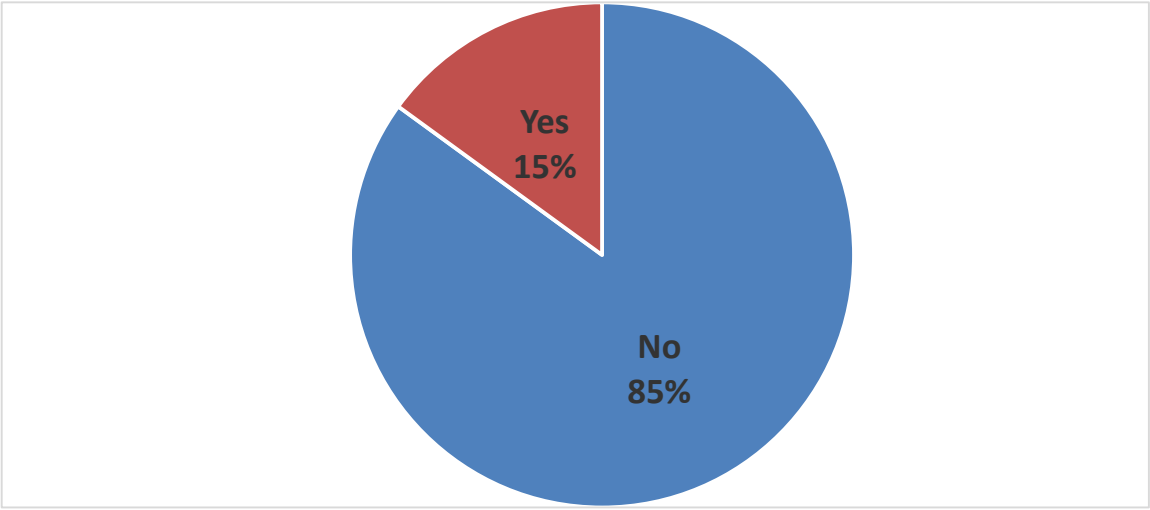

Figure 4.26. Role packaging and transportation

All companies are engaged in agricultural services to contribute the farmer to facilitate the provision of agricultural services by local commercial companies to expand. The most of farmers (60%) doesn't have any access to these services, while 40% have access (Figure 4.27).

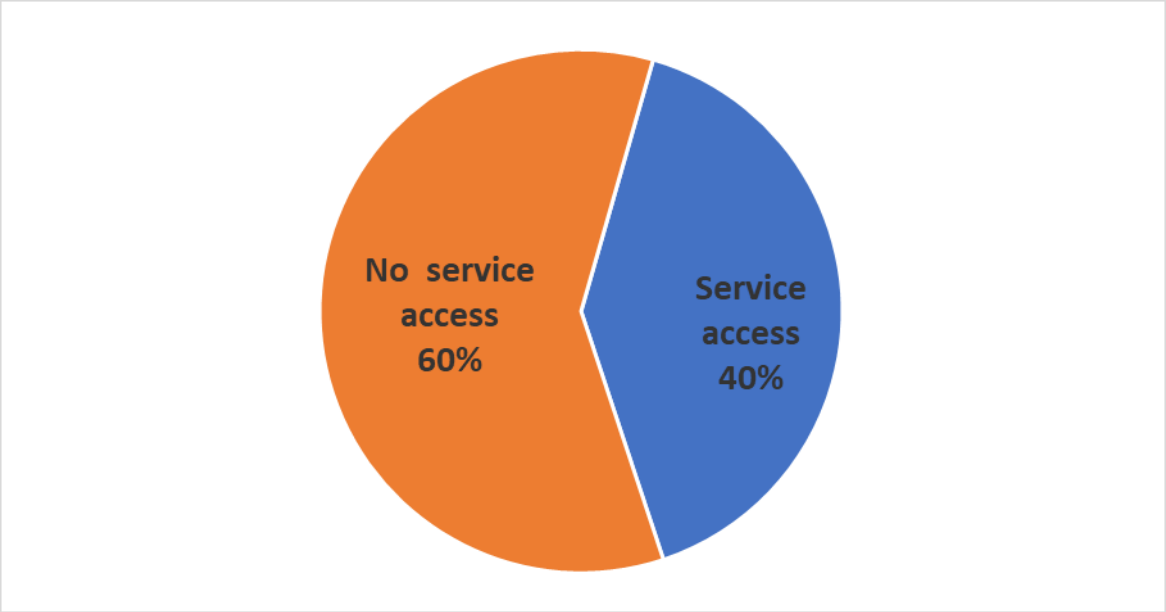

Figure 4.27. Access to company services

Establishing a relationship between the company and the farmers of the producers of the potato, companies provides all requirements necessary for the cultivation of potatoes in terms of technological, economic and agricultural services. 84% of farmers get information from company about hybrid seeds and planting, while 16% get more than one service such as varieties, fertilizers, pesticides and others (Figure 4.28).

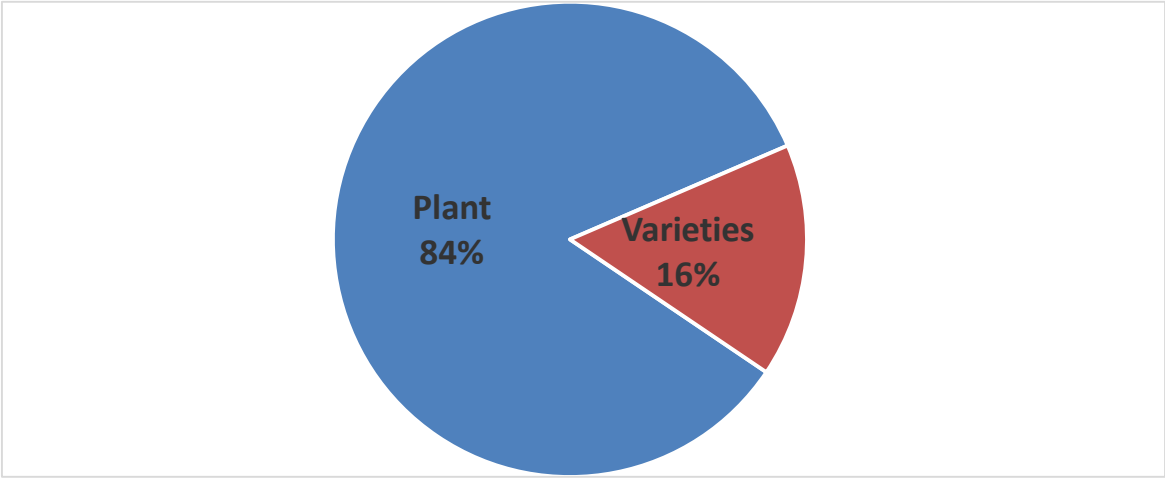

Figure 4.28. Advantage of contract

There are some rare cases of fictitious companies to deceive farmers carry out. According to results, 87%, of the company doesn't abide by agricultural dates the provision of hybrid tubers while 13%, indicated that there is no guarantee of storage and disposal of goods, as shown in the Figure 4.29.

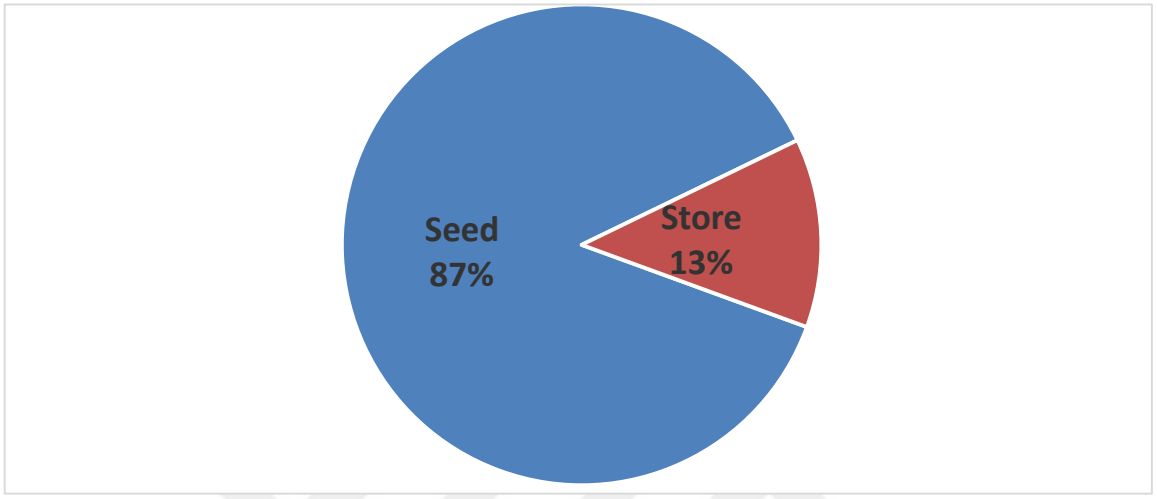

Figure 4.29. Disadvantage of contract

Most farmers don't support the continuation of the contract in this form because it has many shortcomings by companies; Fall in production prices, when agriculture is infected with seasonal insects, such as Colorado insect. According to result, 73% of farmers don't want to extend their contract for next year, while 27% of farmers want to extend contract (Figure 4.30).

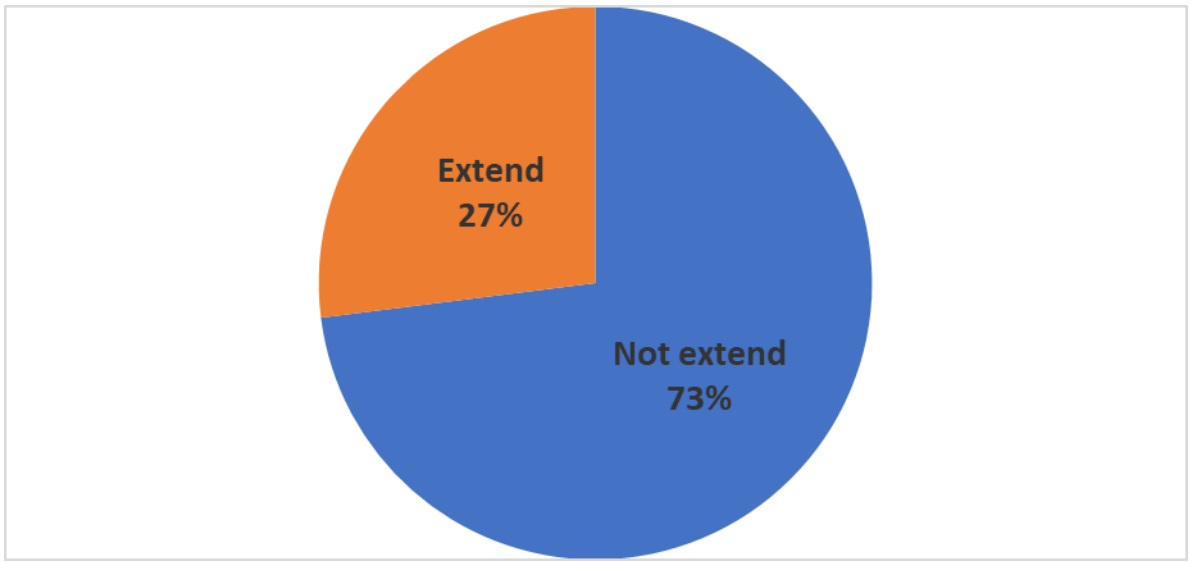

Figure 4.30. Extend contracts for future

According results, 54% of farmers needs to provide the necessary agricultural requirements for the producers of potato crop such as mechanisms, hybrid tubers with high qualities of production and fertilizer (Figure 4.31). Moreover, 43% of farmers need supply stores and factories for the exchange of production, and 3% need control of border outlets to prevent the entry of imported product and frequent taxes domestic production period.

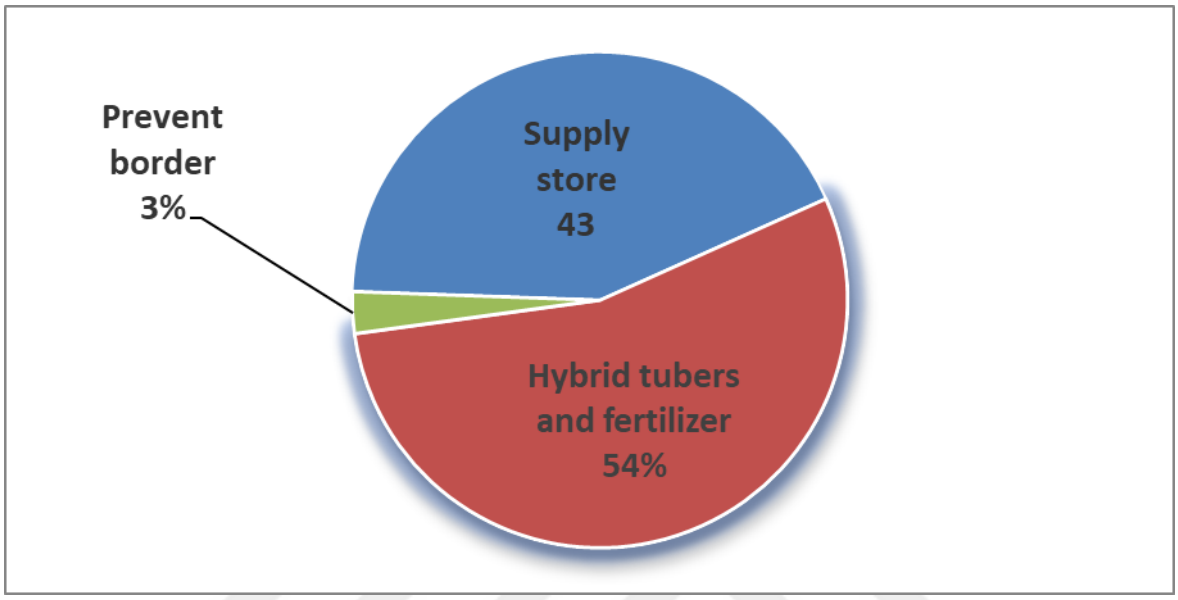

Figure 4.31. Farmers suggestion and needs for potato farming

4.5. Use of Agricultural Extension in Research Area

Agricultural extension means the extent of the social media sphere in which the individual tries out what they have learned from the availability of the values and standards of social relations. The role of the agricultural media, in general, is represented the following points (Elias et al., 2016):

- ✓ Protect farmers interests and take care of their rights and duties.
- ✓ Join the cooperative and specialized agricultural associations and agricultural unions.
- ✓ Intensifying agricultural extension programs and educating farmers and informing them of the new and directing them towards agricultural production and health production at the lowest cost and effort.
- ✓ Urged farmers to use the methods of modern farming techniques.

Agricultural extension program plays an important role in Iraq, especially in the province of Dohuk. The farmers of potato crop are interested in the extension channels which is one of the positive points between them because the interest of the extension program leads to wide ideas on the right way, increase production, experience, and

evolution. Most producers support the extension channels (97%) and others don't care about the extension channels (3%), as shown in the Figure 4.32.

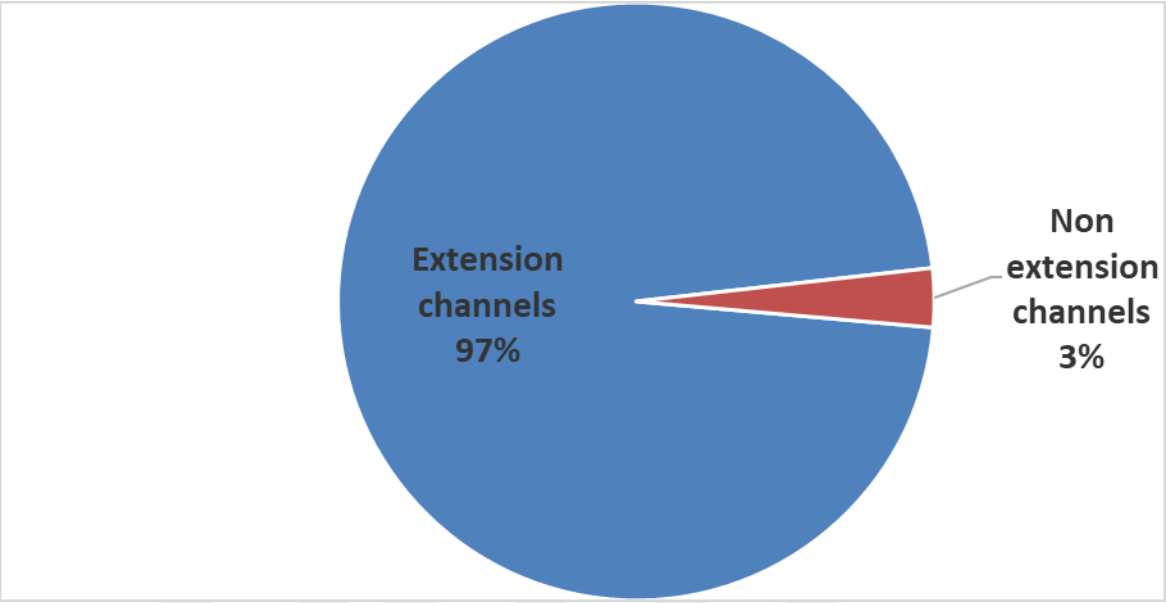

Figure 4.32. The role of extension channels

Agricultural extension organizations and producers of potato crops don't have a regular relationship in a month or a year (unspecified timetable). According to survey results, 52 % of farmers do not use extension service because villages are very far from the city center, 37% of farmers visit extension service only a few times in a year and 11% never used this extension services, as shown in the Figure 4.34.

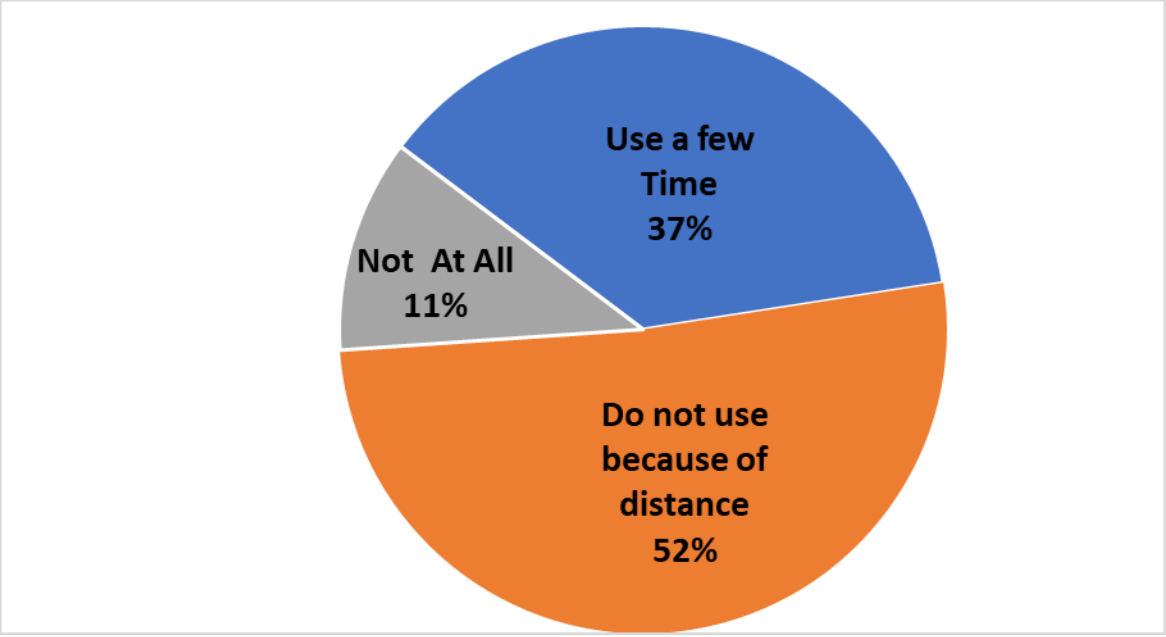

Figure 4.33. Farmers visit to agriculture extension services

The agricultural extension courses in Dohuk governorate have an important role for the agricultural plan and especially the rate of potato cultivation for improving the information. Dealing with the crops a correct manner, the use of mechanic machines in the right way, such as chain potato, cultivation, and others, most farms participate in these prepares and compare in this manner between two years. But it's unorganized response to farmers with a sharing rate of than five points respectively. Firstly, 44% takes several courses in the past and present. Secondly, 35% are sharing one meeting in the past and present. Thirdly, 7% didn't participate in the past and partake one cycle in present. Fourthly, 7% did not participate in the past and partake two sessions in present, and finally, 7% participate two cycles in past and present, as shown in the Figure 4.35.

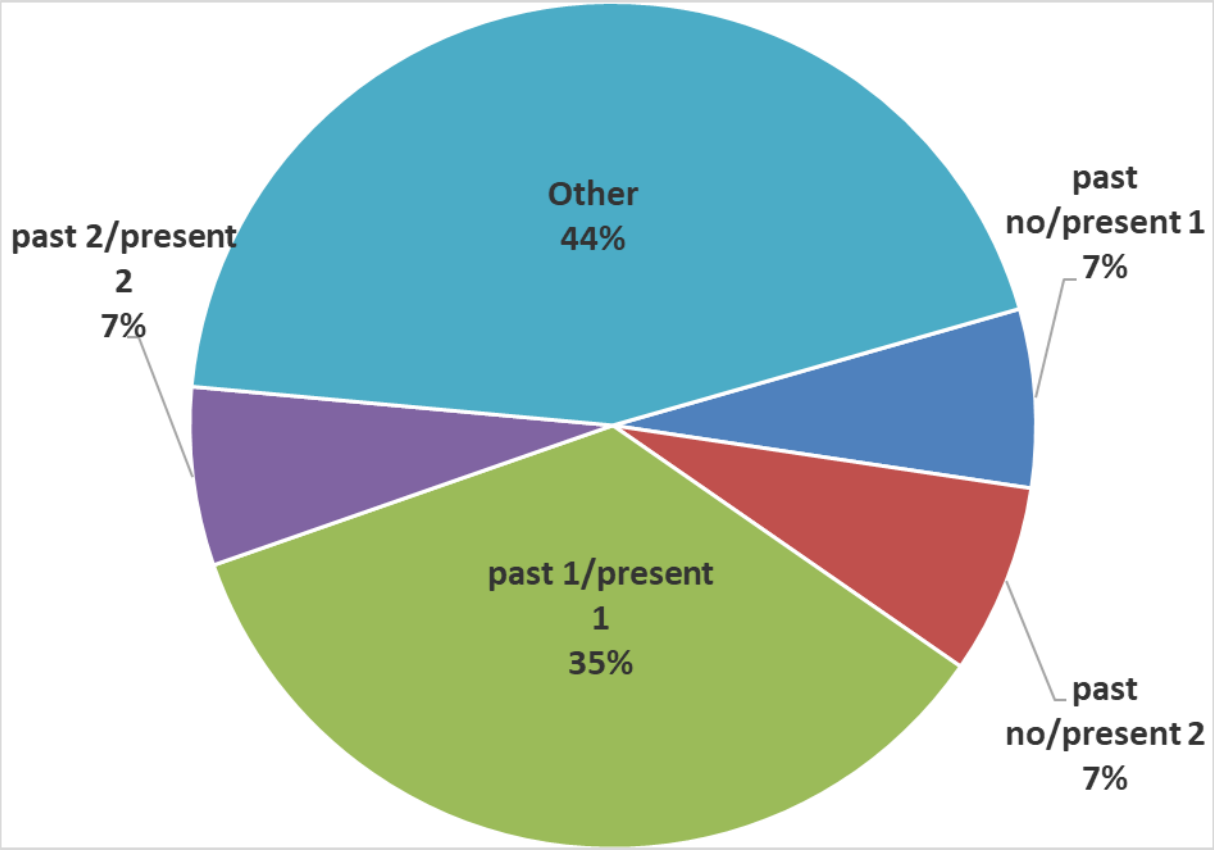

Figure 4.34. The importance of the activities in agric1cultural courses

Most farmers have no problem especially with companies. Option more than two directions, 82% of farmers do not have any problems with companies while 18% of farmers have problems with companies. Farmers problem with companies divided into two categories. Firstly, 16% of farmers have problems by the companies, for example, canal of water and associated content. Secondly, 2% of farmers have problems about fertilizer and pesticide high cost containers, as shown in the Figure 4.36.

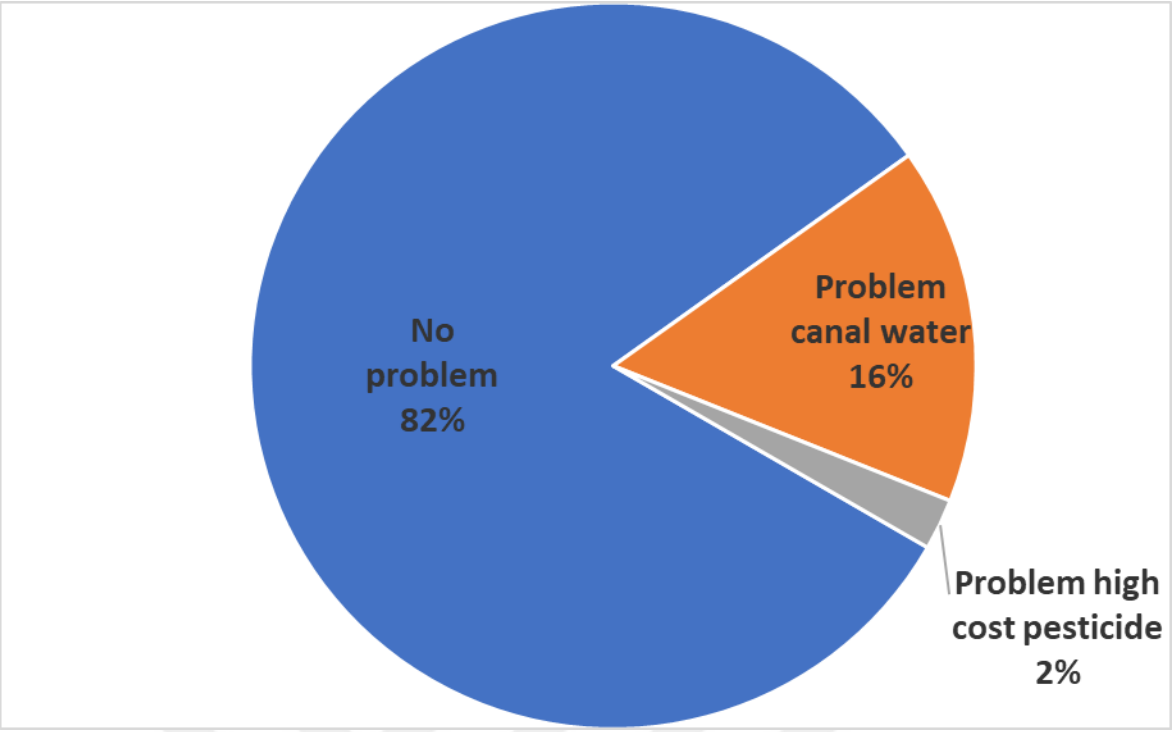

Figure 4.35. Problem with companies

There is a strong relationship between agricultural circular and producer potato in the province of Dohuk. Through the query among the farmers, 75% of the farmers have beneficiary from Ministry of Agriculture, while 25% of farmers have non-beneficiary, as shown in the Figure 4.37.

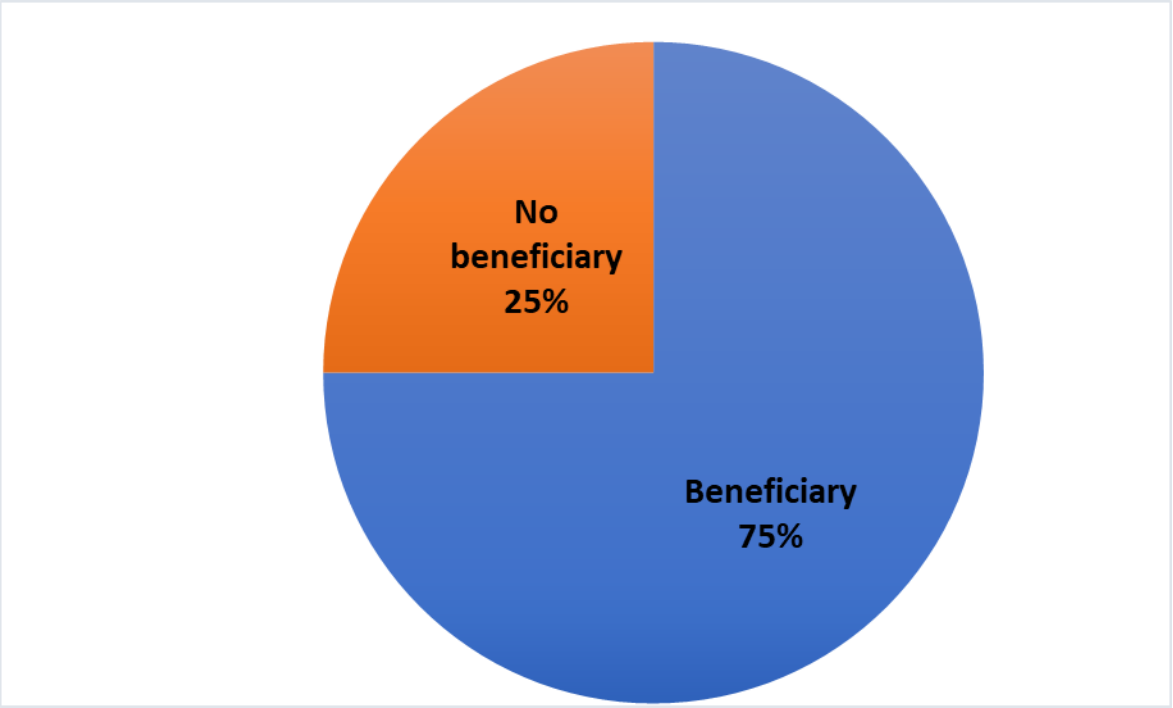

Figure 4.36. Role of ministry of agriculture

4.6. Potato Production Costs and Practices

4.6.1. Land preparation

Land preparation

Potatoes require an all-around depleted soil. Sandy or Sandy topsoil soils are superior to anything overwhelming mud soils for quality potato generation. Potatoes improve on nonpartisan to marginally acidic soils with a pH scope of 6.5 to 7.5. Utilize an etch or ripper for profound culturing. The utilization of straightforward Irrigation Charts for wrinkles and sprinkler water system in view of the dirt and atmosphere conditions constitute effective instruments for water system booking. A mechanical compost spreader or hand communicate preparation should be possible. The planting process will mix the fertilizer into the bed where it can be picked up by the developing potato roots by (Abboud, 2016).

After land planning is equally as useful in any furrow or flood irrigated crop prepare the soil by machine or by a human, the average cost of tillage by machine indicates 120741.17 IQD and its share in total variable costs is about 4.57%. The average cost of human labor indicates 388090.91 IQD and its percentage is about 14.69%. All operations of agricultural from started such as land preparation until harvesting is shown in Table 4.6.

Pre-irrigation

It’s best to plant potatoes into a dirt with adequate dampness to kick the harvest off. Flooding recently planted potatoes will cool the dirt, seal the dirt to air circulation, and kick weeds off. Under warm conditions, it will allow anaerobic microorganisms to begin seed breakdown. Unless there has been adequate precipitation to wet the dirt to a profundity of 30 cm, it is valuable to pre-flood. Having adequate dampness will likewise make the dirt less demanding to tell, potato production counteracts cloud development and aid early season weed control. Soil dampness of 70% to 80% field limit is viewed as perfect for generally soils. Furthermore, the treatment of subsurface water system with a profundity of 13cm fundamentally surpassed the attributes of the aggregate water, relative, mineral substance (NPK), dry weight, paper zone of the plant and delicate weight of roots. According to the results by (USAID, 2011) of plant yield of 625.30 g and aggregate tubers 25012 tons/ha^{-1} and the advertising volume 21.580 tons/ha^{-1}. The interaction between the varieties and the irrigation had a significant effect on some traits of vegetative growth and

yield. The average cost of irrigation indicates 18607.95 IQD and its share in total variable costs is about 0.70%, as shown in Table 4.6.

Pre-Plant Fertilization

If animal manure or a soil amendment is applied to the field, that it be applied to the field after the irrigation and before the disc harrow. The disc harrow would then incorporate the manure into the soil as it is aerating the soil and killing the weeds. According to results, the average cost of farmyard manure indicates 16039.10 IQD and its share in total variable costs is about 0.61%. A soil amendment such as gypsum or sulfur could also be applied just ahead of the pre-irrigation so that it would begin to activate and be carried into the soil with the water. A mechanical fertilizer spreader or hand broadcast fertilization can be done. Al– Muhamadi et al., (2001) found similarly significant effect of potassium fertilizer on the content of leaves of K and N elements gave the highest ratio of these elements at the level of 2.59% for nitrogen and 6.12% for potassium respectively, also total yield increased significantly upon the use of K. fertilizer. The planting process will mix the fertilizer into the bed where it can be picked up by the developing potato roots. The average cost of fertilizer indicates 80873.22 IQD and its share in total variable costs is about 3.06%. Omar et al. (2006) indicated that dry matter in tubers, tuberous weight increased plant yield by 26.67%.

4.6.2. Planting

Iraq farmers in Dohuk region plant potato in two seasons:

1. Spring planting; this is the most favorable time for potato planting. It starts from March in the northern region where there is a higher risk of frost.

2. Fall planting starts from August for the northern region, where frost risk is higher.

In the study area, most operation are done by machinery. The average cost of diesel fuel indicates 32931.82 IQD and its share in total variable costs is about 1.25%.

Planter: A potato planter that can be set to 80cm to 85cm row spacing. The quantity of potato seed one donum requires 950 kg or more of potato seed depending on the planting method (manual or mechanical) and on the variety of seed as well as the final use intended for the harvest. As shown in Table 4.6. the average cost of seed parent indicates 1791006.82 IQD and its share in total variable costs is about 67.81%. Different study done by Jwanya et al., (2014) showed that cost and return analysis revealed that costs

of seeds, labor, and chemical fertilizers made up the highest (89.40%) portion of the average total variable cost of production.

Table 4.6. Potato production costs per planted acre (IQD/Acre)

Variable	Mean	Std. Deviation	Share of Costs (%)
Human labor cost	388090.91	50587.33	14.69
Machinery cost	120741.17	80016.83	4.57
Diesel fuel cost	32931.82	1770.48	1.25
Chemical fertilizers cost	80873.22	47614.60	3.06
Farmyard manure cost	16039.10	7485.97	0.61
Irrigation cost	18607.95	4407.02	0.70
Seeds (potato parent) cost	1791006.82	269019.15	67.81
Pesticide cost	42622.32	19161.74	1.61
Harvesting cost	150118.38	27127.96	5.68
Total variable costs	2641031.68	284974.37	100.00
Total Income	3091485.76	250671.31	
Gross returns	450432.77	298419.08	
Total Fixed cost (Leasehold -rent))	36567.16	68874.21	
Total Cost	81900703.52	617964.60	
Net Income	417023.68	290632.01	
Benefit cost ratio	12.78	20.81	
Gross ratio	0.15	0.09	
Return Per IQD	0.89	0.23	
Expense Structure Ratio	0.05	0.11	

Fertilization

Using fertilizer in cultivation process especially in potato production has an important role to increase the yield. The initial fertilizer application on to the soil surface ahead of the planter. This allows the fertilizer to be mixed into the bed during the planting process. However, planting time application of fertilizer will supply the season's requirements for NPK composite. In the first group farm size is less than 20 acres used NPK composite indicates 112.71 kg/acre, and the second group between 21 to 40 acres used NPK composite about 120.63 kg/acre (Table 4.7). Indeed, when the farm size is more than 40 acres average used result is 128.02 kg/acre. The results explain that the amount of fertilize in the third group is bigger than another two groups of farm size. The average amount of fertilizer that used by farmers is 119.18 kg/acre. The results of F- test indicate that each of the farm size and fertilizer variables significant to each other, because the P-value of the test which is less than 0.05.

On the other hands, with respond to sugar nitrogen used, in the first group is less than 20 of acres used sugar nitrogen about 156.59 kg/acre, the second group used sugar nitrogen 168.28 kg/acre, when the farm size is more than 40 acres, sugar nitrogen used is about 186.25 kg/acre. The average amount of sugar that used by farmers is 167.68 kg/acre. The results of F- test indicates that each of the farm size and fertilizer variables significant to each other, because the P-value of the test which is less than 0.05. According the result by (Khalida, 2010), there was a significant increase in the weight of tubers and plant yield per gram and productivity per unit ton/hectare.

The higher size of the farm the greater the amount of high phosphorus used, such as in third group is more than 40 acres used 2.54 kg/acre (Table 4.7). The second group used 2.37 kg/acre and the first group farm size is less than 20 of acres used high phosphorus fertilizer about 2.31 kg/acre. The results explain that the amount of fertilize in the third group is bigger than another two groups of farm size ($p<0.05$). The average amount of fertilizer that used by farmers is 2.38 kg/acre.

Farmers used also balanced NPK 20-20-20. in the first group farm size is less than 20 acres used balanced NPK 20-20-20 about 2.31 kg/acre, and the second group between 21 to 40 acres used average 2.39 kg/acre. Finally, farmers cultivated more than 40 acres used balanced NPK 20-20-20 about 2.27 kg/acre.

And the final used potassium fertilizer; in the first group farm size is less than 20 of acres used 2.35 kg/acre potassium, and the second group between 21 to 40 acres used 2.37 kg/acre, and third group cultivated more than 40 acres used 2.44 kg/acre. The results explain that the amount of fertilizer in the third group is bigger than another two groups of farm size. The average amount of fertilizer that used by farmers is 2.38 kg/acre.

Table 4.7. Amount of fertilizer used by farm size groups

Farm size* (acres)	Composite (NPK)	Sugar (N)	High phosphor (P)	NPK	Potassium (K)
≤ 20	112.71	156.59	2.31	2.31	2.35
21 – 40	120.63	168.28	2.37	2.39	2.37
> 40	128.02	186.25	2.54	2.27	2.44
Average	119.18	167.68	2.38	2.33	2.38
F-test (P-value)	25.904 (0.000)	107.956 (0.000)	3.748 (0.025)	1.211 (0.300)	0.490 (0.614)

* acre = 2500 m^2

4.6.3. Post Planting Operations

Cultivation

The purpose of post planting cultivation is twofold:

• Kill germinating weeds.

• Build the large bed needed to ensure that there is room for the development of the potato crop (USAID, 2011).

If potatoes are planted on beds that are too narrow such as 75 cm beds, then the potatoes tend to grow near the soil surface and eventually become green from exposure to sunlight. An 80 cm or 85 cm bed spacing allows more room in the bed for the developing crop. This process may need to be repeated several times with the final bed covering the seed with 20 cm to 25 cm of soil. The potatoes should be planted into a field with sufficient moisture to maintain the growth of the growing shoots for several weeks. Farmers need to maximize the width of the bed and minimize the width of the furrow

(USAID, 2011). According to results, the average cost of pesticide indicates 42622.32 IQD and its share in total variable costs is about 1.61%.

Post-Planting Irrigation

The potatoes should be planted into a field with sufficient moisture to maintain growth of the growing shoots for several weeks. Ideally, the next irrigation should not be necessary until the young potato plants have broken through the soil of the final beds. Potatoes have no tolerance for water stress. To optimize yields the total available soil water should not be depleted by more than 30% to 50%. Depletion of the total available soil water during growing period of more than 50% results in decreased yields (USAID, 2011).

There are three types of irrigation used in Dohuk province of Iraq:

Furrow irrigation: efficiencies can be improved using gated pipe systems which reduce evaporation losses and allow more accurate water application in each furrow.

Sprinkler Irrigation: The main water system strategy is sprinkler water system. Legitimately planned sprinkler frameworks make satisfactory, uniform water applications that cool the potato plants and soil, achieve the roots gathered in the upper 47 cm.

Drip Irrigation: Drip irrigation in potatoes apart for increasing tuber yields, prevents tuber cracking and malformation. Drip technology also allows significant savings in water, labor, and energy required for pumping the water. The most important feature of drip systems is the capacity to improve fertilizer use efficiency. This may be the principal reason for yield increases under drip irrigation (USAID, 2011).

4.6.4. Post Emergence Cultural Care

Post Emergence Weed control

Weeds are a problem because they can take nutrients, water, and sunlight away from the potato crop. Some weeds such as dodder and outside can physically damage the plant or the tubers. There are several herbicides available for potato weed control. Costs of production were reduced and crop yields increased because herbicides were cheaper, more effective than hand weeding and cultivation (Gianessi et al., 2007).

Weed control can be accomplished best with herbicides, but can also be done mechanically. If weed control is done by hand or mechanically the farmer should inspect the growth of the shoots frequently. When the shots are within 5 cm to 8 cm of reaching

the surface, the bed surface should be cultivated to kill all germinating weeds. Then the soil should be thrown back up onto the bed, making the bed larger and higher than the original bed (Salah et al., 2013).

Post Emergence Fertilization

Fertilization programs ideally should be based on the results of soil and tissue sample tests and adjusted based on experience with the soil. As a rule, all required phosphorus and potassium should be applied pre-plant or at planting. Nitrogen applications should be split with at least one-third of nitrogen applied during the growing season. NH3 should only be used in drip or furrow irrigation applications, as there would be large losses of N to the atmosphere if applied through sprinklers. The use of an injection system or a drip system to apply urea would permit more uniform application of the nitrogen than furrow irrigation. Total nitrogen applications of 55 to 60 ton per acre of actual N are frequently used in Dohuk production areas. If all the nitrogen came from urea, this would be approximately 120 to 130 ton of urea per acre. The impact of the increased weakness of the Euro against Sterling has been large to the detriment of the GB grower, making export to GB more attractive, and export from GB less so (Grigg, 1995).

Disease & Pest Control

Potato illness control homes are by and large safeguard in nature rather than therapeutic. Seed and the developing plant are dealt with to avert or limit sicknesses. There are very few healing medicines to apply once the illness is available. Numerous potato illnesses are parasitic ailments, which thrive under certain temperature and mugginess conditions. Cases of viral ailments are potato leaf move infection, potato infection, potato virus, potato infection, potato virus, Cucumber Mosaic, Alfalfa Mosaic. Late blight caused by Phytophthora infesters causes annual losses (costs of control and damage) estimated at more than €1,000,000,000 (Haverkort et al., 2008).

Pre-Emergence Diseases

Oversee soil dampness to limit, Fusarium seed piece Rot, Bacterial delicate spoil, and blackleg, Early Blight, Late Early Blight …. and so forth.

Unreasonable dampness will make perfect conditions for these infections. By large, it is vastly improved to pre-water and plant into adequate dampness to convey the grow to a crisis without the water system.

4.6.5. Harvesting

Harvest Timing

Assess developing vines for some tubers set, size, shape, and skin set all the time. As reap time approaches the producer must decide the perfect time to harvest. In this time two type operation of harvesting such as by machinery or by a human. The average cost of harvesting indicates 150118.38 IQD and its share in total variable costs is about 5.68%. Showed in the (Table 4.6) that the selected potato growers on an average per acre 12.78 IQD on benefit cost ratio, 0.15 IQD on gross ratio, 0.89 IQD on return per IQD and final 0.05 IQD on expense structure ratio.

Estimated size of the crop: A gauge can be produced using the normal number of tubers set per vine and their size. Potatoes will keep on sizing after water system has been halted until they have exhausted the vitality and dampness put away in the vines. The average efficiency of the allocation and economic change in the return of capacity to producers of potatoes sequentially (30.5% and 23.5%), since the reason for the low efficiency of the privatization of resource prices (Sarah and Mohsen, 2015).

Market conditions: Market trends may influence the timing of harvest. When the price is high and is expected to drop, a grower may wish to harvest sooner to take advantage of the better price, but only if he believes it will more than compensate him for a lower yield from the early harvest. When the reverse is true and the price is very low, the grower may wish to keep the potatoes in the field in the hope that the price will improve (USAID, 2011).

Inducing Maturity: At the point when after considering every one of the variables, the choice is made to actuate tuber maturity. There are alternatives to consider for set and prepare for harvesting:

Stopping Irrigation: Actually, enabling the field to dry will make the potatoes develop and their skin to set in 7-14 days, contingent on temperature.

Mechanical Vine Killing: Thrash cutting and rolling are the noticeable mechanical strategies used to kill potato vines and are as often as possible joined with ceasing water system in Dohuk ranges.

Chemical Vine Killing: Concoction vine executing strategies comprise of applying agrarian chemicals to dry up the potato vines. Use of substance vine desiccants ought not to be made amid cool and sodden or hot and dry climate.

Expenditures for the consumption of agricultural operation expenditures by type of income groups and their proportions in a group of expenditures such as human lobar are shown in the Table 4.8. About 384752.94 IQD/acre of the average cost of human labor have farm size of less than 20 of acre under farmer's potato cultivation, 387310.34 IQD/acre had between 21 to 40 acres and 395416.67 IQD/acre had cultivated more than 40 acres.

As well as agricultural machinery cost, in the first group farm size is less than 20 indicates 188151.24 IQD/acre, and the second group used about 21 to 40 acres is 87595.07 IQD/acre. Indeed, when the farm size is more than 40 acres, machinery cost is 61446.46 IQD/acre. The results explain that the amount of cost in the first group is bigger than another two groups of farm size. The total average cost of machinery indicates 120741.17 IQD/acre.

Moreover, all machinery needed of diesel fuel, in the first group farm size is less than 20 of indicates 32764.71 IQD/acre, and the second group used about 21 to 40 acres in 32965.52 IQD/acre. Farmers have more than 40 acres spent 33166.67 IQD/acre for diesel fuel. The total average cost of diesel fuel indicates 32931.82 IQD/acre. In finally, compare the relationship between farm size and the total cost for all operations of agricultural such as cost harvesting, in the first group farm size is less than 20 of indicates 158915.67 IQD/acre, and the second group between 21 to 40 acres in 144045.38 IQD/acre. Third, more than 40 acres used cost 145547.15 IQD/acre. The results explain that the amount of cost in the first group is bigger than another two groups. The total average cost of harvesting indicates 150118.38 IQD/acre.

About 9870.91 IQD/acre of the average cost of farmyard manure have farm size of less than 20 of acre under farmer's potato cultivation, 20429.27 IQD/acre had between 21 to 40 acres and 19004.77 IQD/acre had cultivated more than 40 acres. The results explain that the amount of cost in the first group is lesser than another two groups of farm size. The total average cost of farmyard manure indicates 16039.10 IQD/acre. Finally, pesticide cost in the first group farm size is less than 20 of indicates 26804.46 IQD/acre, and the second group used about 21 to 40 acres is 43799.48 IQD/acre. Indeed, when the farm size is more than 40 acres, pesticide cost is 68499.50 IQD/acre. The results explain that the amount of cost in the third group is bigger than another two groups of farm size. The total average cost of pesticide indicates 42622.32 IQD/acre.

Table 4.8. Amount of variable costs by farm size groups

Farm size* **(acres)**	Human labor	Machinery	Diesel fuel	Chemical fertilizer	Farmyard manure	Irrigation	Seed	Pesticide	Harvesting	Total Variable Cost
≤ 20	384752.94	188151.24	32764.71	80204.16	9870.91	18382.35	1739711.76	26804.46	158915.67	2639558.20
21 – 40	387310.34	87595.07	32965.52	75750.00	20429.27	18678.16	1814804.60	43799.48	144045.38	2625377.82
> 40	395416.67	61446.46	33166.67	91343.85	19004.77	18880.21	1838708.33	68499.50	145547.15	2672013.61
Average	388090.91	120741.17	32931.82	80873.22	16039.10	18607.95	1791006.82	42622.32	150118.38	2641031.68
F-test (P-value)	0.697 (0.499)	93.920 (0.000)	0.815 (0.444)	1.683 (0.188)	83.378 (0.000)	0.212 (0.809)	2.681 (0.071)	216.067 (0.000)	7.785 (0.001)	1.170 (0.475)

Table 4.9 compares the relationship between farm size and the share of each cost types. For human labor cost, in the first group is less than 20 acres indicates 14.74% of total production costs. And the second group used between 21 to 40 acres in 14.85%. Third, more than 40 acres share of cost is 14.92%.

About 0.37% of the average cost of farmyard manure have farm size of less than 20 of acre under farmer's potato cultivation, 0.79% had between 21 to 40 acres and 0.72% had cultivated more than 40 acres. The results explain that the share of cost in the first group is smaller than another two groups of farm size, the total share cost of farmyard indicates 0.61%. As well as of seed parent, firstly group less than 20 of acre the percentage cost of seed parent indicates 65.70%. Secondly group used between 21 to 40 acres in 70.34% seed parent. Thirdly, more than 40 acres used share cost 68.85%. The results explain that share cost in the first group is lesser than another two groups of farm size. The average share of seed cost indicates 68.54%. However, in the first group farm size is less than 20 of acre the percentage cost of pesticide indicates 1.02%, and the second group used about 21 to 40 acres in 1.69% by pesticide. Indeed, when the farm size is more than 40 acres used share cost 2.59%. The results explain that the percentage of cost in the third group is bigger than another two groups of farm size. The average share of pesticide cost indicates 1.63%. As well as share cost of harvesting, in the first group farm size is less than 20 of acre the percentage cost of harvesting indicates 6.06%, and the second group used about 21 to 40 acres in 5.53% harvesting. Finally, more than 40 acres used percentage cost 5.50%. The results explain that the share cost in the first group is bigger than another two groups, the total share cost of harvesting indicates 5.73%. The results of F- test indicate that each of the farm size and all variables total share cost some operation more than 0.05 and other less than 0.05.

Table 4.9. Amount of total cost used by farm size groups (%)

Farm size* (acres)	Human labor	Machinery	Diesel fuel	Chemical fertilizer	Farmyard manure	Irrigation	Seed	Pesticide	Harvesting	Total
≤ 20	14.74	7.04	1.26	3.11	0.37	0.70	65.70	1.02	6.06	100.00
21 – 40	14.85	3.37	1.27	2.94	0.79	0.72	68.85	1.69	5.53	100.00
> 40	14.92	2.32	1.25	3.45	0.72	0.71	68.54	2.59	5.50	100.00
Average	14.82	4.56	1.26	3.12	0.61	0.71	67.57	1.63	5.73	100.00
F-test (P-value)	0.106 (0.899)	119.821 (0.000)	0.227 (0.797)	1.197 (0.304)	88.914 (0.000)	0.182 (0.833)	16.832 (0.002)	174.337 (0.000)	7.019 (0.001)	

4.7. Estimation of Potato Production Function

The Cobb-Douglas Production Function is employed to assess the effects of various inputs (Independent Variables) such as human labor, machinery, diesel fuel, fertilizer, farmyard manure, seed, irrigation, harvest, and pesticide on potato production. The result revealed that the specified model has coefficient of determinant (R^2) of 0.98. Model F-statistic is 1203.59 (0.010). The coefficients for seven variables have found to be statistically significant effect on the production of potatoes at 0.05 level, and two of the independent variables didn't have any significant effect on the dependent variable (Table 4.10).

According to the result in Table 4.11, the seed quantity variable has significant and positive effects on production ($p< 0.01$). The coefficient value of seed is equal to 0.187 it means that when the amount of seed quantity used by farmers increased by 1%, the amount of production will increase by 0.187%. In various studies conducted by Ahmad et al., (2014), Yusuf and Wuyah, (2015), seed quantity was found to have a positive effect on potato production similar to this study. The fertilizer variable has significant and positive effects on production ($p< 0.05$). The coefficient value of fertilizer is equal to 0.025 it means that when the amount of fertilizer used by farmers increased by 1%, the amount of production will increase by 0.025%. Similar study done by Yusuf and Wuyah, (2015) showed that effect of fertilizer is positive and significant means that the quantity of chemical fertilizer applied was directly related to output.

The pesticide variable has significant and positive effects on production ($p< 0.01$). The coefficient value of pesticide is equal to 0.051 it means that when the amount of pesticide used by farmers increased by 1%, the amount of production will increase by 0.051%. According to the result by Yusuf and Wuyah (2015), similar to this study, the coefficient pesticide was positive and significant at 1 percent level of probability and in accordance with the expected sign. This means that the quantity of pesticide applied was directly related to output.

Moreover, human labor has significant and positive effects on potato production ($p< 0.01$). The coefficient value of human labor is equal to 0.124, that's mean when the human labor increasing by 1%, the amount of production will increase by 0.124%. Similarly, Hamedani, et al. (2011) found that the elasticity for human energy is 1.019 implying that a given 1% change in human energy will result 1.019% increase in yield.

The diesel fuel factor has significant and positive effects on the production of potato. according to the results from the model when the amount of using diesel fuel increases by 1%, the proportion of production will increase by 0.391%. In addition, the irrigation factor has significant and positive effects on the production of potato. According to the results from the model when the amount of using irrigation increases by 1%, the proportion of production will increase by 0.055%. Similarly, Hamedani et al. (2011) indicated that the elasticity estimates are particularly useful for determining the relationship between input energy and yield. Since Cobb-Douglas function was used in the estimation and the coefficient of variables in log form also represents elasticities. Important variables that influence potato yield are diesel and machinery energy with elasticity of 0.1 and 0.037 respectively in their study.

The harvest factor has significant and positive effects on the production of potato. According to the results from the model when the cost of using machinery increases by 1%, the proportion of potato production will increase by 0.073%. However, the results for farmyard manure and machinery levels had not significantly affected on potato production.

The regression coefficient in the potato production function shows the elasticity of production with respect to each input. The coefficients of all inputs were found to be inelastic means that holding all variable inputs fixed, increasing one of the variable 1% increases total potato production less than 1%.

Return to scale is calculated by adding up the elasticity of each variable in Cobb-Douglas production function. The sum of coefficients is used as an indicator of return to scale. The sum of the all elasticities derived from Cobb-Douglas production function is calculated as 0.94, simply indicating that a decreasing return to scale. This means that when all inputs are increased by 1% the potato production will increase by 0.94%. This result shows that resources used in potato production are inelastic. Result of Cobb-Douglas production function shows that farmers strive a decreasing return to scale in stage II where every farmer intent to maximize profit and minimize cost of production.

Table 4.10. The result of the Cobb Douglas Production Function

Variable Name	Estimated Coefficient	standard Error	T-values	P-values
(Constant)	4.217	0.522	8.086**	0.000
Ln seed	0.187	0.035	5.393**	0.000
Ln irrigation	0.055	0.021	2.677**	0.008
Ln fertilizer	0.025	0.010	2.481*	0.014
Ln pesticide	0.051	0.016	3.236**	0.001
Ln human labor	0.124	0.038	3.271**	0.001
Ln diesel fuel	0.391	0.056	6.953**	0.000
Ln Farmyard manure	0.008	0.007	1.200	0.231
Ln machinery	0.023	0.033	0.687	0.493
Ln harvest	0.073	0.029	2.483*	0.014
R-square	0.981			
Adjusted R- square	0.980			

Note: *, ** are significant of 5%, 1% level respectively.

Therefore, the estimated model can be depicted as:

$$Y = 4.217 + 0.187X_1 + 0.055X_2 + 0.025X_3 + 0.051X_4 + 0.124X_5 + 0.391X_6 + 0.008X_7 + 0.023X_8 + 0.073X_9$$

5. CONCLUSION AND RECOMMENDATION

The potato crop is a great food importance in Iraq especially in Dohuk province and considered a daily consumption. It's the main food crop in terms of quantity, production and consumption, also it's a strategic crop that ranks fourth with wheat, maize, and rice. However, there are many problems facing potato production, especially in Dohuk governorate, which include the high cost of production, which can indicate the high cost of imported inputs such as tillage seeds, irrigation, fertilizers, pesticides, potato bearing, transportation and low productivity.

The main objective of this study is reflecting the reality of the production of the potato crop in the area under study. Also, to analyze the production function of the local potato crop, in addition, the effects of inputs use economic factors of farmers on yields in Dohuk province of the Northern region of Iraq.

To accomplish this objective, the information has been assembled by economic survey of potato farmers with 220 observations in the study area. The Cobb-Douglas production function is employed to assess the effects of various inputs such human labor, seed parent, irrigation, machinery, fertilizer, herbicide and diesel fuel on potato production.

There are many factors that effect on potato productivity like namely socio-economic, biological, managerial and physical. In this study, some important factors were considered to determine their effect on potato productivity. These vital factors were the age of farmers, farming experience, farm size, herbicide, and fertilizer. The Cobb-Douglas production function is employed to assess the effects of various inputs like such human labor, seed parent, irrigation, machinery, fertilizer, herbicide and desilful. The result was revealed, that the coefficient for such human labor, seed parent, irrigation, machinery, fertilizer, herbicide, and diesel fuel had statistically significant effect on potato production.

In this study, it was concluded that the larger of the farmer size, the smaller the cost of the variable, including the agricultural machinery, the transfer of production from the field to the selling point or to the warehouses, the reduction of the cost of harvesting machinery and others. And in return for increasing profits returns and thus increase net profits.

The researcher recommended increasing efficiency productivity of farmers through extension training, attention to appropriate environmental conditions for this crop, particularly about soil and their suitability to produce potatoes. As well as the need to

support production inputs, particularly seeds either directly or indirect by supporting the production of seed projects locally. Result of this study gives authorities to study the obstacles, reasons for high costs and develop appropriate solutions to this problem. So, we note that the efficiency of the customization is high in autumn if the costs are lower.

In this research, we recommended to intensify the extension efforts to increase the level of knowledge of all farmers with priority given to those variables that showed a significant decrease in the level of knowledge the elderly, with low educational attainment, the minimum years of cultivation of the potato, the lowest planted area, the lowest average productivity and the contribution of potato cultivation in the annual income of farmers. The need for farmers to follow the scientific recommendations related to the service of the crop, which in turn leads to increased production, and they need to reduce the minimum import from neighboring countries and to encourage domestic output through full support for farmers.

Based on our search results, we recommend the following:

- ✓ ....View to the average level of knowledge of the farmers concerned, we suggest intensifying the extension efforts in the region and organizing specialized extension courses for farmers, to raise their knowledge in all fields related to the cultivation, service, and marketing of the potato crop.
- ✓ ....Selection of farmers depending on certified hybrid varieties of high quality, resistance to disease and insects.
- ✓ ....Increasing government support and adopting sound marketing policies to support the agricultural sector in the region and Iraq in general.
- ✓ ....Conducting similar studies to identify the level of productivity of farmers in other regions of Iraq.

REFERENCES

Abboud, S. K., 2016. Effect of Different Tillage Systems on Some Soil Physical Properties and Yield of Faba Bean Egypt. *Journal of Agricultural Sciences*, 16(2): 347-370.

Ahmad, I. M., Makama, S. A., Kiresur, V. R. and Amina, B. S., 2014. Efficiency of Sweet Potato Farmers in Nigeria: Potentials for Food Security and Poverty Alleviation. *Journal of Agriculture and Veterinary Science*, 7(9): 2319-2372.

Ahmad, M., Muhammad, R., Ali, A., 1999. An Analysis of Technical Efficiency of Rice Farmers in Pakistani Punjab, *The Bangladesh Journal of Agricultural Economics*. 2(1999): 79-86. (https://mpra.ub.uni-muenchen.de/37702).

Ahmed, S., Rashid, M. H. A., Chowdhury, N., 2013. Comparative Profitability of Boro Rice and Potato Production in Some Selected Areas of Mymensingh District. *Journal of Progressive Agriculture*, 20(2): 253-258.

Al– Muhamadi, S. A. M., Al – Falahi, M. H., Al-ali, H. H., 2001. The Effect of Potassium Fertilization and the Direction of Furrows on The Growth and Yield of Potato Solanum Tuberosum L. *Journal of Tikrit University for Agricultural Sciences*, 5(2):244-250.

Arkan, M. A., Sedeeq, H., Yassen, H. AL., 2011. Calculation of Potato Production Costs for Mechanization Systems in Different Areas in Nineveh Governorate. *Iraq Journal for Agricultural Sciences*, 2(1): 94-107.

Asci, S., Borisova, T., VanSickle, J. J., 2014. Risks in Potato Production, Fertilizer, Water, and Producers' Decision Making. In 2014 Annual Meeting, Dallas, Southern Agricultural Economics Association. (http://ageconsearch.umn.edu).

Bhajantri, A., Shrinivas, f., Others., 2011. Production Processing and Marketing of Potato in Karnataka India-An Economic Master of Business Administration. Analysis. University of Agricultural Sciences, Bangalore, Department of Agricultural Marketing. 117 pages.

Dupreé, L.T., 2008. Transitioning to Organic Fertility Management in Potato Production. Master of Science in School of Plant, Environmental and Soil Sciences Louisiana State University and Agricultural and Mechanical College. 90 pages. (http://digitalcommons.lsu.edu/gradschool_theses).

Duruyurek, M., Dusgun, C., Gulhan, M. F., Selamoğlu, Z., 2015. Production of Bioethanol from Waste Potato Turkish. *Journal of Agriculture-Food Science and Technology*, 3(5):331-334.

Elias, A., Nohmi, M., Yasunobu, K., Ishida, A., 2016. Farmers' Satisfaction with Agricultural Extension Service and Its Influencing Factors. A case Study in North West Ethiopia. *Journal of Agricultural Science and Technology*, 18(1): 39-53.

EPB, 2008. Pakistan Export Promotion Bureau Export Statics. (web:epb.gov.bd).

FAOSTAT, 2017. Statistical database of food and agriculture organization of the United Nations, available at (http://faostat.fao.org/faostat).

Farhan, M. O., Ali, S. B., 2015. Measuring the Economic Efficiency of the Potato in Baghdad Case Study. *Iraq Journal of Tikrit University for Agricultural Sciences*, 46(3): 410-415.

Gbigbi, M. Theophilus., (2011). "Economic Efficiency of Smallholder Sweet Potato Producers in Delta State, Nigeria: A Case Study of Ughelli South Local Government Area. *Research Journal of Agriculture and Biological Sciences*, 7(2): 163-168.

Gianessi, L. P., Reigner, N. P., 2007. The Value of Herbicides in US Crop Production. *Journal of Weed Technology*, 21(2): 559-566.

Grigg, D., 1995. The Nutritional Transition in Western Europe. *Journal of Historical Geography*, 21(3): 247.

Hamedani, S. R., Shabani, Z., Rafiee, S., 2011. Energy Inputs and Crop Yield Relationship in Potato Production in Hamadan Province of Iran. *Energy*, 36(5): 2367-2371.

Hanley, N., Spash, C. L., 1993. Cost-Benefit Analysis and the Environment. Journal of Cheltenham Edward Elgar, 8(3): 78-84. (www.e-elgar.com/shop/cost-benefit analysis-and-the environment).

Hart, O., 1995. Firms Contracts and Financial Structure. *Journal of Clarendon Press*, 10(4): 199-204.

Haverkort, A. J., Boonekamp, P. M., Hutten, R., Jacobsen, E., Lotz, L. A. P., Kessel, G. J. T., Visser, R. G. F., Van der Vossen, E. A. G., 2008. Societal Costs of Late Blight

in Potato and Prospects of Durable Resistance Through Cisgenic Modification. *Journal of Potato Research*, 51(1): 47-57.

Imad, A. Al., 2011. Productivity and Optimal Size of Potato Farms in Anbar Province Iraq for Two Agricultural Seasons 2010, 2011. *Iraq Journal of Tikrit University for Agricultural Sciences*, 14(2): 270-282.

Iman, Y. N., Adnan A. T.., 2011. Economic Analysis of the Efficiency of Potato Production in the Region of Tlkiv Nineveh province for the Spring Season (2011). *Iraq Journal of Tikrit University for Agricultural Sciences*, 41(2): 13-18.

Jwanya, B. A., Dawang, N. C., Zarmai, D. U., IM, M., 2014. Economic Analysis of Irrigated Irish Potato Production in Plateau State. *Journal of Economic Analysis*, 4(12): 80-86.

Khalida, O., 2010. The Effect of Inoculation with Azotobacterial Bacteria and Different Levels of Nitrogen Fertilizer on Production of Potato plant (*Solanum tuberosum L.*). *Journal of Tikrit University for Agricultural Sciences*, 1(38): 5-10.

Majhol, A. H., 2010. Production of Cotton, Maize and Potato Crops, Ministry of Planning and Development Cooperation, Organ Central Bureau of Statistics and Information Technology. *Journal of Tikrit University for Agricultural Sciences*, 10(5): 27-33.

Map of Dohuk Distract and Iraq Government., 2015. (http://images.rambler.ru).

Meliko, M. O., Chauke, K., Oni, S. A., 2012. The Efficiency of Small-Scale Agriculture in Limpopo Province of South Africa. *African Journal of Agricultural Research*, 7(12): 1789-1793.

Mohammadi, A., Tabatabaeefar, A., Shahin, S., Rafiee, S., Keyhani, A., 2008. Energy Use and Economic Analysis of Potato Production in Iran a Case Study Ardabil Province. *Journal of Energy Conversion and Management*, 49(12): 3566-3570.

Mudombi, S., 2007. Socio-Economic Determinants of Smallholder Farmers' Adoption of Improved Sweet Potato a Case Study of Wedza Community in Zimbabwe. Collaborative Master's Program in Agricultural and Applied Economics. University of Zimbabwe Faculty, Agriculture Department, Agricultural Economics and Extension, 139 pages.

(Shakespeare Mudombi (CMAAE programme- University of Zimbabwe, 2007).

Mukunda, E., Mathenge, E., Ngai, M., 2013. Sweet Potato Marketing Among Smallholder Farmers the Role of Collective Action. In Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists. (http://ageconsearch.umn.edu).

Musleh, B., Fadel, E., 1989. Vegetable Production, Directorate of the High Circular Printing Press, Baghdad University. *Journal of Iraq University for Agricultural Sciences*, 38 (4): 65-82.

Mutai, B. K., Agunda, E. N., Muluvi, A. S., Kibet, L. K., Maina, M. C., 2013. Determinants of Smallholder Sweet Potato Farmers Participation in Different Market Options: The case of Vihiga County, Kenya. *Journal of Development and Agricultural Economics*, 5(8): 314-320.

Noonari, S., Wigan, H., Memon, I. N., Ahmed, F., 2016. Economic Analysis of Potato Production in Sindh Pakistan. *Journal of Economic Analysis*, 6(5): 100-107. (https://www.researchgate.net).

Olagunju, F. I., Fakayode, S. B., Babatunde, R. O., Ogunwole-Olapade, F., 2013. Gender Analysis of Sweet Potato Production in Osun State Nigeria. *Journal of Agricultural Extension, Economics & Sociology*, 2(1): 1-13.

Omar, H. Al., Omar H., 2006. Effect of Number of Spray with Spray with Nutrient Fertilizer (Scotts) on Growth and Production of Potato. Desiree. *Journal of Tikrit University for Agricultural Sciences*, 6(2): 152-158.

Pedersen, S. M., Bizik, J., Dallas Costa, L., Coutinho, J., Dolezal, F., Gluska, A., 2005. Production of Table Potatoes in Europe-A Multinational Gross Margin Analysis. In International Farm Management Association 15th Congress in Campinas-SP, Brazil. 14(19) :246-253.

PHDEB, 2010. Potato Marketing Strategy. Pakistan Horticulture Development and Export Board 2010. URL (Open Site 14.9.2017). (http://www.sedf.gos.pk/sukkur/presentations/phdec).

Prajneshu, A., 2008. Fitting of Cobb-Douglas Production Functions Revisited. *Journal of Agricultural Economics Research Review*, 21(3): 289-292.

Pule, B. B., Meitz, J. C., Thompson, A. H., Linde, C. C., Fry, W. E., Langenhoven, S. D., 2015. Potatoes South Africa. *Journal of Plant Pathology*, 62(1): 154-165. (http://www.potatoes.co.za/research/factsheets.aspx).

Radar, N. A., 2009. Analysis of the Urban Land Use Map in the Central Commercial Area of Duhok City Using GIS Techniques.

Reyes, B., Donovan, C., Bernstein, R., Maria, M., 2012. August. Market Participation and Sale of Potatoes by Smallholder Farmers in the Central Highlands of Angola. A Double Hurdle approaches. *In Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August 2012, 43 pages.*

Salah, AL. A., Yassen H. A., Yasser, f. AL., 2013. Effect of Some Tillage Equipment and Depth on Some Technical Parameters for Machine Unit Under Different Speeds. *Journal of Tikrit University for Agricultural Sciences*, 4(1): 151-169.

Sarah, B. A., and Mohsen, A. F., 2015. Measuring the Economic Efficiency of the Potato in Baghdad Case Study. *Journal of Tikrit University for Agricultural Sciences*, 46(3):410-415.

Scott, G. J., Rosegrant, M. W., Ringler, C., 2000. Global Projections for Root and Tuber Crops to the Year 2020. *Journal of Food Policy*, 25(5): 561-597.

Scott, G. J., Suarez, V., 2012. The Rise of Asia as the Center of Global Potato Production and Some Implications for the Industry. *Potato Journal. (India),* 39(1):1-22. (http://epubs.icar.org.in/ejournal/index.php/PotatoJ/article/viewFile/32257/14421).

Sgroi, F., Di, T., Anna, M., Testa, R., Tudisco, S., 2014. Economic Sustainability of Early Potato Production in the Mediterranean Area. *Journal of American, Applied Sciences*, 11(9):1598-1603. (http://www.thescipub.com/ajas.toc).

Stewart, J., 2008. Calculus: Early Transcendentals. Thomson Brooks. *Journal of Cole, Belmont*, 1308 pages.

Taha, Z., Sarahan, R., Farouk, A., Aziz, K., (2007). Effect of Potassium Fertilizer and Soil Cover in Three Cultivated Potatoes Categories in Basrah Governorate. *Journal of Tikrit University for Agricultural Sciences*, 41(2): 2224-9796.

Tan, B. H., 2008. Cobb-Douglas Production Function. Journal of Universidad Nova de Lisboa. (docentes.fe.unl.pt).

Thorne, F., Fox, J. A. S., Mullins, E., Wallace, M., 2016. Consumer Willingness-to-Pay for Genetically Modified Potatoes in Ireland: An Experimental Auction Approach. *Journal of Agribusiness*, 33(1):43-55.

Tolno, E., Kobayashi, H., Ichizen, M., Esham, M., Balde, B. S., 2016. Potato Production and Supply by Smallholder Farmers in Guinea: An Economic Analysis. *Asian Journal of Agricultural Extension, Economics, and Sociology*, 8(3): 1-16.

Tripathi, R. S., Singh, R., Singh, S., 2005. Contract Farming in Potato Production an Alternative for Managing Risk and Uncertainty. *Journal of Agricultural Economics Research Review*, 18(2): 47-60.

USAID, 2011. Potato Production Cultivation Through Harvesting. URL (Open Site 13.9.2017). (www.inma-iraq.com).

Van der Waals, J. E., Steyn, J. M., Franke, A. C., Haverkort, A. J., 2016. Grower Perceptions of Biotic and Abiotic Risks of Potato Production in South Africa. *Journal of Crop Protection*, 84: 44-55.

Yusuf, A., Wuyah, Y. T., 2015. Economic Analysis of Small Scale Sweet Potato Production in Zaria Local Government Area of Kaduna State. *American Journal of Economics, Finance and Management*, 1(3): 171-178.

Zangeneh, M., Omid, M., Akram, A., 2010. A Comparative Study on Energy Use and Cost Analysis of Potato Production Under Different Farming Technologies in Hamadan Province of Iran. *Journal of Energy*, 35(7): 2927-2933.

CURRICULUM VITAE

Personal Identity

Name, Surname : Qasim Mohammed Ibrahim

Nationality : Iraqi

Date and place of birth : 25 May 1983 Dohuk, Iraq

Marital Status : Married

Mobile : +964 750 497 75 30 , 0541 574 37 98 .

E-mail : qasimzaxo14@gmail.com

EDUCATIONAL BACKGROUND

Degree	Place of Education	Date of Graduate
High School	Zakho High School	2004-2005
BSc	College of Agricultural Dohuk, Horticultural Department	2005-2009
Master Degree	Graduate School of Nature, Dep. of Bioengineering and Applied Science, Kahramanmaraş Sütçü Imam University, Turkey	2015-2017

WORK EXPERIENCE

Year	Place	Position
2009	Ministry of Education	Education Zakho

Computer and Programs Skills

- Microsoft Office (MS Word, MS Excel, MS Access, MS PowerPoint)
- SPSS Program

.

Language Skills

- English
- Arabic
- Turkish