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The Effects of Virtual Water Trade on the Future Water Management in Palestine

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Dedication

To

All who lighten the road for me to complete this research …my parents

My husband ……..

My brother and sisters……

Those who enlightened my way with their encouraging words

Those who enlightened my way with their helping and advice

My beloved city Nablus……..

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Also special thanks to my brother and sisters. In them I see big hope and help. I don't forget my teacher whom light my way with faith

Paradise Talal Aslan.

الإقرار

أنا الموقع أدناه مقدم الرساله التي تحمل عنوان

The Effects of Virtual Water Trade on the Future Water Management in Palestine

أقر أن ما اشتملت عليه هذه الرساله إنما هو نتاج جهدي الخاص باستثناء ما تمت الإشاره إليه حيثما ورد، وإن هذه الرساله ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة أو لقب علمي أو بحثي لدى أي مؤسسة تعليمية أو بحثية أخرى.

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Student's name: **اسم الطالب:**

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Abbreviations

WB	West Bank
VW	Virtual water
Kg	Kilogram
PWA	Palestinian Water Authority
PCBS	Palestinian Central Bureau of Statistics
Kc	Crop Coefficient
OPT	Occupied Palestinian Territories
MCM	Million Cubic Meter
MOA	Ministry of Agriculture
C^o	Celsius Degree
RH	Relative Humidity
L/C/D	Litter Per Capita Per Day
WWAP	World Water Assessment Program
ET	Evapotranspiration
Kc	Crop Coefficient
EA	Economic Analysis
WRAP	Wellness Recovery Action Plan
MOPIC	Ministry of Planning and International Cooperation
ARIJ	Applied Research Institute Jerusalem
SUSMAQ	Sustainable Management of West Bank and Gaza
WWAP	World Water Assessment Program
RF	Rain-fed plant
IRR	Irrigated Plant
GH	Green House

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Abstract

Water in Palestine has witnessed a real problem through several years due to a number of factors such as society, economy, climate and politics. For several years, Different methods have been adopted by Palestinians to alleviate water scarcity, but no such method realized the importance of evaluating and managing the water that is used in the production process to produce a specific product, which is called the concept of Virtual Water.

The thesis confined to the West Bank governorates, its objectives were to apply the concept of Virtual Water as a new method to manage and alleviate water scarcity. It has quantified the virtual water of main agriculture and livestock products produced locally in the West Bank, and compare the socio-financial feasibility of producing versus importing some agricultural products. Finally it suggests an agricultural plan for the optimal use of water under two expected water scenarios.

The basic approach has been to collect data and use it as main input to analytical computer programs; CROPWAT, and EXCEL.

The results of thesis show the main produced crops in the West Bank with high virtual water which were tomatoes produced in green houses (750-1300 m^3/dunum), Almonds(850-1100 m^3/dunum), Dates(850-1500 m^3/dunum), Bananas(2000m^3/dunum), Citrus(700-1200 m^3/dunum),

Mangos(1200m^3/dunum), Avocados (800-900 m^3/dunum), Guavas (800-900 m^3/dunum), and Grapes (700-940 m^3/dunum), whereas, the crops with low virtual water value were potatoes (250-500 m^3/dunum), cauliflower (150-500 m^3/dunum), cabbage (200-600 m^3/dunum), onion (300-470 m^3/dunum), and watermelon (200-400 m^3/dunum).

Tulkarm and Qalqilia, were the main governorates producing current deficit crops with the least virtual water value comparing to other governorates. In Tulkarm, the least virtual water were, Potatoes, onions, watermelons and oranges, their virtual water was 260, 325.9, 343, and 740.1m^3/dunum, respectively. While in Qalqilia the least virtual water were, potatoes, watermelons, oranges, calamondin, and peach, their virtual water was 260, 343, 740.3, 740.3 and 967.6 m^3/dunum respectively. In each governorate the production of deficit crops mainly depended on replacing the excess high Virtual water crops with deficit low virtual water crops, whatever the expected cost ranges (0.580 to 0.994) \$/m^3, and (0.580 to 0.718) \$/m^3, in Tulkarm and Qalqilia respectively, the replacing had positive effect on the employment rate (one of social aspects), and local production financially was more feasible than importing.

The virtual water was estimated for the main live stock bred in several West Bank governorates, Hebron had the least virtual water value in its livestock (calves, dairy cows, goats, and sheep) and their products. The virtual water of live stock does not depend mainly on Palestinian resources only, and most feed simply has been imported. Palestinians only use the available water resources for watering, servicing and sometimes feeding some types with very limited quantities. This thesis has estimated both local virtual water which excludes the virtual water of imported feed and the whole virtual water includes the imported, and focused more on the local one.

The results confined to the part of virtual water depends on Palestinian water resource were 2349, 2082, 161, and 128 m^3/ton for dairy cows, beef cow, goat, and sheep breeding in Hebron respectively, and 3577, 3500, 2197, and 1973 m^3/ton for beef cow meat**,** carcass, raw skin, and offal respectively, while 606, 89, 370, 358, and 312 m^3/ton, for dairy cow carcass, milk, raw skin, meat, and offal respectively. For sheep carcass, offal, and raw skin the results were 211, 126, and 202 respectively, finally for goat meat and raw skin were 277 and 398 respectively.

Ramallah used the least virtual water for raising laying hens and their products. The virtual water was 0.15, 10, 13, and29 m^3/ ton for hens, eggs, carcass and steak respectively.

Hebron, Ramallah and Nablus approximately have the same value of virtual water for broiler chicken, which was 7 and 8 m^3/ton for the broiler chicken and its meat respectively.

The thesis has concluded that it is important to consider the concept of virtual water besides the socio- financial analysis to assess the present production strategies which in most cases need adjustment, and to improve the future production strategies in order to achieve the best management of water resources and alleviate water scarcity in the West Bank.

Chapter One

Introduction

Chapter One

Introduction

1.1 General Introduction

All over the world, fresh water resources have become scarcer during the past decades due to physical, social and economic factors in many countries. And this causes an increased stress on water intensive resources

The physical factor is considered as the main reason affecting the availability of water in a region, and it represents by the geographical configuration and climate conditions.

The social and economic factors refer to the increase in population within suitable conditions. The increase of population means demanding more on agricultural, industrial and animal products to meet their needs. The problem appears when there is mismanagement in using water resource.

Political conflicts are another factor which prevents the country from covering its water needs or making any developmental progress.

Palestine is one of the Middle East countries which faces the problem of water scarcity as a result of physical, socio–economic, and political factors. The access of Palestinians to water resources is restricted by the Israel occupation. Israel controls most of Palestinian water resources, over exploits them, and rejects any water or sanitation infrastructure in the Occupied Palestine. As a result, the amounts of available water for Palestinians' use do not cover their needs and do not give a fair and equitable share of water resources among Palestinians and Israelis. According to the PCBS (2011), the average of daily drinking water consumption per capita in the West Bank was less than 135 liter in 2011, whereas it was 353 liter per capita in Israel.

While Palestinians who live in the Occupied Palestine are restricted to access water resources or get a fair portion of it, Israeli settlers face no such challenges. They have intensive-irrigation farms, lush gardens and swimming pools. The PCBS (2011) stated that the 536,932 illegal Israeli settlers in the West Bank use more water than the Palestinian population.

During the past years, several ideas, researches, studies and regulations around the world have tried to solve water problem by a number of methods. Some of these methods were to reallocate water resources, create new sources of water "manmade river", desalinate seawater, increase the number of water wells, reuse treated waste water and use regulations to increase the awareness of using water economically. Allan (2003) suggested anew attractive concept "Virtual Water" as a solution for the water problem. He defines it as the total volume of freshwater used to produce products at certain places.

This concept can alleviate scarcity not by finding new sources of water as wells. Allan believes that countries can save water by defining those products which consume large amount of water and others which do not. Once this is done, the country will easily recognize its products priority. In other words, it will prefer low-intensive water products over high-intensive ones.

Virtual Water seems to be an appealing instrument for decision makers and those who work in water security. In addition, it is expected to have several social, environmental, economic and political advantages in the coming years. The international trade also will become more productive, sustainable, and improved if this concept is adopted. Furthermore, countries will be friendlier to environment, and there will be no need for water transfer. It also does not cause political obstacles. **(Allan, 1997, 2003).**

1.2 Significance of Study

One of the main challenges facing the world is the lack of fresh water. The scarcity has forced researchers to look for alternative water sources to offer adequate quantities of water with high quality. Unfortunately, reallocation of water resources, manmade rivers, desalination of sea water, new wells and treating waste water, are methods which require high technical skills, large economical investments and political approval, especially in Palestine.

This study sheds light on virtual water as a new method for managing and alleviating water scarcity. Moreover, it examines if it is technically, economically and socially effective to be adopted in Palestine.

1.3 Research Objectives

The main objective of the study is to apply the concept of Virtual water to alleviate water scarcity, and quantify the virtual water of main agriculture and live stock products in the West Bank. Moreover, it compares the socio-economic feasibility of producing with importing agricultural products. In addition, depending on the two previous mentioned objectives, it suggests agricultural plan for the optimal use of water resources under two expected water scenarios.

1.4 Research Questions and Motivations

1.4.1 Research Questions

1. Which products are considered as high virtual water and which are low virtual water?
2. Is the concept of virtual water easy to be adopted in Palestine or not?
3. Does the virtual water concept have a positive effect on present and future management of water resources in the West Bank?
4. Would virtual water affect poverty and employment rates or not?

1.4.2 Research Motivations

The main motivation of this study is the water scarcity in Palestine. This scarcity refers to the climate (arid, semi arid), the growing population, the mismanagement of water resources and the political situation. Moreover, limited studies on this concept in Palestine, was another reason to do this study.

1.5 Who Will Benefit from This Work?

The outcome of this research will be of great importance for:

1. Education and research sectors since this work is one of the recent studies carried out in the West Bank. It stimulates the interest to carry out similar work at different locations and different fields.
2. Economists and decision makers who work in water sector.

3. Ministry of Agriculture. It directs their attention to a new policy for alleviating water scarcity in agricultural sector and develops their policies towards saving water resources.
4. Farmers. This work helps in changing the traditional practice of water use in agricultural and live stock sectors.

1.6 Thesis Chapters

The thesis is divided into six chapters. Chapter one introduces water scarcity as a problem in Palestine and it gives a general idea about virtual water as a new alternative method. Chapter two is a literature review which discusses the concept of virtual water and explores previous related studies. Chapter three describes the study area. Chapter four introduces the methodology this study follows. Chapter five includes results and discussions. Finally, Chapter six demonstrates conclusions and recommendations.

Chapter Two

Literature Review

Chapter Two

Literature Review

2.1 Introduction

Human activities consume and pollute a lot of water. At a global scale, most of the water use occurs in agricultural production, but there are considerable water volumes consumed and polluted in the industrial and domestic sectors **(WWAP, 2009).**

Water availability strongly varies in space and time, natural water is a renewable but finite resource, and thus one cannot consume more than quantities of water available **(Hoekstra, 2010).**

'Availability' does not mean that water can always be fully consumed without undesired consequences. And If the present practice of using water will continue, two thirds of global population will have a water stress in their living area by 2025**(www.waterwise.org.uk).**

Every day we waste a lot of water when we brush our teeth, clean house, cars, schools etc.., if we cut a second, minute or hour off our cleaning we will save liters of water which can be used for other beneficial activities.

Water wise try to highlight on the quantities of water consumed every day by individual, and communities, and how a management locally and internationally should be designed (**www.waterwise.org.uk)**.

The responsible water management is needed in many areas around the world suffering from water stress and many of them will suffer more and more if no wise a action take place, since many changes will affect the availability of water as, climate change, population growth, etc….

Sustainable water use can be achieved begins at home level, and then transfer to the work level. And so on until reaching the highest goal which is the global level, there are a lot of actions, can be taken to reduce the amount of water lost, so it is time for us all to act (**www.waterwise.org.uk)**

The concept of "Virtual water" considered as one of method help in solving global water scarcity, introduced lately in the early nineties by Professor John Anthony Allan from King's College London and the School of Oriental and African Studies **(Allan,1993; 1994).**

The first international meeting on virtual water concept was held on December2002 in Delft, the Netherlands. A special session is devoted to the issue of (VW) trade at the third world water forum in Japan, March 2003**(Hoekstra, 2003)**.

Ten years ago, after introducing the concept of virtual water it has globally been recognized as an important concept for achieving regional and global water security**(Hoekstra, 2003)**.

The concept of Virtual water (VW) refers to the volumes of water used directly and in directly to produce a commodity, good or service, in other words meaning the amount of water required for the whole life cycle of products**(Allan,1997;1999).**

The virtual water concept almost applies to everything produced, and thus sectors, cities, household, business, individuals, or any other users, used the embedded water without realizing **(Hoekstra, 2003)**.

The virtual water of agricultural products (crops) , which is also called a specific water demand, defined as the total amount of water required to produce that crop (m^3/tone), **(Chapagain and Hoekstra, 2004).** The volume of virtual water is mainly affected by the crop type; climatic conditions, water management options and the agricultural practice, and so not all the crops have the same value of virtual water (**www.waterwise.org.uk)**.

The virtual water content in livestock can be calculated based on the virtual water demand of their feed and the volumes of drinking and servicing water consumed during their lifetime **(Chapagain & Hoekstra, 2003).**

Virtual water (VW) has differently been referred to "Hidden, Embedded, shadow" **(Allan, 2003)**, "Exogenous or endogenous water" **(Haddadin, 2003)**, or "Ultra-Violet water" **(Savenije, 2004)**.

Hidden, Embedded or Ultra violet terms are referring to that water contained in everything of our production in invisible form.

It was called shadow because no one is aware of it , since the water cannot be poured or collected into a cup like water in bottle, but that does not mean the water in products are not real **(www.waterwise.org.uk).**

Exogenous and indigenous represent that water can move between nations in its invisible form, and thus the importing countries called the water embedded in importing products "Exogenious virtual water", while Exporting countries called the water embedded in Exported product "Indogenious virtual water". In all terms used the word 'virtual' refers to the fact that most of water used to produce a specific product may be not in the all quantities saved and contained in it, the real-water content of products is generally negligible if compared to the virtual-water content **(Hoekstra and Chapagain, 2008).**

Determination of virtual water is not an easy job, because there are many factors affecting the quantities of water needed for all life cycle of product, the main factors summarized as:

1. The time and place of production, (the country or region produce products, and the season), so crops, meat and industries virtual water (m3/ton), may vary in the same region as time changed , and will vary from region to another because of changeable climate, culture , production pattern and many other reasons**(Hokestra,2003)** .

For example, to produce one kilogram of grain grown under rain-fed and favorable climatic conditions (say in the Netherlands or Canada), we need about one to two cubic meters of water that is 1000 to 2000 kg. For the same amount of grain grown in an arid country (say in Egypt or Palestine), where the climatic conditions are less favorable (high temperature, high evapotranspiration), we need up to 3000 to 5000 kg **(Chapagain & Hoekstra, 2003).**

2. Types of products

The virtual water for producing beef, meet, dairy products is generally more than crops production, Roughly, livestock products contain 5 to 20 times more virtual water per kg, than crop products, is needed, this is because water is used to grow crops, used as feed to animals in addition to their water needed for drinking and servicing **(Chapagain & Hoekstra, 2003)**

For example in Britain it takes about 136 drops of water to produce one drop of tea, and about 1100 drops of water to produce one drop of coffee **(www.waterwise.org.uk**).

3. Water use efficiency (agricultural practice, the drip irrigation method save more water than sprinkler irrigation) **(Hoekstra, 2003)**.
4. Gross nation income affects the quantities and the type of product consumed more than others, so in countries with high GNI, people are directed to consume more quantity of meat, and generally meat has higher virtual water than crops **(www.waterwise.org.uk).**
5. The method used in contributing water into their final products **(Hoekstra, 2003)**.

The concept of virtual water is connected with a term called 'trade'. If the products are transferred, the embedded water is transferred too, thus ‘Virtual-water trade’ occurs when water-intensive products are traded from one place to another **(Hoekstra and Hung, 2005; Chapagain and Hoekstra, 2008).**Allan elaborated the idea of using Virtual-water trade ,specially virtual water import (coming with food imports), as a partial solution to problem of water scarcity in the middle East, and he focused on reality that water can be transferred in invisible aspect, the amount of water embedded in products will be huge than one can imagine.

The fact that human needs a few litters of water per day for drinking and washing, while the water used per capita for services and producing goods is considered to be at least a few thousand of litters per day.

The concept of Virtual water trade is a recent discussion topic and has a variety of views

1. Some communities in the world are harnessing their water resources to achieve their security by allocating their resources and using it in a wise way, to specify their demand within their water availability, because their politicians find that the increasing of global trade leads to an increase invisible interdependency of nations, such that when they import high-intensive product to achieve their food security they in the same time import water, and in fact they export two fortune without realizing, in addition, the number of people who work in agriculture or other sector will lose their jobs, and the country will be forced to give them other jobs, which sometimes difficult to be achieved **(Hoekstra, and Hung, 2004).**

   Some in the UK may be disturbed when they realize that 70 percent of the water consumed as embedded water comes from foreign nations **(www.waterwise.org.uk).**

2. Un fortunately other communities did not generally have a positive relation between countries need and the availability of water resources, and thus, water-scarce countries has two options, either over exploitation their resources to increase their requirements, or adopting an open economy strategy, and so the country depends on their possibility of

water resource . In addition, they believe in importing products produced by other nation resources (adopting virtual water concept) **(Hoekstra, 2008).**

It's important for countries to highlight on their water scarcity problems, by determining the quantities of virtual water in and out their borders, and thus helping water poor nations to a alleviate scarcity by importing high- intensive water products, instead of exploitation their water resources to produce them. In addition, it can Help countries to manage their water resource such that the sustainability will be real, and it represent a flexible solution to a very awkward strategic challenge, awkward can be clarified in a recent example was in spring 2008, when Spanish city of Barcelona had to ship in fresh water from France, various islands, including Aruba,Tonga, Naura and the Canary Island have at time received freshwater by tanker from elsewhere **(Gleick et al,2002)**.Much larger- scale international water transfer have been suggested in many world countries , like the idea of transferring water from Congo to Chad or from Northern Russia and Siberia to Central Asia, or from Antarctica to Persian Gulf**(Hoekstra , 2010)**. These ideas of transferring water around the world evaluated as small scale and not convenient due to the huge cost, social and environmental considerations, In comparison to large-scale water transfers via elaborate pipelines/canals or in comparison to the construction of huge energy-intensive desalinization plants, the trade in embedded water (V.W) may be more practical.

Virtual water is considered as an analytical tool to assess a better policies, it encourage companies to be more response to environment since embedded water trade has the ability to reduce environmental damages resulting from over abstraction of local and regional water resource, it will save earth to sustain life, when the global water resource Redistribute by shifting water from rich water countries, to a country with poor water resources, and then the poor achieve their requirements, and rich can profit from their abundance water resource, in addition the global water efficiency will improve, because nations will be able to share global water, by optimizing the use of their internal waters without having to worry about food and water security issues.

Some nation adopt the concept of virtual water not only for water issue, but also it can reduces the pressure on using lands specially when the availability of fertilizing land limited as in Egypt**(Hoekstra, 2010)**, other consider the concept as a good method for evaluating water price, because water contained in products invisible.

Many regions over the world do not consider the economically value of water, economists generally do not aware much about it, no international agreement aware or bother to water used to produce products, since the water input hardly contribute to the overall price of traded commodities, so the market price do not include water price, while the cost of water use and the negative impact on ecosystem or communities through using water as a component of producing products should be included in total price of products (**Hoekstra, Hung, 2004).**

After Dublin conference the sounds was like a mantra for water policy makers to consider water as an economic goods, and thus water scarcity

,water excess and deteriorations of water quality will be solved **(Hoekstra, Hung, 2002).**

Sixteen percent of the water use in the world was not for producing products for domestic's consumption but for making products for exportation **(Hokestra and Chapagain, 2008).**

Exporting country should be wise and aware to what types of products they exports, and thus they should review water consumed for producing exports, and evaluate to which extent the present policy of exporting is good **(Rosegrant et al., 2002)**, the fact that the foreign income connected with the exports generally does not cover most of the costs connected with water use, and then many water problems which are closely linked to international trade will appear **(Hoekstra and Chapagain, 2008).**

Subsidized water in Uzbekistan is overused to produce cotton for export; Thailand experiences water problems due to irrigation of rice for export; Kenya depletes its water resources around Lake Naivasha to produce flowers for export to the UK and the Netherlands; Chinese rivers get heavily polluted through waste flows from factories that produce cheap commodities for the European market **(Hoekstra, 2010).**

In arid nations, like Sudan, the habitat depend heavily on the goat export for foreign income, and generally live stock as goats have a high virtual water and more than any production of most crops **(www.waterwise.org.uk).**

The nations with the largest net annual water use for producing export products were the USA (92 billion m3), Australia (57 billion m3)(the driest inhabited continent on Earth), Argentina (47 billion m3), Canada (43 billion m3), Brazil (36 billion m3), and Thailand (26 billion m3)**(Hoekstra , 2010)**.

The economic efficiency of trade in a water-intensive commodity between two countries basically evaluated based on a comparison of the opportunity costs of producing the commodity in nation participating in a global trade. Export of water –intensive commodity is remarkable if the cost of producing the commodity is comparatively low **(Rosegrant et al., 2002)**.

In the period 1997-2001, Japan, the largest (net) importer of water-intensive goods in the world, annually saved 94 billion m3 from its domestic water resources. This volume of water would have been required, in addition to its current water use, if Japan had produced all imported products domestically. In a similar way, Mexico annually saved 65 billion m3, Italy 59 billion m3, China 56 billion m3, and Algeria 45 billion m3 **(Chapagain et al., 2006a).**

As Chapagain and Hokestra (2004) show countries with a very high degree of water scarcity-e.g. Kuwait, Qatar, Saudi Arabia, Bahrain, Israel, Oman, Lebanon, Malta, and Jordan indeed have a very high virtual water imports dependency (more than 50% according to them).

Jordan considered as one of water-scarce countries which heavily depends on import of water-intensive commodities. It imports five to seven billion m3 of water in virtual form per year, which is in sharp contrast with the 1 billion m3 of water withdrawn annually from domestic water sources **(Haddadin, 2003; Hoekstra and Chapagain, 2008).**

People in Jordan export goods and services that require little water, and import of products that need a lot of water which covers up huge shortage of Jordan's water. Indeed, Jordan by using this strategy preserves the scarce domestic water resources, but the negative side is that the Jordanians are heavily water dependent **(Hoekstra, 2010)**.

Other water-scarce countries with high virtual water import dependency (25%-50%), are for instance Greece, Italy, Portugal, Spain, Algeria, Libya, Yemen, Mexico, Switzer land, and Denmark (1997-2001). In addition to this some European countries as the Uk, Belgium, the Netherlands, Germany do not have an image of being water scarce **(Hoekstra, 2010)**.

2.2 Selected Virtual Water Studies

The global interest of virtual water has developed day after day and as a result many studies about the virtual water concept were published, the following describe some of ***prior related studies***:

- *Virtual water trade, (International Expert Meeting on Virtual Water Trade).* In his scientific paper (2003), Hoekstra provides a summary introduction of the virtual water concept, its practical use, and studies detected to, he also summarizes the efforts applied for quantifying the virtual water trade flows between nations and to draft national virtual water trade balances.
- *Water trade in Andalusia. Virtual water:* In his scientific paper (2006), Esther Velázquez, analyses the relationships between the productive process and the commercial trade with water resources used by them. For that, the first aim was to find out the exported crops which have the highest water consumption and analyzes the

crops that were imported. The second aim was to use a new concept called the virtual water for saving water.

The main conclusion involved the fact that Andalusia uses large quantities of water in its great exports of water via potatoes, vegetables, citrus fruit and orchards. On the other hand, it imports low water requirement products, such as cereals and arable crops.

The paper suggested that Indonesians should change their trade practice, in other words, they should try to produce cereals and arable crops rather than importing them. And instead of exporting potatoes, vegetables, and orchards they can import them, and so the pressure on the water resources of the region would diminish to a considerable extent.

- *Are virtual water "flows" in Spanish grain trade consistent with relative water scarcity?:* In their scientific paper (2008), P. Novo, A. Garrido, C. Varela-Ortega, evaluate whether Spanish international trade with grains is consistent with relative water scarcity. For this purpose, the study estimates the volume and economic value of virtual water "flow" through international grain trade for the period 1997–2005, with in different rainfall levels.

The results of calculations show that Spain through grain trade considered as a net virtual water "importer". The volume of net virtual water "imports" amounts 3420, 4383 and 8415 million m^3 in wet (1997), medium (1999) and dry (2005) years, respectively. Valuing blue water "exports" oscillate between 0.7 and 34.2 million Euros for a wet and dry year, respectively.

From a water resources perspective, virtual water can bring important insights across countries for improving water and land management globally, fostering adaptation strategies to climate change and to trans-boundary resource management.

- *Assessment of regional trade and virtual water flows in China*: In their scientific paper (2006), Dabo Guan, Klaus Hubacek, evaluate the current inter-regional trade structure and its effects on water consumption and pollution via ‘virtual water flows’, for assessing trade flow and the effects on water resource, they developed an input–output model for eighty dro-economic regions in China to calculate the virtual water flows between North and South China.

The results show that the present trade structure in China is not very convenient with regards to water resource allocation and efficiency. North China as a water scarce region virtually exports about 5% of its total available freshwater resources, while accepting large amounts of wastewater for other regions' consumption. On the contrary, South China is a region with a lot of water resources is virtually importing water from other regions while their imports are creating waste water polluting other regions' hydro-ecosystems.

Findings show the need for increased investments in water transportation infrastructure and water treatment plants. However, from a sustainability point of view it is important to be incorporated in decision- making processes and public policies, the direct and indirect (virtual water) consumption, especially for water-scarce regions such as North China, in order to achieve sustainable consumption and production in the future.

This study was one of the very first to use the concept of virtual water flows not only for agricultural products, but also industrial and service products.

- *Virtual water 'flows' of the Nile Basin, 1998–2004*, A first approximation and implications for water security: In their scientific paper, Mark Zeitoun, J.A. (Tony) Allan , Yasir Mohieldeen, interprets an initial approximation of the 'trade' in virtual water of Nile Basin states in terms of national water security.

The state was separated as Southern Nile and Eastern Nile states as groups, and for the basin states as a whole, and the virtual water content (on the basis of weight) of select recorded crop and livestock trade between 1998 and 2004 is provided, and analyzed for each.

During the period under study, Nile Basin states 'exported' about 14,000 Mm3 of primarily rain-fed derived virtual water outside of the basin annually, and 'imported' roughly 41,000 Mm^3/y.

The findings reinforce the importance of considering virtual water 'trade' in devising policy related to national water (and food) security.

- *Water rationalization in Egypt from the perspective of the virtual water concept:* In their scientific paper (2009), Abd-Alla Gad and Raffat Ramadan Ali, present the vision for the future water status in Egypt. This vision is based on a perception of the current available water resources status. The topics of water usage, water use efficiency, the institutional and legislative frameworks of water management, and the strategies and policies to rationalize water use and to augment water supply were discussed. It highlighted the importance of taking the concept of virtual water in consideration when the issue of water rationalization is discussed.

- *Virtual water flows between nations in relation to trade in livestock and livestock products*: In their Value of Water Research Report Series No. 13 (2003), A.K. Chapagain, A.Y. Hoekstra, which cover the period from 1995 to 1999, develop a methodology to evaluate the virtual water content of various types of livestock and livestock products and to quantify the virtual water flows related to the international trade in livestock and its products.

First, the virtual water content (m3/ton) of livestock is calculated, based on the virtual water content of their feed and the volumes of drinking and service water consumed during their lifetime. Second, the virtual water content is calculated for each livestock product, taking into account the product fraction (ton of product obtained per ton of animals) and the value fraction (ratio of value of one product from an animal to the sum of the market values of all products from the animal). Finally, virtual water flows between nations are derived from statistics on international product trade and virtual water content per product.

The results are combined with the estimates of virtual water trade flows associated with international crop trade as reported in Hoekstra and Hung

(2002, 2003), to get a comprehensive picture of the international virtual water flows.

The full calculation of the virtual water content of a live animal for each animal category is shown for all countries of the world, Canada in the report is chosen just as an example.

- *The green, Blue and grey water footprint of farm animals and animal products*: In their value of water research report series No .48, (2010), M.M. Mekonnen, A.Y. Hoekstra, provide a comprehensive account of the global green, blue and grey water footprints of different sorts of farm animals and animal products, distinguishing between different production systems and considering the conditions in all countries of the world separately. The animal categories considered in report were: beef cattle, dairy cattle, pig, sheep, goat, broiler chicken, layer chicken and horses.

The results show that the global average of water footprint for meat from beef (15400m^3/ton) is much larger than the footprints of meat from sheep (10400 m^3/ton), pig (6000 m^3/ton), goat (5500 m^3/ton) or chicken (4300 m^3/ton). The global average water footprint of chicken egg is 3300 m^3/ton, while the water footprint of cow milk amounts to 1000 m^3/ton.

The difference in footprint related to more than one factors, a first explanatory factor in the water footprints of animal products is the feed conversion efficiency. The more feed is required per unit of animal product, the more water is necessary (to produce the feed). The unfavorable feed conversion efficiency for beef cattle is largely responsible for the relatively large water footprint of beef. Sheep and goats have unfavorable feed conversion efficiency as well, although better than cattle. A second factor is the feed composition, in particular the ratio of concentrates versus roughages and the percentage of valuable crop components versus crop residues in the concentrate. Chicken and pig have relatively large fractions of cereals and oil meal in their feed, which results in relatively large water footprints of their feed and abolishes the effect of the favorable feed conversion efficiencies. A third factor that influences the water footprint of an animal product is the origin of the feed. The water footprint of a specific animal product varies across countries due to differences in climate and agricultural practice in the regions from where the various feed components are obtained is sometimes relatively large.

As a result the animal products generally have a larger water footprint than crop products.

- *Virtual water in food production and global trade*: In their scientific paper (2003), Zimmer and Renault, present two parts, The first part looks at methodological steps that need to be properly addressed when estimating virtual water in food product consumption and trade, By doing so, their goal is to come up in the future with reliable and accurate methodologies for assessing virtual water, whereas the second part focuses on preliminary results on world assessment of water embedded in food products and of traded virtual water.

Regarding methodology, there are at least three important aspects that need to be properly addressed: Processes and products, Mapping the fluxes, and Specifying the scope of the studies.

One of the main conclusions was for launching more detailed studies on virtual water.

- *Virtual water trade as a policy instrument for achieving water security in Palestine*: In his paper (2007), Yasser H. Nassar, water Engineer,86/15 Talzatter, Jabalia camp, Gaza, Palestine, analyzed the virtual water trade in Palestine from a water resource management perspective, his research paper objectives are triple: analyzed and quantified the virtual water imports and exports from agricultural products, estimated the physical aspects of virtual water export and import; and evaluated the economic aspects of virtual water export.

The paper determines the surplus and deficit of vegetable, field crops, Citrus, fruit, olives(rain fed), in addition to some livestock products like egg, red meat, poultry, milk, and then determine the virtual water of surplus as virtual water of import and the virtual water of excess as export virtual water, the results were 56 Mm^3/year for exports, and 2,200 Mm^3/year for import, thus Palestine imports about 30 times more water than exports, the economic aspect determine the total revenue of export by US$ 60 million, the expenditure in agricultural imports such as wheat and meat products is about US$ 620 million.

The scientific paper presented agricultural policy measurements of virtual water as the following:

1. The country ought to continue importing the virtual water contained in food production.
2. Export of citrus is not feasible comparing to vegetables, because of their high virtual water value.
3. Some crops should be shifted from Gaza to West Bank, which has better water quantity and cultivated areas, and the agricultural water in Gaza reallocated to domestic use to create new jobs for agricultural workers.
4. Increase the agricultural quality to compete in international markets.
5. Research on a better use of waste water in agriculture is needed.
6. Agricultural sector needs support from Palestinian Authorities.

- *Water footprint of the Palestinians in the West Bank*: in their scientific paper (Journal of the American Water resource association, (2008), Dima W. Nazer, Maarten A. Siebel, Pieter Van der Zaag, Ziad Mimi, and Huub J. Gijzen, calculate the water footprint for the West Bank. The consumption component of the water footprint of the West Bank was found to be 2,791 million m^3 ⁄ year. Approximately 52% of this is virtual water consumed through imported goods. The West Bank per capita consumption component of the water footprint was found to be 1,116 m^3 ⁄ cap ⁄ year, while the global average is 1,243 m^3 ⁄ cap ⁄ -year. Out of this number 50 m^3 ⁄ cap ⁄ year was withdrawn from water resources available in the area. Only 16 m^3 ⁄ cap ⁄ year (1.4%) were used for domestic purposes. This number is extremely low and only 28% of the global average and 21% of the Israeli domestic water use.

According to the commonly accepted limits, the paper shows that the West Bank is suffering from a severe water scarcity, and the approach of ‘‘use, treat, and reuse’’ may help to improve the situation of water scarcity.

Most of virtual water studies mainly discussed Four points, the first is to suggest or use a method for analyzing, quantifying, and assessing the virtual water either for whole studied country or divided it to studies parts, the second point is to evaluate what is called virtual water trade or flow between nations, and comparing the imports virtual water with exports , the third point discusses the concept of virtual water as method for managing water at local and global level, and the fourth point noted in limited studies was to evaluate the economic aspects.

This research has some ideas of international studies and did not show up in the local studies before, but it emphasizes what was discussed in some Palestinian studies, and promote the effectiveness of virtual water concept for managing and alleviating water scarcity in Palestine.

The research quantifies the virtual water of main agricultural crops and livestock produced locally in *each* West Bank governorate, the attractive and modern point discussed in this research related to the focus on virtual water of agricultural product considering the socio- economic factors to provide agricultural management plan for two Palestinians water scenarios, present water condition extended from (2012-2017), and future water condition (fully independent state) extended from (2017-2032), as a result of climatic, social and mainly political issues.

Chapter Three

Description of the Study Area

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Description of the Study Area

3.1 Geographic Location

Historical Palestine is the area situated in the western part of Asia between the Mediterranean Sea in the west and the River Jordan and the Dead Sea in the east. It is bordered by Lebanon in the north, Syria and Jordan in the east, the Mediterranean Sea in the west and Egypt, and the Gulf of Aqaba in the south.

The case study In this research is the West Bank , it located at West of the Jordan river& Dead Sea, bounded by 1948 cease-fire line from South, West, and North. It consists of nine governorates (Jenin, Tulkarm, Qalqilia, Nablus, Ramallah, Jericho, Jerusalem, Hebron, and Beithlahem).

Figure (3.1): Study Area Delineation, West Bank-Palestine.

Source: www.globalresearch.ca

3.2 Area

The land area of the West Bank is estimated at 5640 km^2, and 220 km^2 water; the northwest quarter of the Dead Sea. (*The world face book- Middle East: West Bank, 2013*).

3.3 Geography

The regions of West Bank Geography are Jordan valley and Al- Aghawr, inner plains, Mountain and Hills, the geographical coordinates of West Bank location are 32° North latitude and 35° 15" East longitude.

3.4 Climate

In general the climate in the West Bank is temperate; warm to hot in summer, cool to mild in winter, it is noted that temperature and precipitation vary with latitude.

In summer, the temperature reaches up 35°*C*. The hottest months are July and August**.**

Winter season lasts for three months, and some time the temperature falls to zero, generally the rainfall is very restricted, the major rainfall months represented by November and February.

The mean annual rainfall (2010-2011) varies from about 650 mm in the western part to less than 100mm in the east, the long –term annual average is about 454 mm. The rainfall is unevenly distributed. It varies considerably by governorates from the North to the South.

In the whole day time the land has seven hours of sunshine, in the winter, and in the summer season there are thirteen hours of sunshine.

West Bank consists of nine governorates, some of those have close climate conditions, while other differ, for more detail about each governorate, see **Appendix (1).**

3.5 Demography

The total Population of the Palestinian Territory at mid 2012 was about 4.29 million, 2.65 million of them in the West Bank.

The population growth rate in the West Bank in (2012) is estimated by 2.7% **(PCBS, 2012).**

3.6 Sources of Water

3.6.1 Ground Water

3.6.1.1 Well Abstraction

The main source and dominant contributor of water to Palestinians is obtained from ground water wells. The total renewable groundwater resources have been estimated as 578-814 Mm^3/year in West Bank.

In the West Bank, groundwater resources are contained in deep (karstic) limestone and dolomite aquifers. Most large production Wells are 200-800 meters deep and the water table lies between 100 and 450m below the surface. These aquifers are commonly divided into three main aquifers-Basins (Western, Eastern and North-Eastern). The Western and the Northeastern basins are shared between the West Bank and Israel, the eastern basin falls entirely within the West Bank **(WRAP, 1994; MOPIC, 1998a; SUSMAQ and PWA, 2001).**

3.6.1.2 Springs Discharge

There are many springs that discharge water from the three ground water system of the West Bank. There are about 300 main springs emerging from different aquifers in the Eastern basin and North-eastern basin and Western basin; most of them are small springs with an average discharge of less than 0.1 liter/second. The long–term annual discharge of these springs is around 54 MCM. Recently the overall yearly discharge has dramatically decreased to about 21 MCM in 2011. This significant decrease is attributed to several reasons, one of them is drought. While the Dead Sea springs which are located in the eastern basin discharged about 110 MCM/yr, these springs are under the control of the Israelis, **(PWA, water status Report, 2011)**.

The following table (3.1) shows the annual spring discharge in the West Bank during (2005-2011).

Year	Declining in discharge (MCM)
2005	53.64
2006	55.63
2007	44.82
2008	24.02
2009	30.91
2010	34.13
2011	21.03

3.6.2 Surface Water

The main source of surface water is Jordan River, but Palestinians have lost their share and access to this river due to the political issues which represent by the fact that Israel controls the flow of the river, such that

Palestinians take zero quantity. **(WRAP, 1994; MOPIC, 1998a; ARIJ, 1998).**

The run off wades represent another surface water source, the long-term average annual flow of flood water through wadis in the West Bank is about 165 MCM/y. Generally, the West Bank wadis are classified into eastern wadis (toward the Jordan Valley and the Dead Sea) and western wadis (towards the Mediterranean) by the direction of flow. Currently, about 2 MCM/y is being harvested through several agricultural bonds in Jordan Valley and a small scale dam in Al Auja Area **(PWA, 2012).**

3.6.3 Non –Conventional Water Resources

According to a recent PCBS survey in 2011, around 32%-35% of the households in the West Bank are connected to waste water (WW) collection systems. Today only one Palestinian waste water treatment plant in functioning in the west bank, treating less than 3% of all sewerage produced, and another one starts working recently.

Desalination of brackish water to achieve acceptable level of drinking water quality is an important option that is still not implemented in West Bank.

Not only systematically blocking the development of Palestinians' waste water and sanitation sector, but also Israel has been, unilaterally imposing new wastewater arrangement that are patently unfair. Around 15 MCM of the generated WW is treated inside of Israel from Jenin, Tulkarm, Nablus, Ramallah, Beitjala, and Hebron. Since 1996, for example, Israel has unilaterally deducted over $US 24 million from Palestinians tax revenues for the construction and maintenance of wastewater treatment plants in Israel built to treat and reuse Palestinian wastewater for the exclusive use of Israel's' a agricultural sector**(PWA, Water Status Report, 2011)**.

West Bank water supply relies heavily on the import of water from Mekorot systems. The total quantity provided to the Palestinian Communities in the West Bank through Mekorot is about 53 MCM (around 49 MCM for domestic usage and 4 for agricultural usage) **(PWA, water status Report, 2011).**

Palestinians sometimes depend on rainwater harvesting system to collect water for their different uses**.**

Palestinians are accustomed to occasional droughts, scarcity of water, water restrains, and frequent displacement of people as a result; reaching the needed amount of drinking water is a huge challenge in the middle of the on-going circumstances.

3.7 Water Used in the West Bank for Different Sectors

One of the most relevant water service parameters at present situation in the West Bank (with water shortage in many localities), is the quantity of water available to each use.

Water in the West bank is used mainly for Domestics and agriculture, while the industry has the least advantage.

For domestic use, the needed quantities to provide per capita supply rate evaluated by 150 l/c/d (based on the WHO standards supply rate), while as average the total amount of water supplied for domestic water consumption in the West Bank is only 72 l/c/d.

For agricultural purposes the amount of water used varies from one place to another and depends on rainfall, temperature, quality of soil, etc. It also depends on the type of crop being grown and the irrigation technology used (submersion, sprinklers, drip irrigation, etc.).

If the current political situation persists, it is considered that the amount of water available for irrigation will be severely constrained. Some agricultural wells will be taken over by municipalities for domestic water purposes.

As yet, there are no large industrial facilities (chemical plants, cement factories, etc.) consuming high volumes of water in the West Bank. Most industries are just small factories and they use the urban water supply network as their sole source of water. Many of these industries are billed for conventional customers.

The fully independent Palestinian state, means Palestinians will attain their full water rights and hence the current restrictions on water use will be alleviated and the agreements on the equitable shares in trans-boundary water resources will take place .These additional amounts will enable Palestinian to develop an ambitious irrigation program, and the market opportunities for industries will increase and more investors will venture to develop small factories.

The following table (3.2) shows the water demand and use in 2012 and the projected demand and use up to year 2032 for agricultural and non- agricultural uses in the West Bank.

Year	Demand for Non-agriculture (Mm^3/ yr)	Demand for agriculture (Mm^3/ yr)	Used for non-agriculture (Mm^3/ yr)	Used for agriculture (Mm^3/ yr)
2012	105	84	101.09	58.70
2017	146	150	134.38	69.4
2022	219	180	197.11	102.8
2027	302	216	225.06	216.3
2032	394	295	416	492.7

Source: PWA, 2012.

3.8. Water Tariffs in the West Bank Governorates

Prices paid for water itself are different from water tariffs, a water tariff is a price assigned to water supplied by a public utility through a piped network to its customers. The term is also often applied to wastewater tariffs. Water and wastewater tariffs are not charged for water itself, but to recover the costs of water treatment, water storage, transporting it to customers, collecting and treating wastewater, as well as billing and collection.

The tariff system in the West Bank is complex, and there is no unified system which controls and determines it as summarized in Table (3.3).

Table (3.3) The Water Tariffs in the West Bank Governorates

Governorate	Average Tariff (NIS/m^3)	Maximum tariff (NIS/m^3)
Bethlehem	4.6	15
Hebron	5.4	20
Jenin	4.3	19
Jericho	2.5	5
Jerusalem	4.1	-----
Nablus	4.5	15
Qalqilia	4.1	18
Ramallah	4.1	9.7
Tulkarm	3.1	20

Data source: PWA, 2012

Note: Max. Tariff: includes Water Tankers prices

3.9 Over View on Agriculture in the West Bank

The agricultural activities considered as a basic instrument affecting the economic sector of West bank, such that, it can help Palestinian to achieve their food security, provides employment to large Palestinian numbers, and affect the national income.

3.9.1 The main Agricultural crops Produced in the West Bank

Over the years Palestine has been characterized by its moderate climate and rich soil to yield variety kinds of fruit, vegetables and field crops.

Fruit occupied nearly 1099 thousand dunums in West Bank, while vegetable represent 134 thousand dunums **(PCBS 2006/2007).**

Palestine is famous of growing olives, Almond, Citrus and grapes as fruit trees, distributed as follows: Olives mainly grow in Nablus, Jenin, Ramallah, and Tulkarm. Almonds mainly grow in Tulkarm,and Jenin, while Citrus grow mainly in Qalqilia, Nablus, Tulkarm, and Jericho, finally grapes are mainly produced in Hebron and Beithlahem **(PCBS 2006/2007).**

West Bank interest in producing different kinds of vegetables mainly Tomato, squash, cucumber, which depend on rain feed or irrigation, in most governorates the green house, is used to increase their productions **(PCBS 2006/2007).**

Wheat considered as a main type of field crops which mainly grows in Jenin, Hebron, and Tubas, irrigated by irrigation system or depended on rain fed.

The following Table (3.4) summarizes the statistics quantities of irrigated crops produced in the West Bank governorates (2003-2007).

Crops	Production of Vegetables (Ton)			
	2007/2006	2006/2005	2005/2004	2004/2003
Jews' Mallow	6,138	7,402	6,732	8,364
Broad Beans	3,009	3,766	3,896	3,205
Muskmelon	1,472	2,421	2,210	3,730
Tomato	102,266	102,601	101,021	80,724
Cucumber	116,922	105,921	89,084	88,113
Eggplant	42,083	42,504	43,396	37,668
Squash	39,810	37,932	31,268	34,580
Cauliflower	18,581	19,391	14,041	15,119
White Cabbage	14,842	14,427	9,843	10,132
Water melon	8	758	807	1,468
Hot pepper	7,438	6,604	2,309	4,704

Table (3.5) The Statistics quantities of some irrigated fruits produced in the West Bank (2003-2007).

Crops	Production of Fruit (Ton)			
	2007/2006	2006/2005	2005/2004	2004/2003
Grapes	56,718	48,791	63,028	52,114
Olive	34,154	134,910	72,462	128,432
Lemon	7,174	12,575	7,844	8,351
Banana	6,160	8,000	9,800	9,148
Orange	9,380	13,275	14,420	15,360
Date	353	196	1,274	1,673
Guava	592	583	510	522
Peach	1,463	1,319	1,061	950
Mango	160	150	150	150
Avocado	372	372	475	265
Apricot	902	1,031	965	1,452
Calamondin	4,552	7,250	5,864	6,107

3.9.2 Types of crops exported and imported in the West Bank (2009-2012)

The biggest threat to trade agricultural products is the political instability, restrictions on movement and delays at checkpoints and that make it difficult for goods to be competitive of large regional suppliers such as Syria, Egypt, and Lebanon.

Despite the problems associated with the movement and access restrictions, farming cooperatives provide a way to strengthen the agricultural sector, bringing farmers together to improve marketing practices, since the amount of export to Israel is more than to abroad.

Targeted export markets include Israel, Western Europe, Saudi Arabia and other GCC countries (Bahrain, Kuwait, Oman, Qatar, United Arab Emirates), as well as potential markets in newly or imminently acceding countries to the European Union.

The properties of the Palestinian crop sector are quality and variety of produce, long and off-season availability, and proximity to markets.

The following two :

Table (3.6 and 3.7) show some types of crops exported from West Bank to Israel and other countries (2009-2012).

Exported Crops from West Bank	Mainly Imported regions
Avocado	Jordan
Orange	Jordan
Onion	Jordan
Potato	Jordan
Tomato	Jordan
Date	Jordan, Emirates
Guava	Jordan
Cucumber	Emirates
Thyme	Jordan, Emirates
Lemon	Jordan, Emirates
Almonds	Jordan
Grapes	Jordan
Apple	Israel
Plum	Israel
Grapes	Israel
Citrus	Israel
Avocado	Israel
Carrot	Israel
Apricot	Israel
Kiwi	Israel
Garlic	Israel
Pear	Israel

source: Palestinian Ministry of Agriculture (2012)

3.10 Over View on Live stock in The West Bank

Livestock considered as an important fortune to Palestinians, such that, it will achieve food security, provides career to large number, sometimes we get rid of waste residual by feeding to some kinds of animals, produces a natural fertilizers used in agricultural land to increase crop yield, and increases the national income.

Different kinds of animals are breeding in Palestine, mainly cows (beef and dairy), sheep, goats and chicken (broiler and laying hens).

The number of cows was estimated about 23503 head in West Bank, breeding mainly in Hebron, Jenin, and Nablus governorates **(PCBS, 2010).**

Sheep numbers were approximated by 687146 head, and mainly breeding in Hebron, Jenin, Nablus, and Bethlehem governorates **(PCBS, 2010).**

Goat numbers were approximated by 331197, and mainly bred in Hebron, Jenin, Bethlehem, and Jericho governorates **(PCBS, 2010).**

Finally, mainly two types of chicken bred in Palestine called Broiler and laying hens, approximated by 31127 and 1928 birds respectively, Hebron mainly breeds Broiler while Ramallah considered as main governorate in breeding Laying hens **(PCBS, 2010).**

The following charts represent the Percentage distribution of main live stock breeding in West Bank **(Moayed Salman, 2012).**

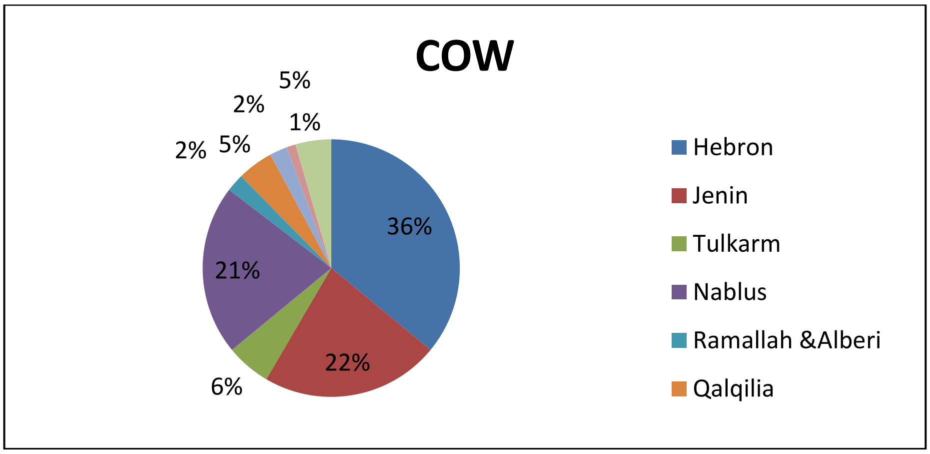

Figure (3.2): Percentage Distribution of COW in WESTBANK (2010).

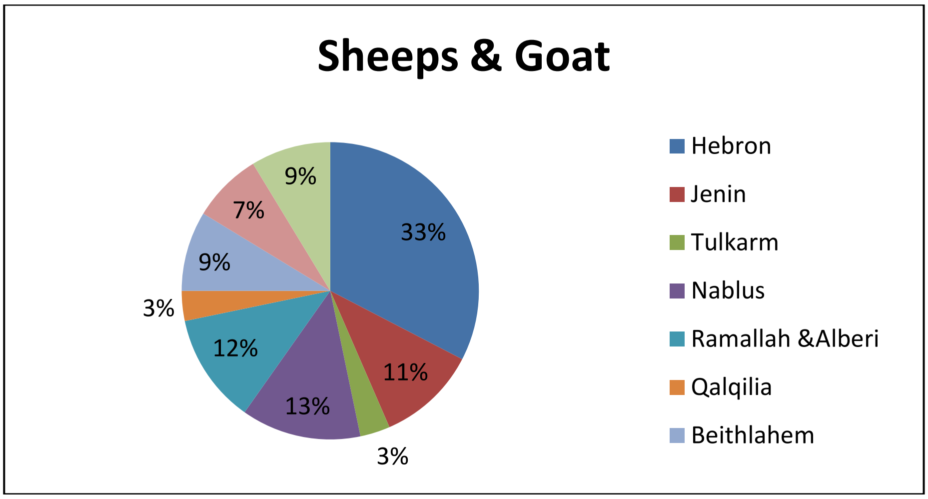

Figure (3.3): Percentage Distribution of Sheep & Goat in WESTBANK (2010).

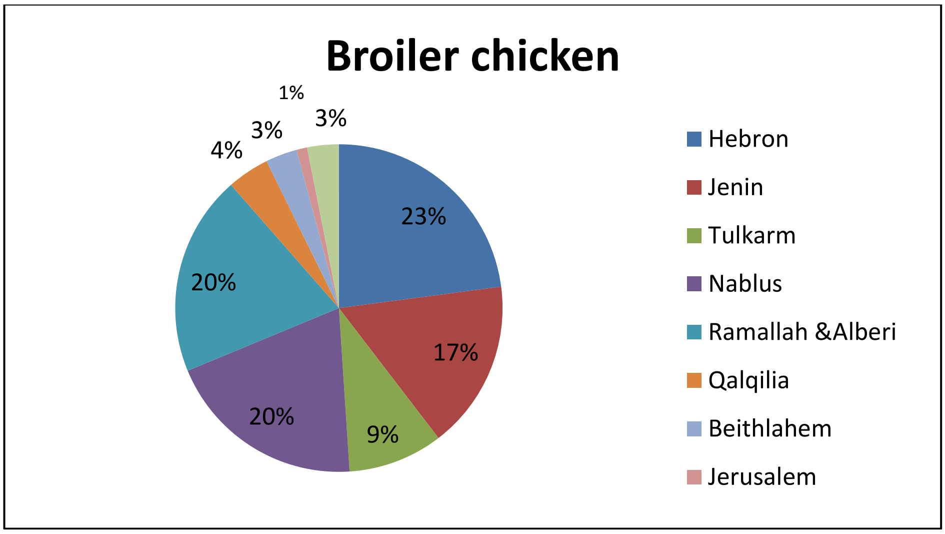

Figure (3.4): Percentage Distribution of Broiler Chicken in WESTBANK (2010).

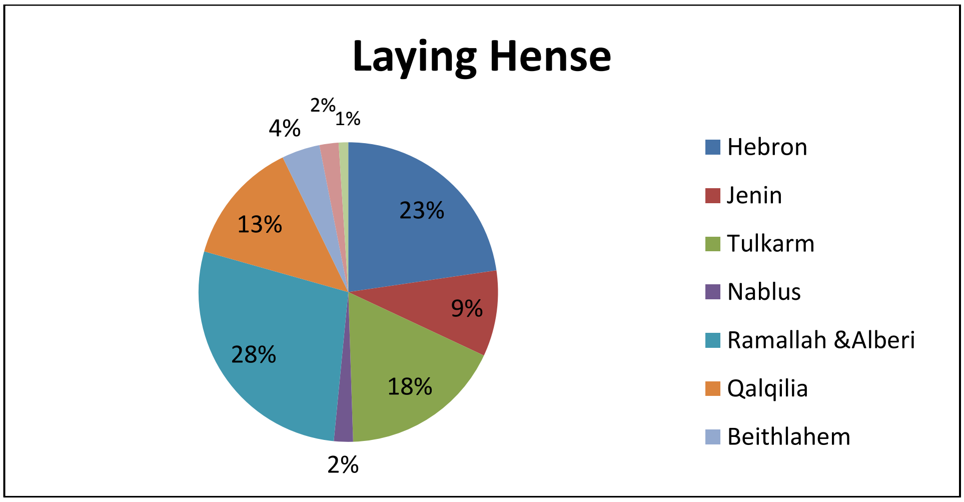

Figure (3.5): Percentage Distribution of Laying hens Chicken in WESTBANK (2010).

The West Bank produces 79.2% of Palestine's total livestock production (white and red meat, dairy, table eggs, and honey) **(PCBS, 2010).**

The largest contributions by governorate are Hebron (22.9%), Jenin (11.1%) and Nablus (10.5%) **(PCBS,2010).**

Meat and milk production is concentrated in Hebron, Jenin and Nablus governorates.

Mainly two systems used for breeding live stock in Palestine, farming system (open and, semi-open breeding) and Industrial system.

Many problems are facing the agricultural and livestock sector in Palestine, late any development of both, but generally the Palestinian Ministry of Agriculture try to alleviate controllable effects.

Chapter Four

Methodology

Chapter Four

Methodology

4.1. Research Description

The overall research methodology is divided into four components:

- The first step includes collecting Metrological, tradable, statistical data, and information on Palestinian water resources, from Palestinian Ministries; in addition, literature review was carried out in order to understand the basis of using the virtual water concept as water management tool.
- The second step includes evaluation of the virtual water for main agriculture crops (using CROPWAT program), and live stock taking into consideration their main products.
- The third step highlights the agricultural products, and plans the best agricultural practice, for two water scenarios, depending on the second step considering the socio- economic evaluation.
- The Fourth step includes decision analysis in addition to conclusions and recommendations.

4.2 Methodology Out Line

4.2.1 Data Collection

Palestinian ministries were the main source of data collected, each Ministry has its own information related to their field, and the Ministries which helped in completion this thesis were:

1. The Palestinian Metrological Department

The main data collected from the Palestinian Metrological department revolved around climatic data.

- Mean temperature.
- Relative humidity.
- Wind speed.
- Sun shine hours.
- Latitude and altitude.
- Rain fall.

For all governorates in West Bank, the mean temperature, Relative humidity, Wind speed, and rainfall averaged over thirty two years (1979-2011). Whereas the sun shines hour averaged over twenty eight years (1979-2000 and 2009-2011).

For more detail see **APPENDIX (1).**

2. The Palestinian Central Bureau of Statistics

The following data were determined from the Palestinian Statistics center

- The main kinds of agricultural crops grown in all governorates, depending on quantities.
- The pattern of growing (Rain fed, irrigated, and plastic house).
- The area used for growing main kinds of crops and their yield.
- The number of main kinds of livestock in each governorate (Dairy cow, Beef cow, Sheep, Goats, Broiler chicken, and laying hens) breeding in WB governorate.
- The main governorate breeding specific kinds of livestock.

3. The Ministry of Agriculture

The following data were determined from the Agricultural ministry:

- The planting and harvesting date for main crops according to governorate.
- The crop day's growth stages for main crops from planting to harvesting date, FAO Drainage paper # (24) also helped in approximating these days.
- The crop coefficient (Kc), by a little correlating of what suggested in FAO Drainage paper # (24)conforming to our country.
- The Palestinian Agricultural strategy for (2012).
- The type and amount of excess and deficit crops (2012).
- The kinds of exported and imported crops.
- The cost of importing some types of crops.
- The kind and cost of the agricultural production requirements.
- The number of labors required to work in dunum of a specific crop type, and their wages in a particular governorate.

4. The Palestinian Water Authority

- Annual water status report 2011.
- National water strategy for Palestinian, toward building a Palestinian state, draft copy, 2012.

5. Other References.

Internet website, scientific papers, and books, see the references (3, 4,5).

4.2.2 Cropwat Computer Model

CROPWAT is a decision support computer program, developed by the land and water development Division of FAO for planning and managing of irrigation.

The versions of CROPWAT program develop with time, CROPWAT v 5.7 (original), CROPWAT v 7.0, and the newest one used in this research is CROPWAT v 8.0.

CROPWAT v 8.0 is a Windows program based on the previous DOS versions. Apart from a completely redesigned user interface, CROPWAT 8.0 for Windows contains a group of updated and new features, including:

- Monthly, decade *and daily* input of climatic data for calculation of reference evapotranspiration (ETo).
- Backward compatibility to allow use of data from CLIMWAT database.
- Possibility to estimate climatic data in the absence of measured values.
- Decade *and daily* calculation of crop water requirements based on updated calculation algorithms including adjustment of crop-coefficient values.
- Calculation of crop water requirements and irrigation scheduling *for paddy & upland rice,* using a newly developed procedure to calculate water requirements including the land preparation period.
- Interactive user adjustable irrigation schedules.
- Daily soil water balance output tables.

- Easy saving and retrieval of sessions and of user-defined irrigation schedules.
- Graphical presentations of input data, crop water requirements and irrigation schedules.
- Easy import/export of data and graphics through clipboard or ASCII text files.
- Extensive printing routines, supporting all windows-based printers.
- Context-sensitive help system.
- Multilingual interface and help system: English, Spanish, French and Russian.

CROPWAT represents a tool for calculating reference evapotranspiration, Crop water requirements, crop irrigation requirements, and more specifically the design and manage of irrigation schemes.

CROPWAT model was adopted in this research to calculate the reference evapotranspiration (Et_0), and crop water requirements (CWR).

The main Input key requires for model to calculate the crop water requirements and irrigation requirements represented by:

1. Reference Crop Evapotranspiration (Eto) values measured or calculated using the FAO Penman-Montieth equation based on decade/monthly climatic data: minimum and maximum air temperature, relative humidity, sunshine duration and wind speed.
2. Rainfall data (daily/decade/monthly); the program divides the monthly rainfall into a number of rain storm each month;

3. A Cropping Pattern consists of the planting date, crop coefficient data files (containing Kc values, stage days, root depth, depletion fraction). And the area planted (0-100% of the total area).

When local data are not available, CROPWAT 8.0 includes standard crop and soil data, while local data are available, these data files can be easily modified or new ones can be created.

For Irrigation Scheduling, the model requires additional information beside the previous three points mentioned.

4. Soil type: total available soil moisture, maximum rooting depth, initial soil moisture depletion (% of total available moisture);
5. Scheduling Criteria – several options can be selected regarding the calculation of application timing and application depth (e.g. 80 mm every 14 days, or irrigating to return the soil back to field capacity when all the easily available moisture has been used).

The program and the manual developed by Martin Smith, Derek Clarke & Khaled El-Askari, and its manual available in Acrobat format and can be downloaded from:

http://www.fao.org/nr/water/infores databases_cropwat.html.

4.2.3 Estimation of the Virtual water for Crops.

The main kinds of crops in WB governorate were analyzed with those developed crops suggested by the Palestinian ministry of agriculture in Palestinian Agricultural strategy (2012), to determine their virtual water values.

To determine the volume of water used to produce Crops, a specific product can be applied (**Chapagain and Hoekstra, 2004**).

$$CWU_{[C]} = [CWR_{[C]} * \text{Quantities Produced}] / \text{Yield} \quad (1)$$

Where:

CWU *(m³/yr)*, crop water use, is the total volume of water used in order to produce a particular crop.

CWR *(m³/ha)*, is the crop water requirement measured at field level, and it can be defined as the total water used for evapotranspiration from growing to harvesting date for a specific crop grown in limited climate region, this assumption claims that crops grow under standard circumstances without shortage of water.

Quantities produced (Production), is the total volume of crop '*c*' produced (ton/yr), and ***Yield*** the production volume of crop '*c'* per unit area of production (ton/ha).

The crop water requirement is calculated by accumulation of data on daily crop evapotranspiration *Etc* (mm/day) over the holistic growing period, (**Chapagain and Hoekstra, 2004)**.

$$CWR = \sum ET_C \quad (2)$$

Et_c means the actual evapotranspiration from specific crop, and the summation is done over the period from the first day of planting to the final day at the end of the growing period by using CROPWAT model.

If we multiply the summation with constant 10, then the unit of CWR converts from mm into m^3/ha.

Actual crop water can be represented by crop water requirement if the water used achieved all the plants need. In fact, this assumption may have some exaggeration of actual water; on the other hand we regardless from analysis of the amount of water needed to grow crops and neglecting the loss related to irrigation and drainage.

The actual crop evapotranspiration per day (ET_c), differs distinctly from the reference evapotranspiration, as the ground cover, canopy properties and aerodynamic resistance of the crop are different from grass. The CROPWAT program distinguishes field crops from grass by using crop coefficient (*Kc*), thus the ET_c determined by multiplying the reference crop evapotranspiration *ET0* with the crop coefficient *Kc*, (**Chapagain and Hoekstra, 2004**).

$$ETc = ETo * Kc \tag{3}$$

The reference evapotranspiration (ETo) is defined as the evapotranspiration from reference surface to a reference crop. FAO defined the reference crop as hypothetical crop with an assumed height of 0.12m having the surface resistance of 70 sm−1 and albedo of 0.23, closely resembling the evaporation of an extension surface of green grassof uniform height which is actively growing and adequately watered.

Several methods exist to determine ETo, the Penman-Monteith Method has been recommended by CROPWAT program, as the appropriate combination method to determine ETo from climatic data parameters represented by Temperature, Humidity, Sunshine, and Wind speed, as presented in equation (4)

$$Et0 = \frac{\left[0.408\Delta(Rn-G)+\gamma\frac{900}{T+273}U2(es-ea)\right]}{\Delta+\gamma\ (1+0.34\ U2)} \qquad (4)$$

Where;

ETo: reference evapotranspiration [mm day-1].

Rn: net radiation at the crop surface [MJ m-2 day-1].

G: soil heat flux density [MJ m-2 day-1].

T: means daily air temperature at 2 m height [°C].

u2: wind speed at 2 m height [m s-1].

es: saturation vapor pressure [kPa].

ea: actual vapor pressure [kPa].

es - ea saturation vapor pressure deficit [kPa].

Δ: slope vapor pressure curve [kPa °C-1].

γ: psychrometric constant [kPa °C-1].

The major factors determining *Kc* are crop variety, climate and crop growth stage.

As the crop grows and develops, the ground cover, crop height and the leaf area change. The evapotranspiration during the various growth stages will change, and thus the *Kc* for a specific crop will differ over the growing period **(Chapagain and Hoekstra, 2004)**.

The growing period can be divided into four distinct growth stages: initial, crop development, mid-season and late season (see **Figure 4.1**).

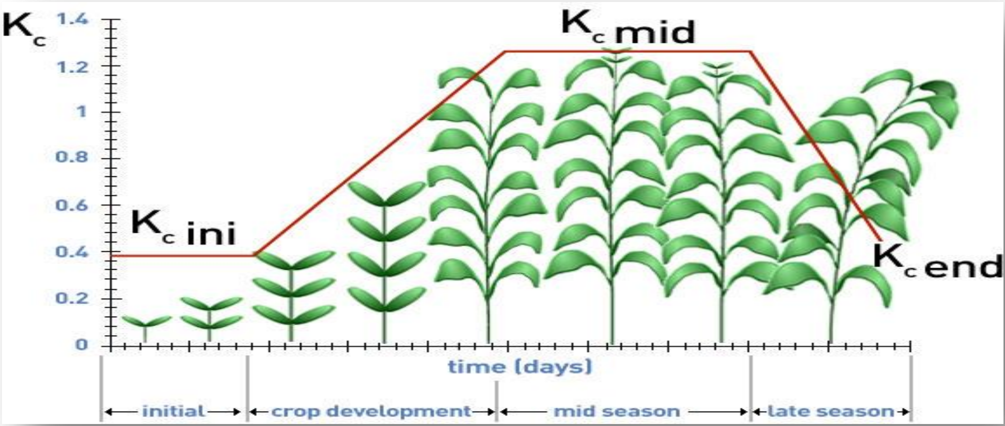

Figure (4.1): The Growing Stages of Plants
Source: from (www.fao.org/nr/water/crop info_maize.htm) .

- The *initial stage* extended from planting date to approximately 10% ground cover, the length of the initial period is highly dependent on the crop, the crop variety, the planting date and the climate. For perennial crops, the planting date is replaced by the 'green up' date, i.e., the time when the initiation of new leaves occurs. During the initial period, the leaf area is small, and the evapotranspiration is mostly being soil evaporation. And so, the K_c *value* during the initial period is large when the soil is wet from irrigation practice and rainfall and is low when the soil surface is dry.
- The *crop development stage* runs from 10% ground cover to effective full cover, which for many kinds of crops occurs at the initiation of flowering. As the crop grows, develops and shades more of the ground, evaporation becomes more restricted and transpiration gradually becomes the major process. Through this stage, the K_c value complies with the extent of ground cover. Typically, if the soil surface is dry, K_c= 0.5 corresponds to about 25-40% of the ground

surface covered by vegetation. A K_c value of 0.7 often corresponds to about 40-60% ground cover. These values will vary, depending on the crop, frequency of wetting and whether the crop uses more water than the reference crop at full ground cover.

- The *mid-season stage* extends from effective full cover to the start of maturity. The start of maturity is often indicated by the beginning of the ageing, yellowing or senescence of leaves, leaf drop, or the browning of fruit to the degree that the crop evapotranspiration is reduced relative to the reference *ET*. This stage is the longest stage for perennials and for many annuals, but it may be relatively short for vegetable crops that are harvested fresh for their green vegetation. In the mid-season stage *Kc* has its maximum value and remains constant.
- The *late season* stage extends from the start of maturity to harvest or full senescence. The calculation of crop evapotranspiration is presumed to end when the crop is harvested, dries out naturally, reaches full senescence, or experiences leaf drop. If the crops irrigated more time until harvested the *K c* value will be big, while if the crop is agent and dry out in the field before harvest, the K_c will be small.

(FAO irrigation and drainage paper 24) was used as a useful guide in determining growth stages and planting date, thus the values were adjusted depending on local observations obtained from interviewing agricultural experts working in the Palestinian ministry of agriculture, they use their experience and sense to a adjust the FAO suggested values.

4.2.4 Estimate the Virtual water of Livestock

The virtual water of livestock represented by the total volume of water used for grown up at the end of life span and process feed (**Chapagain and Hoekstra,2004)**.

This amount of water used for feeding, drinking, and servicing.

$$VWC_{[a]} = VWC_{[feed]} + VWC_{[drinking]} + VWC_{[servicing]} \quad (5)$$

Where $VWC_{[a]}$ means the total virtual water for specific kind of animal at the end of life span, $VWC_{[feed]}$ represents the volume of water used to produce their feeds , these amount of water depend on the type of crops eaten by specific kind of animals and quantities needed for mixing food, most of the animal feed imported from outside, mainly from Ukraine, thus the virtual water depends on other water resources rather than the Palestinian resources, clover is one of crops produced some times in Jenin governorate, and used for feeding animal, the virtual water value of clover produced locally was determined by using CROPWAT program, while other feed virtual water determined by referring to imported virtual water**(Chapagain and Hoekstra,2004).**

The quantity of water used for mixing was neglected in this research, since breeders in Palestine generally do not depend on mixing feed type, since these types of food cost breeders a lot.

The $VWC_{[drinking]}$ represents water used for drinking all over their span life, nearly countries all over the world have its own researches and studies, defined the volume of water used by its own livestock, Palestine also has its own studies,*(estimation of water requirement for livestock production in Palestine)*, is one of those studies adopted in this research.

Finally VWC $_{[servicing]}$ means the part of total water used for cleaning animals and their houses and like so, generally in all countries no enough data related to water used for servicing, sometime simple reasonable guess needed, or some references can be helpful, like Albert (1996) and Jermar (1987), in this study guesses and references are combined to gather, the analysis were to assume the servicing quantities equal 50% of drinking quantities for animal life span.

4.2.4.1Estimate the Virtual water of Livestock Products

In this **section** livestock products were calculated depending on the estimation of the whole virtual water for animals mentioned in section **(4.2.4).**

Depending on the level of production, some of products were specified as primary while others considered as secondary.

Primary livestock products represent the products derived directly from animal, as cows produce milk, a carcass and skin. Some of these primary livestock products are then further processed into so-called secondary products, like, cheese and butter.

Primary product includes (part of) the virtual water content of the live animal in addition of water needed for processing.

Logic should be used to contribute the entire virtual water content of animal to its own primary products, so the useful method was by determining two terms, ‘product fraction’ and ‘value fraction’.

Product fraction [P_f], defined as the weight of the primary product obtained per ton of live animal (Chapagain and Hoekstra, 2003), whereas the value fraction [V_f], is the ratio of the market value of one product from the animal to the sum of the market values of all products from the animal (**Chapagain and Hoekstra,2004)**.

The virtual water of livestock products can be determined by using Equation (6).

$$VWC_p = (VWC + PWR) * V_f/V_p \qquad (6)$$

Where:

VWC_p: The virtual water of a specific product produced from animal 'a'.

VWC: The total virtual water content of the animal 'a'.

PWR: The processing water requirement per ton of animal, for producing primary products 'p' (m^3/ton).

V_f: fraction factor of product *p*.

V_p: product fraction of product *p*.

For more details to value fraction and product fraction see **APPENDIX (3).**

This research focused on the main live stocks breeding in Palestine like dairy cow, beef cow, sheep, goats, broiler chicken and laying hens, and then determined the virtual water content for each primary and secondary product.

The following **Figure (4.2)** summarizes the methodology used for analyzing the crops and livestock virtual water (VW).

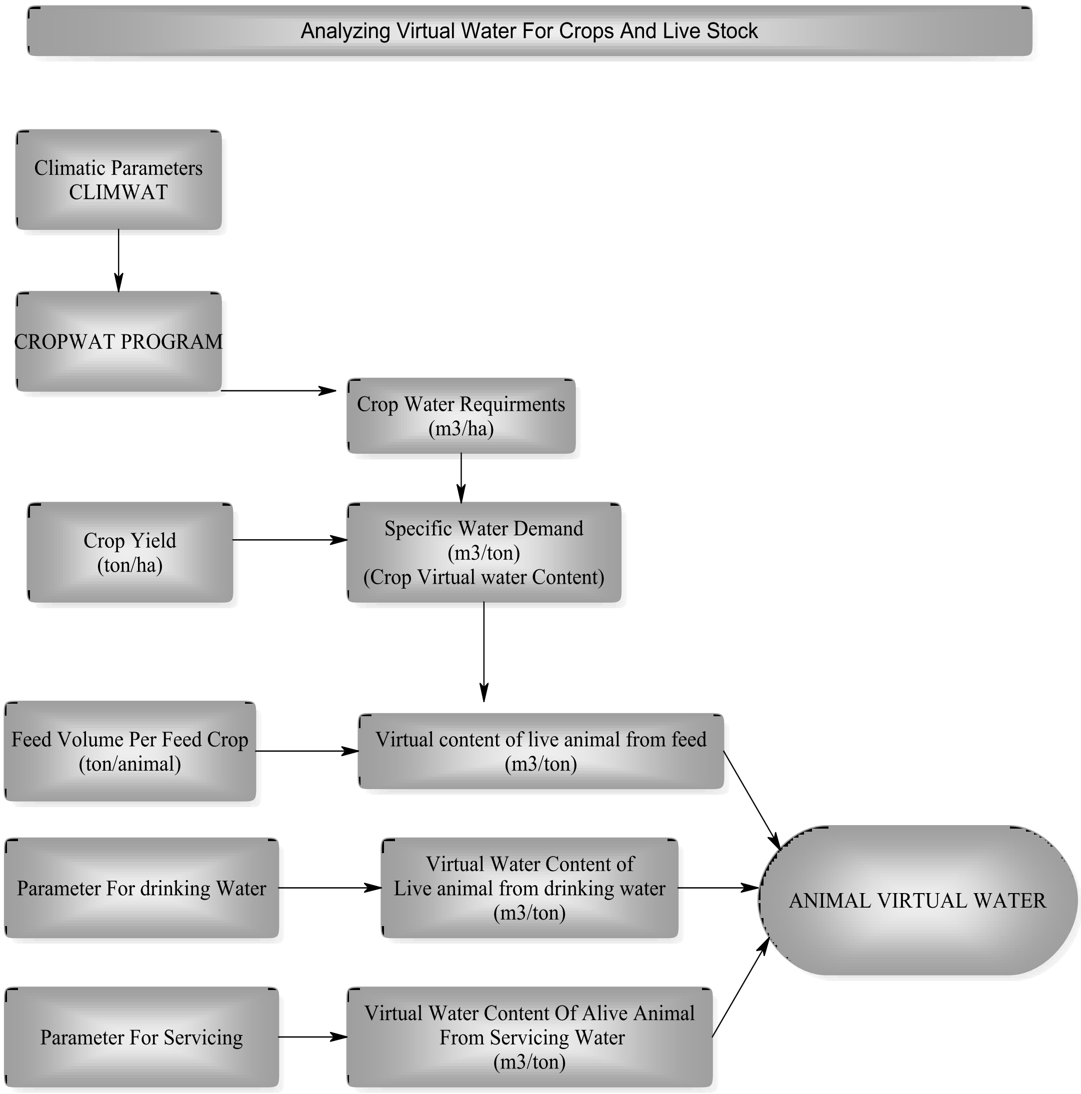

Figure (4.2): Analyzing Virtual Water for Crops and Live stock.

Source: Designed by the researchers

4.2.5 Water Scenarios and the Financial Evaluation

The financial side of virtual water was an important step conducted in this research such that the complete picture will help in adopting the best suggestion.

Two scenarios were discussed, the first scenario is called *Present water situation (2012-2017)*, and the second scenario is called *future, Peaceful water situation (2017-2032).*

4.2.5.1 Scenario Number One: Present Water Situation (2012-2017)

The present scenario begins from the current water situation, 2012 with a few and limited amount of water available for the utilization of the Palestinian, and expected to extend for 2017, during these five years the negotiation will continue between the Israeli and Palestinian sides to obtain additional quantities of water for the Palestinian use. However, the increasing will be limited and approximately will not achieve all the population needs, for more details see **APPENDIX (5).**

To suggest an agricultural plan dealing with the current water condition, it was necessary to follow some specific steps:

1. Analyze the main crops for each governorate to determine their virtual water.
2. Define the excess and deficit crops as determined in the Palestinian statistics center 2012, the excess was in: grapes, lemon, Guava, Avocado, plum, cherry, tomato, cucumber, squash, eggplant, broad beans and hot pepper, while the deficit was in :orange, calamondin,

watermelon, dry onion, and Potato, regardless the deficit was due to the local market requirements or exportation.

3. Determine the governorates which produce the deficit crops.
4. Limit the study on those governorates consuming less water to produce those deficit crops.
5. Analyze the cost of producing the deficit crops which need less water for producing and compare it financially with importing cost.

The cost analysis of deficit crops, depend on more than one assumption of water cubic meter cost, the first assumption is to analyze depending on the real recent cost of water cubic meter in each studied governorate. The second assumption assumes gradual increasing of water cubic meter cost, and in both assumption the assumed increase in cost is (0.5 NIS) which equals (0.138 $), the highest value of assumption was the cost of water cubic meter used for agricultural purposes will reach the cost of water cubic meter used for domestic use in the specified governorates.

Table (4.1) Summarize the present cost of water cubic meter used for Agricultural purposes a according to each governorate.

Agricultural area Affiliated to governorate	The Cost Of water cubic meter for irrigating crops (NIS/m^3)
Jenin	1.6-1.7
Tulkarm	1.6-1.7
Qalqilia	1.6-1.7
Jericho	2-2.1
Hebron	2.5
Nablus	2-3

The assumed increased of water cubic meter cost related to several things such as the population increase, the climate change and the expected political pressures on reducing the Palestinian water resources if the transition stage of negotiation not success.

In all previous assumption we assume that the cost of all factors of agriculture production requirements was constant except the cost of the water cubic meter which was variable according to the time.

The factors of the agricultural production requirements were presented by:

- Seed/seedling.
- Fertilizers (Manure, Nitrogen, Phosphate, Potash, Iron, compound fertilizers).
- Chemicals (Pesticides, herbicides, fungicides)
- Hired machinery (Land preparation, Planting (Sowing), Fertilization, Crop husbandry, Harvesting).
- Hired Labor (Land preparation, Planting (sowing), Crop husbandry, Harvesting, Irrigation).

The Fixed cost includes

- Depreciation.
- Interest on Capital.
- Land rent.

The cost of water per cubic meter required per dunum of a specific crop determine by using equation (7)

$$TWC\ (\$/dunum) = CCM\ (\$/m^3) * VW\ (m^3/dunum) \quad (7)$$

Where:

TWC: The water cost per dunum ($/dunum).

CCM: The cost of water cubic meter ($/m^3).

VW: The virtual water of a specific crop grown in one dunum (m^3/dunum).

The Total cost of agricultural requirements per dunum($/dunum), calculated by using Equation (8)

$$TCR = TWC\ (\$/dunum) + CAR\ (\$/dunum) \quad (8)$$

Where:

TCR: Total cost of agricultural requirements per dunum ($/dunum).

CAR: The cost of all agricultural requirements excluding the cost of water cubic meter ($/dunum).

To determine the cost of producing one kilogram of crop locally, Equation (9) used

$$CKC = CAR\ (\$/dunum) / Yi\ (Kg/dunum) \quad (9)$$

Where:

CKC: The cost of producing a kilogram of crop locally ($/Kg).

Yi : Average Yield of one acre (Kg/dunum).

6. The excess a mount were evaluated depending on its virtual water value, and then the lands and water used to produce high intensive excess products, converted to less intensive deficit products, which prove the feasibility of producing locally (less water and less cost than import , more economic value).
7. Final step was to assess the impact of present condition Plan on labors as one of social aspects.

4.2.5.2 Scenario Number Two: Future Water Situation, (2017-2032).

The suggested scenario with its year related to the expected condition suggested by Palestinian negotiations committee, and adopted by Palestinian water Authority in national water strategy for Palestinian.

The future scenario assumed Palestine as a fully independent state (attain their full water rights, and hence the current restrictions on the water use will be alleviated), such that, the currently zero MCM used from Jordan valley will alternate by 240 MCM as was suggested by Johnston plan, the unfair of present quantities taken from basins will be adjusted to be more equitable, Israel blockage on development Palestinians' waste water Plants will be reduced, the harvesting system will be developed, the political obstacles on border will fade.

The main key in planning this stage was to think how present scenario plan can serve this stage, and how the participation in global market can be achieved.

The following Figure (4.3) represents the financial analysis for agricultural products.

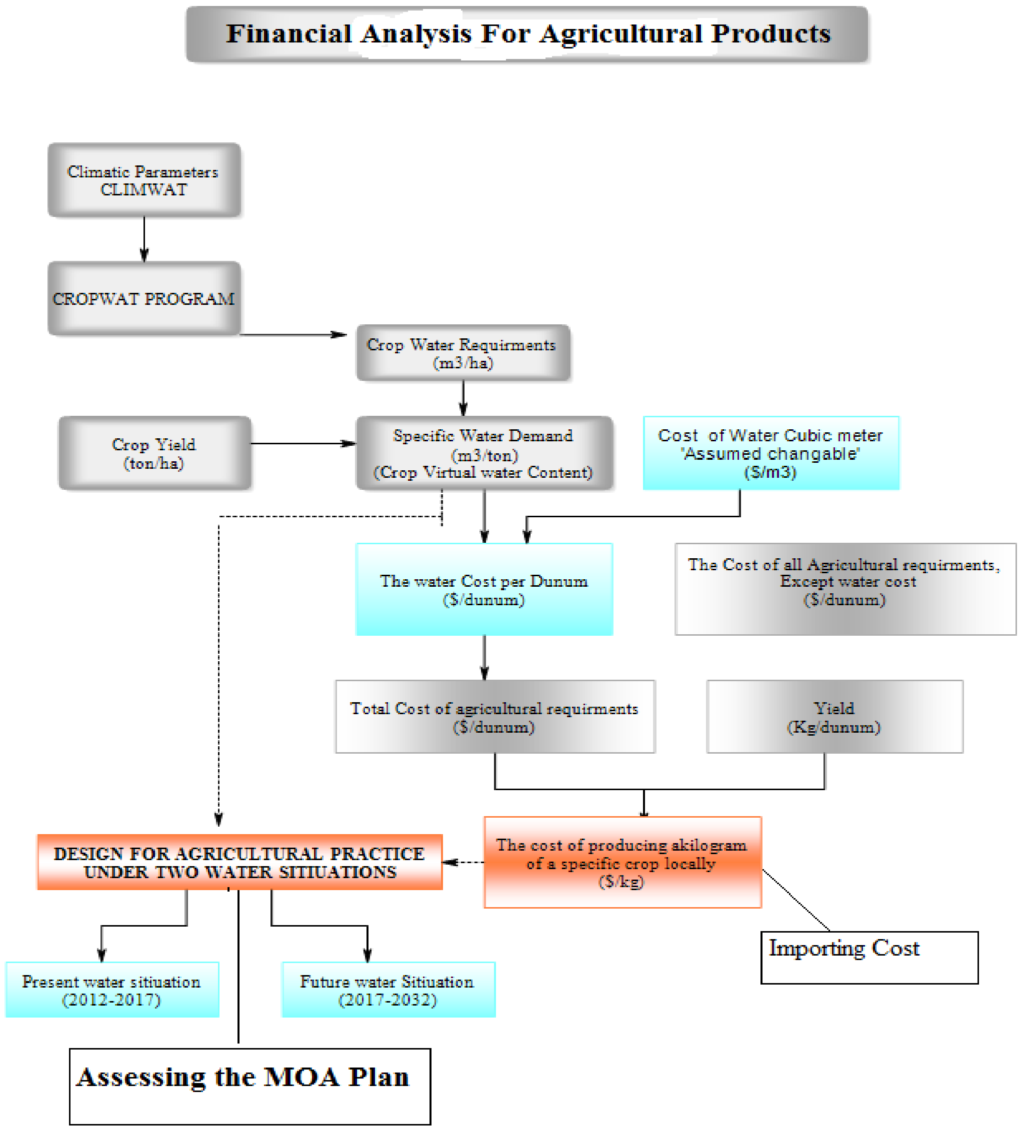

Figure (4.3): The Financial Analysis for Agricultural Crops.
Source: Designed by the researchers

4.2.6 Assessing the Impact of using the concept of Virtual Water on the Social Aspects (Employment rate).

It was essential to assess the effect of replacing the excess high virtual water with deficit low virtual water crops on the rates of Agricultural employments as one of social aspects.

The Assessing method depended mainly on the following steps:

1. The results of analyzing method in sections (4.2.3 and 4.2.5.1), which include the values of virtual water for excess and deficit crops in the governorates which financially preferred to produce those deficits crops with least virtual water rather than importing.
2. Determine how many dunums of deficit crops can be produced using the virtual water saved from replacing the excess crops.
3. Define the expected labor worked per dunum for excess and deficit crops as summarized in the following Table (4.2).

Excess and Deficit Crops	**Expected labors per dunum**
Tomato (Open)	20
Potato	10
Water Melon	15
Lemon	5
Orange	5
Calamondin	5
Hot-pepper	10
Onion	10
Banana	10
Date	10

Source: from Palestinian ministry of Agriculture (2013).

4. Compare the number of labors who worked per dunum in excess crops to the number of labors who lost their jobs and who got a new job in producing dunum of deficit crops.
5. Finally, evaluate the positivity of replacing method on the rates of Agricultural employments.

4.2.7 Assessing the Strategy of Palestinian Ministry of Agriculture

The strategy for developing some kinds of crops suggested by the Palestinian Ministry of Agriculture (2012), analyzed economically to be assessed related to the concept of virtual water.

The Guava, Mango, Avocado, Water melon, Musk melon were an examples of suggested developing crops mainly in three governorate, Jenin, Tulkarm, Qalqilia, and Jericho

The data analyzed by using Excel sheet and the feasibility and effectiveness of their suggestions were determined.

4.2.8 Assessing the Accuracy of Calculations and Results.

The accuracy of results depends mainly on the accuracy of data and analyzing methods, in addition to, the comparison with other previous close studies.

Data accuracy is one components of data quality, it refers to whether the data values stored for an object are the correct values, and to be close to correct, a data values must be represented in a consistent and unambiguous form.

The accuracy of analysis depends on the methods used in analyzing (equations, hypotheses and computer model, etc).

Results in previous approved researches may help in comparing the new results and determine how the work is accurate.

To achieve high accuracy of calculations the study adopted the following steps:

1. All Data collected from official sources (MOA, PCBS, PWA), and formally approved studies.
2. The Collected data with more than one source compared to gather, such that the data from MOA and PWA compared With PCBS.

3. All statistics data were averaged over many years, as an example the climatic data were averaged over thirty years.
4. Missing data were correlated by depending on FAO suggestion, such that the Agricultural experts in MOA were interviewed to correlate the suggested values in FAO drainage paper # (24), to conform our country.
5. CROPWAT Computer model experts were asked to input the data in correct form.
6. The results were compared to approximated values of water required for irrigating one dunum of a specific crop exists in MOA.

   MOA collected these approximated data by asking farmers who works on field in each West Bank governorate.

The Table (4.3) summarized the approximated cubic meter of water required to produce one dunum of a specific vegetables in the West Bank regions.

Type of crop	Jordan valley Regions	Semi- Valley Regions	Mountainous and Internal Plains Regions
Green house- Tomato	1200	1000	800
Open-Tomato	450-500	350-400	250-300
Green house- Cucumber	600	500	400
Open-Cucumber	250	200	150
Watermelon	300	200	120
Dry- onion	350	250	200
Cauliflower	150	120	80
Cabbage	150	120	80
Eggplant	500	450	350
Potato	600	500	350
Hot-pepper	500	450	350
Broad beans	150	100	100

The Table (4.4) summarized the approximated cubic meter of water required to produce one dunum of a specific Fruits in the West bank.

Type of crops	Average water requirement (m3/dunum)
Citrus	(1000)
Peach & Plum	(700-500)
Banana	(1800-2000)
Date	(1000-1200)
Grapes	900
Guava	700-900

The data in table (4.3 and 4.4), represents a part of virtual water, that is the water required for irrigating only and did not consider the additional rain water and *losses* so in most case the calculated virtual water (includes *total water requirements(irrigation &rain), and losses*) would be close but in most cases higher than those approximated irrigated quantities.

Chapter Five

Results and Discussions

Chapter Five

Results and Discussions

5.1 Virtual Water Estimation

5.1.1 The Virtual water for Main Crops.

The results show that the virtual water of different crops determined in WB governorate, differ from one governorate to another.

At one governorate level the results show that the same crops type may have more than one virtual water value, affected by the planting date, and agricultural pattern (RF, Irr, Pl).

The tables below summarize the virtual water value of irrigated crops in WB governorates.

1. **Jenin**

The main sixteen irrigated crops grown in Jenin were analyzed, and their virtual water summarized in **Table (5.1)**,The values were compared ,and as a result the Tomato (green house) (1185 m^3/dunum), Plum(1112.7 m^3/dunum), Egg plant (1000 m^3/dunum), and Citrus (832.25 m^3/dunum), respectively considered as the highest crops consuming water for their production (highest VW value), while as average Cauliflower (312.5m^3/dunum), Muskmelon (333.1 m^3/dunum), Onion (342.3m^3/dunum), Cucumber (355.3m^3/dunum), and Potato (384.5 m^3/dunum),respectively considered as the smallest (smallest VW value).

Table (5.1) The Virtual Water of Main Irrigated Crops Produced in Jenin Governorate.

Jenin		
Crops	**Planting type**	**Virtual Water(m^3/dunum)**
Tomato	Green house-Spring	**1185**
Plum	Open/irrigated	**1112.7**
Eggplant	Open/irrigated	**1000**
Cherry	Open/irrigated	**940.5**
Orange	Open/irrigated	**833.1**
Lemon	Open/irrigated	**831.4**
Tomato	Green house/ Autumn	**818**
Hot pepper	Open/irrigated	**731.7**
Tomato	Open/irrigated	**724.1**
Okra	Open/irrigated	**630.6**
Cucumber	Green house/ spring	**622.95**
Squash	Open/irrigated/summer	**538.6**
Jewsmallow	Open/irrigated	**527.5**
Potato	Open/Irrigated/winter	**500**
Cauliflower	Open/ Irrigated/Spring	**490.1**
Water melon	Open/ irrigated/	**437.9**
Water melon	Open/ Irrigated	**401.8**
Cucumber	Open/ Irrigated	**355.3**
Onion	Open/Irrigated	**342.3**
Water melon	Open/Irrigated	**335**
Muskmelon	Open/irrigated	**333.1**
Squash	Open/irrigated/Spring	**283.2**
Cauliflower	Open/ Irrigated/Winter	**272.2**
Potato	Open/ Irrigated/Autumn	**269**
Cauliflower	Open/irrigated/Autumn	**175.1**

2. **Tulkarm**

The main twenty one crops grown in Tulkarm were analyzed, and their virtual water summarized in **Table (5.2)**, the values compared ,and as a result the Peach (967.9 m^3/dunum), Apricot (900.6 m^3/dunum) , Avocado (860.35 m^3/dunum), Guava (850.4 m^3/dunum), Tomato(plastic house) (844.7 m^3/dunum), considered as the highest crops in consuming water for their production (highest VW value), while as an average the Potato (260

m^3/dunum),Cauliflower (263.2 m^3/dunum), Cucumber (Open Irrigation) (276.8 m^3/dunum), Broad beans (312.3 m^3/dunum), Onion (325.7 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.2) The Virtual Water of Main Crops Produced in Tulkarm Governorate.

Tulkarm		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Peach	Open/Irrigated	**967.9**
Tomato	Green house/spring	**948.9**
Apricot	Open/Irrigated	**900.6**
Avocado	Open/Irrigated	**860.35**
Guava	Open/Irrigated	**850.35**
Eggplant	Open/Irrigated	**843.8**
Apple	Open/Irrigated	**822.2**
Olive	Open/Irrigated	**757.4**
Calamondin	Open/Irrigated	**754.8**
Lemon	Open/Irrigated	**747.2**
Orange	Open/Irrigated	**740.1**
Grapes	Open/Irrigated	**702.7**
Tomato	Green house/ Summer	**740.9**
Tomato	Open/ Spring	**638.5**
Hot-pepper	Open/Irrigated	**537.2**
Cabbage	Open/Irrigated	**531.3**
Squash	Open/ Spring	**438**
Jews-mallow	Open/Irrigated	**419.4**
Cucumber	Green house/summer	**401.8**
Cucumber	Green house/ Winter	**399.8**
Cauliflower	Open/irrigated/spring	**372.9**
Watermelon	Open/Irrigated	**366.7**
Water melon	Open/Irrigated	**343.7**
Onion	Open/Irrigated	**325.7**
Broad beans	Open/Irrigated	**312.3**
Water melon	Open/Irrigated	**291.7**
Cucumber	Open/Irrigated	**276.8**
Potato	Open/Irrigated/Autumn	**260**
Squash	Open/ irrigated/Autumn	**230.1**
Cabbage	Open/ irrigated/Autumn	**215.7**
Cauliflower	Open/irrigated/Autumn	**153.4**

3. **Qalqilia**

The main sixteen crops produced in Qalqilia analyzed, and their virtual water summarized in **Table (5.3)** , the values compared ,and as a result the Mango(1155m^3/dunum), Peach (967.6 m^3/dunum), Plum (967.6 m^3/dunum), Apricot (900.4m^3/dunum), and Guava (898.8m^3/dunum),respectively considered as the highest in consuming water for their production (highest VW value), while the Thyme(196.6m^3/dunum), Potato (259.8m^3/dunum), Cauliflower (267m^3/dunum), cucumber (open irrigation)(281.2m^3/dunum), and Cabbage (376 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.3) The Virtual Water of Main Crops Produced in Qalqilia Governorate.

Qalqilia		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Mango	Open/Irrigated	**1154.9**
Peach	Green house/spring	**967.6**
Plum	Open/Irrigated	**967.6**
Tomato	Green house/ Spring	**944.3**
Apricot	Open/Irrigated	**900.4**
Guava	Open/Irrigated	**898.8**
Apple	Open/Irrigated	**822**
Calamondin	Open/Irrigated	**740.3**
Orange	Open/Irrigated	**740.3**
Lemon	Open/Irrigated	**732**
Tomato	Green house/summer	**745.6**
Tomato	Open/ Irrigated/Summer	**655.1**
Tomato	Open/ Irrigated/ Spring	**627.8**
Cabbage	Open/Irrigated/ Spring	**534.9**
Cucumber	Green house/ Spring	**449**
Cucumber	Green house/summer	**404.3**
Cauliflower	Open/irrigated/spring	**379.1**
Watermelon	Open/Irrigated/May	**366.7**
Watermelon	Open/Irrigated/April	**343.7**
Tomato	Open/ Irrigated/ Autumn	**336.6**

Broad beans	Open/Irrigated	**310.9**
Watermelon	Open/Irrigated/March	**291.7**
Cucumber	Open/Irrigated	**281.2**
Potato	Open/Irrigated/Autumn	**259.8**
Cabbage	Open/Irrigated/Autumn	**217.1**
Thyme	Open/ Irrigated	**196.6**
Cauliflower	Open/Irrigated/ Autumn	**154.4**

4. **Nablus**

The main Thirteen crops grown in Nablus analyzed, and their virtual water summarized in **Table (5.4)** , the values compared ,and as a result the Date (1148 m^3/dunum), Olive (838 m^3/dunum), Citrus (808 m^3/dunum), Eggplant (793.1 m^3/dunum), and Grapes (680.5 m^3/dunum), considered as the highest in consuming water for their production (highest VW value), while the Cauliflower (243 m^3/dunum), Cucumber (255.8 m^3/dunum), Squash (302 m^3/dunum), Potato (309.7 m^3/dunum), and Broad beans (330.2 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.4) The Virtual Water of Main Crops Produced in Nablus Governorate.

Nablus		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Date	Open/Irrigated	**1147.7**
Olive	Open/Irrigated	**837.5**
Orange	Open/Irrigated	**810.9**
Calamondin	Open/ Irrigated	**810.9**
Lemon	Open/Irrigated	**801.5**
Eggplant	Open/Irrigated	**793.1**
Grapes	Open/Irrigated	**680.5**
Tomato	Green house/Irrigated	**768.1**
Hot-pepper	Open/Irrigated	**584**
Tomato	Open/ Irrigated	**579**
Onion	Open/Irrigated	**414**
Muskmelon	Open/Irrigated	**407**
Broad beans	Open/Irrigated/winter	**406.7**
Squash	Open/Irrigated/winter	**377.7**

Broad beans	Open/Autumn	**330.2**
Potato	Open/irrigated	**309.7**
Cauliflower	Open/Irrigated/winter	**266.5**
Cucumber	Open/Irrigated	**255.8**
Squash	Open/irrigated/Autumn	**226.2**
Cauliflower	Open/irrigated/autumn	**218.6**

5. **Ramallah**

The main five crops grown in Ramallah analyzed, and their virtual water summarized in **Table (5.5)** , the values compared ,and as a result the Tomato (green house) (1047 m^3/dunum), and Eggplant (976.4 m^3/dunum), considered as the highest in consuming water for its production (highest VW value), while the Tomato(open) (494 m^3/dunum), and Squash (587.1 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.5) The Virtual Water of Main Crops Produced in Ramallah Governorate.

Ramallah		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Tomato	Green house/ Spring	**1046.8**
Eggplant	Open/Irrigated	**976.4**
Lemon	Open/Irrigated	**861.3**
Cucumber	Green house/ Irrigated/Spring	**671.8**
Squash	Open/Irrigated	**587.1**
Tomato	Open/Irrigated	**494**

6. **Jerusalem**

The main four crops grown in Jerusalem analyzed, and their virtual water summarized in **Table (5.6)** , the values compared ,and as a result the Tomato(green house)(1306 m^3/dunum), cucumber (green house)(660 m^3/dunum) considered as the highest in consuming water for its production (highest VW value), while the Cauliflower (200.8 m^3/dunum), and cucumber (open) (348 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.6) The Virtual Water of Main Crops Produced in Jerusalem Governorate.

Jerusalem		
Crops	**Planting type**	**Virtual Water (m^3/acre)**
Tomato	Green house/Irrigated	**1306**
Cucumber	Green house/ Irrigated	**660.3**
Squash	Open/Irrigated	**623.3**
Cucumber	Open/Irrigated	**347.8**
Cauliflower	Open/Irrigated	**200.8**

7. **Hebron**

The main seventeen crops grown in Hebron analyzed, and their virtual water summarized in **Table (5.7)** , the values compared ,and as a result the Peach, Plum, and Apricot considered as the highest in consuming water for its production (highest VW value), while the Broad beans (340.2 m^3/dunum), Cauliflower (477 m^3/dunum), cucumber(open)(528 m^3/dunum), Hot pepper (563.2 m^3/dunum), and Squash (578 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.7) The Virtual Water of Main Crops Produced in Hebron Governorate.

Hebron		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Tomato	Green house/Autumn	**1185.9**
Peach	Open/Irrigated	**1088.3**
Plum	Open/Irrigated	**1088.3**
Apricot	Open/ Irrigated	**1015.3**
Eggplant	Open/Irrigated	**993**
Cherry	Open/Irrigated	**966.1**
Apple	Open/Irrigated	**957.9**
Almond/Hard	Open/Irrigated	**943.4**
Grapes	Green house/ Irrigated	**917**
Lemon	Open/Irrigated	**860.7**

Tomato	Green house/Spring	**833.5**
Tomato	Open/ Irrigated	**724**
Jews- mallow	Open /Irrigated	**686**
Cabbage	Open/Irrigated	**641.7**
Cucumber	Green house/Irrigated/spring	**606.75**
Squash	Open/Irrigated	**577.7**
Hot-pepper	Open/Irrigated	**563.2**
Cucumber	Open/Irrigated	**527.7**
Cauliflower	Open/Irrigated	**477**
Broad beans	Open/Irrigated	**340.2**

8. **Bethlehem**

The main nine crops grown in Bethlehem analyzed, and the virtual water for producing summarized in **Table (5.8)** , the values compared ,and as a result the Tomato (plastic house)(1037 m^3/dunum), Grapes (943 m^3/dunum), and Egg plant (925 m^3/dunum), considered as the highest in consuming water for its production (highest VW value), while the Broad beans (349.9 m^3/dunum) , Cauliflower (499.8 m^3/dunum), and cucumber (open) (549.6 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.8) The Virtual Water of Main Crops Analyzed in Bethlehem Governorate.

Bethlehem		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Tomato	Green house/Spring	**1037**
Grapes	Open/Irrigated	**942.9**
Eggplant	Open/Irrigated	**924.7**
Tomato	Open/ Irrigated	**703.4**
Jews-mallow	Open/Irrigated	**702**
Cucumber	Green house	**692**
Hot-pepper	Open/Irrigated	**677**
Cabbage	Open/Irrigated	**654.6**
Cucumber	Open/Irrigated	**549.6**
Cauliflower	Open/Irrigated	**499.8**
Broad beans	Open/Irrigated	**349.9**

9. **Jericho**

The main seventeen crops grown in Jericho analyzed, and their virtual water summarized in **Table (5.9)** , the values compared ,and as a result the Banana (1872.4 m^3/dunum), Date (1563.3 m^3/dunum), Citrus (1132 m^3/dunum), Tomato (green house) (948.2 m^3/dunum), and Grapes (920 m^3/dunum),considered as the highest in consuming water for its production (highest VW value), while the Green beans (172.2 m^3/dunum), Thyme (260 m^3/dunum), Cabbage (293.7 m^3/dunum), cucumber (open irrigated)(299 m^3/dunum), potato and Broad beans (357.3 m^3/dunum), respectively considered as the smallest (smallest VW value).

Table (5.9) the Virtual Water of Main Crops Analyzed in Jericho Governorate

Jericho		
Crops	**Planting type**	**Virtual Water (m^3/dunum)**
Banana	Open/Irrigated	**1872.4**
Date	Open/Irrigated	**1563.3**
Calamondin	Open/Irrigated	**1149.5**
Orange	Open	**1128.8**
Lemon	Open/Irrigated	**1117**
Tomato	Green house/Irrigated/Spring	**948.2**
Grapes	Open/Irrigated	**920**
Tomato	Open/Irrigated	**897.2**
Wheat	Open/Irrigated	**822.8**
Eggplant	Open/Irrigated	**636.3**
Barely	Open/Irrigated	**626.4**
Cucumber	Green house/Irrigated/Winter	**596.8**
Cabbage	Open/Irrigated/winter	**574.3**
Jews mallow	Open/Irrigated	**533.8**
Eggplant	Green house	**489**
Onion	Open/irrigated/spring	**470.1**
Tomato	Open/Irrigated/Autumn	**431.8**
Cucumber	Green house /Irrigated	**425.7**
Cucumber	Green house/irrigated	**409.9**
Tomato	Open/irrigated/autumn	**375.9**

Cauliflower	Open/Irrigated/winter	**360**
Broad-beans	Open/Irrigated	**357.3**
Potato	Open/Irrigated	**357.3**
Cucumber	open/ irrigated	**330.5**
Cabbage	Open/Irrigated/Autumn	**293.7**
Cucumber	Open/Irrigated	**266.8**
Thyme	Open/Irrigated	**260**
Green- beans	Green house/Irrigated/Autumn	**197**
Green- beans	Open/ Irrigated	**147.4**
Water Melon	Open/ Irrigated	**240.7**

The virtual water for crops grown in the previous governorates (Jenin,Tulkarm, Qalqilia, Nablus, Ramallah, Jericho, Hebron, Beithlahem and Jerusalem), were varied from each other, affected by many factors, such as the area and shape of plants, the expansion of salt stomata, numbers of stomata, the amount of water content in cells, the long of growth stage, soil type;(if the soil is hard and impermeable the evapotranspiration will be more than permeable one), irrigation efficiency, and climatic parameters (temperature, sun shine hours, humidity, wind speed), such that if the planting time was in high temperature, high wind speed, or less humidity the evapotranspiration will be higher (higher virtual water), than those grown in low temperature, low wind speed, or high humidity.

To explain the reason for the variety of the virtual water for *a specific crop* from one governorate to another, some examples are explained in the following few lines:-

The average value of temperature and relative humidity in Jenin is less than in Tulkarm, while the wind speed is faster, and thus two factors (less humidity, faster wind speed) in Jenin will be the dominant in increasing the evapotranspiration (increase VW), because the expected results will move toward the most two factors, sometimes with less expectation may less temperature be the dominant for decreasing the value by the comparison with Tulkarm.

Jericho specialized in high temperature, and low humidity comparing to other governorate, although the wind speed is almost high, thus the evapotranspiration for most crops will be high (high virtual water).

As a summary one should realize that there is more than one factor affecting the previous virtual water results that one should think about, while some factors increase the evapotranspiration, others may reduce it according to the number of the dominant factors.

The virtual water of citrus is higher than other (most) types of vegetables and this result is compatible with what founded by Yasser H. Nassar, 2007.

In general the virtual water of vegetables is lower than the virtual water of fruits, and this result is compatible with what founded by Yasser H. Nassar, 2007.

The virtual water of most crops is alittle higher than the quantities of water required for irrigation (assumed by the MOA), because the virtual water did not consider the irrigation quantities only, but it took into consideration the total water requirements and the additional lose, and this reflected the logic of results.

5.2 Financial Analysis

5.2.1 The Planning of Scenario Number One 'Present Water Situation'

The main step was to determine the governorate producing deficit crops with least virtual water, as summarized in **Table (5.10)**

Table (5.10) the Governorate Producing Deficit Crops with Least Virtual Water

Targeted Governorates	Virtual water of Crops (m3/dunum)						
	Orange	**Calamondin**	**Water Melon**	**Date**	**Onion**	**Potato**	**Peach**
Jenin	833.1	x	• 335.3 • 401.8 • 437.9	x	342.3	• 269 • 500	x
Tulkarm	*740.1*	754.8	• 291.7 • 343.7 • 366.7	x	*325.7*	*260*	967.9
Nablus	810.9	810.9	x	*1147.*	414	309.7	
Qalqilia	740.3	*740.3*	• 291.7 • 343.7 • 366.7	x	x	*259.8*	*967.6*
Jericho	1128.8	1149.5	*240.7*	1563.3	452	357.3	x
Hebron	x	x	x	x	x	x	1066.3

The following points can be obtained from **Table (5.10).**

1. Tulkarm has the least virtual water in producing orange, onion and potato.
2. Qalqilia has the least virtual water value in producing calamondin, potato and peach.
3. And Jericho has the least virtual water in producing water melon.

The financial evaluation was an additional aspect considered in this study, to have a complete picture.

The financial analysis suggests comparing the importing cost with the cost of local production of less virtual water governorates.

The table below summarizes the range cost of importing deficit crops mainly from Israel (2012).

Table (5.11): The Average Importing Cost from Israel.

Range of for Importing crops from Israel ($/Kg)						
Orange	Water Melon	Onion	Potato	Calamondin	Date	Peach
0.276	0.276	0.414	0.331	0.552	1.381	0.552
0.359	0.552	0.552	0.663	0.967	1.934	0.829
0.442	0.497	0.691	----------	----------	-------	1.105
0.691	0.967	0.967	----------	-----------	-------	---------

The local production suggests two cases, the first case dealing with present water cubic meter cost, while the second suggests a changeable water cubic meter cost.

Tables below summarize the cost of producing deficit crops locally taking into consideration the changing in water cubic meter cost.

Table (5.12) The Cost of Producing Deficit Crops Locally in Jenin Governorate.

Crops produced and used locally ($/Kg)Cost of				
Water cubic meter cost ($)	Orange	Water melon	Onion	Potato
0.580	0.337	0.210 0.216 0.220	0.672	0.324 & 0.315
0.718	0.370	0.217 0.225 0.230	0.702	0.339 & 0.338
0.856	0.403	0.225 0.235 0.240	0.731	0.354 & 0.361
0.994	0.436	0.233 0.244 0.250	0.761	0.369 & 0.384
1.133	0.468	0.241 0.253 0.260	0.791	0.384 & 0.407
1.271	0.501	0.248 0.262 0.270	0.820	0.398 & 0.430

1.409	0.534	0.256 0.272 0.280	0.850	0.413 & 0.453
1.547	0.567	0.264 0.281 0.290	0..879	0.428 & 0.476
1.657	0.593	0.270 0.288 0.298	0.903	0.440 & 0.494

As noted from the previous table, the local production of orange in jenin at present cubic water cost (0.580 $), cost 0.337 $/kg (1.22 NIS/kg), is acceptable comparing to importing cost (0.276-0.691 $/kg), but as the cost of cubic meter of water will increase over the present cost the importing cost will be in some cases less than the local production cost.

The cost of producing water melon locally is generally more feasible than importing when the cost of cubic water ranges from (0.580-1.657 $).

The onion at present cubic water cost (0.580 $) can be imported in less two cost (0.414 and 0.552 $/kg), than producing locally in Jenin (0.672 $/kg).

Table (5.13) The Cost of Producing Deficit Crops Locally in Tulkarm Governorate.

Crops produced and used locally ($/Kg)Cost of						
Water cubic meter cost ($)	Orange	Water melon	Onion	Potato	Clement	Peach
0.580	0.117	0.206 0.211 0.213	0.232	0.230	0.315	1.076
0.718	0.128	0.212 0.218 0.221	0.242	0.240	0.344	1.228
0.856	0.139	0.219 0.226 0.230	0.251	0.250	0.373	1.379
0.994	0.149	0.226 0.234 0.238	0.261	0.261	0.402	1.531

Producing Potatoes at present cubic meter cost (0.580 $) locally has been preferred over importing, but if the cost of cubic meter increases to be (0.994$), then some of importing cost (0.331$/kg) may be less than producing locally (0.369 and 0.384$/kg).

The expected increase of water cubic meter in Tulkarm governorate ranges from (0.580 to 0.994 $) , whatever the cost changes in this range the local production of orange, water melon, onion, potato , calamondin and peach will be the best.

Table (5.14) The Cost of Producing Deficit Crops Locally in Qalqilia Governorate

Crops produced and used locally ($/Kg)Cost of					
Water cubic meter cost ($)	Orange	Water melon	Potato	Clement	Peach
0.580	0.212	0.154 0.158 0.160	0.322	0.489	0.411
0.718	0.232	0.159\ 0.164 0.166	0.336	0.534	0.470

The expected increase of water cubic meter in Qalqilia governorate ranges from (0.580 to 0.718 $) , whatever the cost changes in this range the local production of orange, water melon, potato , clement and peach in Qalqilia governorate will be the best.

Table (5.15) The Cost of Producing Deficit Crops Locally in Nablus Governorate

Crops produced and used locally ($/Kg)Cost of					
Water cubic meter cost ($)	Orange	Calamondin	Onion	Potato	Date
0.552	0.469	0.602	0.263	0.442	1.286
0.691	0.515	0.661	0.277	0.455	1.444
0.829	0.561	0.720	0.291	0.468	1.603
0.967	0.607	0.779	0.304	0.481	1.761
1.105	0.652	0.838	0.318	0.494	1.920
1.243	0.698	0.897	0.331	0.507	2.078
1.38	0.744	0.956	0.345	0.520	2.237

The cost of producing one kilogram of orange will be more than importing cost at present water cost (0.552 $and more).

The local production cost of onion will be preferable over importing whenever the cost of water cubic meter ranges between (0.552- 1.38$)

Calamondin local production at present water cost (0.552 $) is acceptable, while if the cost of water cubic meter reach (0.691$ and more) the importing cost in most cases will be preferred over local production.

The potato at present water cost (0.522 $), cost (0.442 $/kg), which is higher than imported cost (0.331 $/kg), but if the importing cost reaches (0.663 $/kg), the local production will be more feasible until the water cubic meter cost reaches more than (1.38 $), which is not expected.

Finally, the cost of date at present water cost (0.552 $), equal (1.286 $/kg), which is less than importing cost range (1.381-1.934 $/kg), but if the water cubic meter increases to (0.691 $ and more), the importing cost will be less, but since dates represent a cultural aspects for the Palestinians, the importing issue may not be accepted.

Table (5.16) The Cost of Producing Deficit Crops Locally in Jericho Governorate

Crops produced and used locally ($/Kg)Cost of						
Water cubic meter ($)	Orange	Calamondin	Water melon	Date	Onion	Potato
0.552	0.293	0.983	0.208	1.166	0.376	0.264
0.691	0.331	1.111	0.214	1.332	0.396	0.266
0.829	0.369	1.239	0.220	1.867	0.489	0.288
0.967	0.407	1.368	0.225	1.664	0.438	0.301
1.105	0.445	1.496	0.231	1.830	0.459	0.313
1.243	0.482	1.624	0.236	1.996	0.480	0.325
1.38	0.520	1.752	0.242	2.162	0.501	0.338

Orange local production at present water cost (0.552 $) is acceptable, while if the cost of water cubic meter reach (0.961$ and more) the difference in costs means the importing cost in most cases will be preferred over local production.

Calamondin produced at present water cubic meter cost (0.552 $), costs (0.983 $/kg), which in most cases be more than importing cost.

Water melon produced locally is more useful than importing it, when the cost of water cubic meter ranges between (0.552 – 1.38 $).

The onion local production cost will be the best when the cost of water cubic meter is less than 0.829 $, while if the cost increases over this value the importing will be preferable over local production.

The potato local production will be preferable over importing when the water cubic meter cost ranges between (0.552-1.38 $).

The local production cost of dates at present cubic meter (0.552$) costs was accepted over importing, and the importing will be more feasible if the water cubic meter cost equals 0.829 $ and more.

The financial analysis defines some of West Bank governorates as assistants in solving deficit crops problem. Tulkarm and Qalqilia simply can produced most of deficit crops, Jenin and Jericho can produce some, but Tulkarm and Qalqilia were mainly using the least amount of water to produce those deficit crops (less virtual water), and as the results showed us, both governorates economically did not have a problem in local production, however the expected cost of water changed.

The present amount of water produced and supplied locally (2012), was almost used, and thus it's not logic neither to think about developing additional area for solving deficit problem nor for exporting, the best solution was to use a replacement method, such that instead of having excess high intensive crops, exported to other countries, replaced those excess by deficit crops with low intensive water, and economically feasible.

The following Table (5.17): Summarizes the suggested replacement method.

Governorate	Replacement suggestion	Virtual water (m^3/dunum)	Suggested changeable area, as an example (Dunum)	Production (Kg/dunum)	Effect on Workers
Jenin	Replace the Tomato with potato	• Tomato (1185-818) • Potato (191.7-380.4)	• One dunum Tomato	The Tomato reduced by (22000-20000 Kg) While the potato increased by (2500-3000 Kg)	increased
	Replace the Tomato with water melon	• Tomato(1185-818) • Watermelon (335.3- 437.9)	• One dunum Tomato	The tomato Reduced by (22000 kg), while the water melon increased by (6000 Kg)	increased
Tulkarm	Replace the lemon with orange	• Lemon(747.2) • Orange(740.1)	• One dunum Lemon	The lemon will decreased by (4200 Kg), While the orange will increase by (9600 Kg)	No much effect
	Replace the tomato with clement	• Tomato (948.9) • Clement (754.8)	• One dunum Avocado	The Avocado decreased by (4000 Kg), while the clement will increase by (3600 Kg)	Little decrease
	Replace the Tomato with potato	• Tomato (948.9-638.7)) • Potato (189.6)	• One dunum Tomato	The Tomato will decrease by (4000-18000Kg), while the Potato will increase by (3500 Kg)	increase
	Replace hot pepper by onion	• Hot pepper (537.2) • Onion (325.7)	• One dunum Hot pepper	The Hot pepper will decrease by (2770Kg), while the onion will increase by (4600 Kg)	increase

	Replace tomato (Plastic house) to water melon	• Tomato (948.9-638.7) • Water melon (291.7-366.7)	• One dunum Tomato	The tomato will decrease by (16000 Kg), while the watermelon will increase by (6000)	increase
Qalqilia	Replace the plum by orange	• Plum (967.6) • Orange (740.3)	• One dunum Plum	The Plum will decreased by (2300 Kg), while the orange will increase by (5300 Kg)	Approximately no effect
	Replace the plum by clement	• Plum (967.6) • Clement (740.3)	• One dunum Plum	The plum will decrease by (2300 Kg), while the clement will increase by (2300 Kg)	increase
	Replace the tomato by watermelon	• Tomato (944.3) • Watermelon (291.7-366.7)	• One dunum Tomato.	The tomato will decrease by (19000 kg)while water melon (8000 Kg)	increase
	Replace the tomato with Potato	• Tomato (944.3) • Potato (189.5)	• One dunum Tomato	The tomato will decrease by (19000), while the potato will increase by (2500 Kg)	increase
Jericho	Replace the banana with the Date	• Banana (1872.4) • Date (1563.3)	• One dunum Banana	The Banana will decrease by (4200 Kg), while the date will increase by (1300 Kg)	Approximately no effect
	Replace the lemon by watermelon	• Lemon (1117) • Watermelon (240.7)	• One dunum Lemon	The lemon will decrease by (2300 Kg),while the watermelon will increase by (8000 Kg)	Much increase

1. Jenin

Potatoes and watermelon are the examples of the Palestinians deficit crops which relatively use less water to be produced in jenin rather than other West bank governorates, and local production financially feasible.

The suggestion was to replace one dunum of excess plastic house Tomato, to grow the deficit potato, and one dunum of excess plastic house tomato to grow the deficit watermelon.

The tomato will be replaced since it represents an excess amount related to the statistics (2012), and their virtual water values are higher than other excess crops and both potato and watermelon which were grown in Jenin.

Decreasing one dunum of the tomato means approximately twenty labor will lose their jobs, but at the same time reducing one dunum of tomato may provide sufficient amount of water to produce two to six dunums of potato, and thus if one dunum of tomato will lose twenty labor the new potato lands will employ ten labors per dunum , in other words from twenty to sixty labors .

And deceasing a dunum of tomato, may provide sufficient amount of water to produce one to three dunums of water melon, and thus if one dunum of tomato will lose twenty laborsthe new water melon lands will employ fifteen labors per dunum , in other words forty- five labors for three dunums.

2. Tulkarm

Orange, Calamndin, Onion, Potato and watermelon are the examples of deficit crops which have less virtual water values in Tulkarm comparing to other governorates.

The suggestion was to replace one dunum of excess lemon to grow the deficit orange, one dunum of excess plastic house tomato to grow the deficit calamondin, one dunum of greenhouse tomato to grow the deficit potato, and one dunum of excess Hot-pepper to grow the deficit onion.

The lemon, tomato, and eggplant will be replaced since they represent an excess amount related to the statistics (2012), and their virtual water values are higher than orange, calamondin, potato, onion and other excess crops grown in the same governorate (Tulkarm).

Decreasing one dunum of the lemon means approximately five labors will lose their jobs, but at the same time reducing one dunum of lemon will provide sufficient amount of water to produce one dunum of orange, and thus if one dunum of lemon will lose five labors the new dunum of orange will employ five labors. Decreasing one dunum of tomato will lose twenty labors but instead, the tomato will provide sufficient amount of water to produce one dunum of calamondin, thus if one dunum of tomato will lose twenty labors the new calamondin dunum will employ five labors per dunum, and thus the number of the workers will be reduced but may they work in other suggested crop lands.

Decreasing one dunum of the green house tomato means a approximately twenty labors will lose their jobs, but at the same time reducing one dunum of tomato will provide sufficient amount of water to produce three to five dunums of potato, and thus if one dunum of tomato will lose twenty labors the new potato lands will employ ten labors per dunum, in other words thirty to fifty.

Decreasing one dunum of the tomato means a approximately twenty labors will lose their jobs, but at the same time reducing one dunum of tomato will provide sufficient amount of water to produce one to three dunums of watermelon, and thus if one dunum of tomato will lose twenty labors, the new dunum of water melon will employ fifty labors, in other words forty five labors for three dunums.

Deceasing one dunum of hot- pepper means approximately ten labors will lose their jobs, but at the same time reducing one dunum of hot-pepper may provide sufficient amount of water to produce one and half dunum of Onion, and thus if one dunum of hot-pepper will lose ten labors, the new onion dunum will employ ten labors, in other words ten to fifteen labors.

3. Qalqilia

Orange, Calamondin, Potato and watermelon are the examples of deficit crops which have less virtual water values in Qalqilia comparing to other West Bank governorates.

The suggestion was to replace one dunum of excess Plum to grow deficit orange, one dunum of excess Plum to grow deficit calamondin, one dunum of excess plastic house tomato to grow deficit potato, and one dunum of excess plastic house tomato to grow deficit watermelon.

The Plum, and tomato will be replaced since they represents an excess amount related to the statistics (2012) ,and their virtual water values are higher than orange, calamondin, potato ,watermelon and other excess crops grown in the same governorate (Qalqilia).

Decreasing one dunum of the Plum means approximately six labors will lose their jobs, but in the same time reducing one dunum of Plum will provide sufficient amount of water to produce one dunum of orange, and thus if one dunum of plum will lose six labors the new orange dunum will employ five labors , decreasing one dunum of Plum will provide sufficient amount of water to produce one dunum of calamondin, and will employ five labors per dunum , and thus the workers number will reduced but may they works in other suggested crop lands.

Decreasing one dunum of the green house tomato means approximately twenty labors will lose their jobs, but in the same time reducing one dunum of tomato will provide sufficient amount of water to produce one to three dunums of water melon, and thus if one dunum of tomato will lose tweenty labors the new dunum of water melon will employ fifty labors, in other words thirty labors for three dunums.

Decreasing one dunum of the green house tomato means approximately twenty labors will lose their jobs, but in same time reducing one dunum of tomato will provide sufficient amount of water to produce one to four dunums of potato, thus if one dunum of tomato will lose twenty labors, the new dunum of potato will employ ten labors, in other words forty labors for four dunums.

4. Jericho

Date and watermelon are the examples of deficit crops which have less virtual water values in Jericho comparing to other West Bank governorates. The suggestion was to replace one dunum of banana to grow deficit Date, one dunum of excess lemon to grow deficit watermelon.

The Banana, and Lemon will be replaced since they represents an excess amount related to the statistics (2012) ,and their virtual water values higher than Date, and watermelon, and other excess crops grown in the same governorate (Jericho).

Decreasing one dunum of Banana means approximately ten labors will lose their jobs, but in the same time reducing one dunum of banana will provide sufficient amount of water to produce one dunum of Date, thus if one dunum of banana will lose ten labors, the new dunum of Date will employ approximately ten labors.

Decreasing one dunum of the Lemon means approximately five labors will lose their jobs, but in the same time reducing one dunum of lemon will provide sufficient amount of water to produce one to four dunums of water melon, thus if one dunum of lemon will lose five labors, the new dunum of watermelon will employ fifty labors, in other words sixty labors for four dunums.

Table (5.18) The Proposed Export Crops

Suggested crops	Proposed Planting governorate	Expected Yield (Kg/ dunum)	Virtual water (m3/ dunum)	Mainly Importing country
Potato	Tulkatm	3500	189.6	Jordan
	Qalqilia	2500	189.5	
	Jenin	(2500-3000)	(191.7-380.4)	
Cabbage	Tulkatm	3000	(215.7-531.3)	Jordan
	Qalqilia			
	Jenin	2500	(217.1-534.9)	
Thyme	Qalqilia	2200	196.6	Jordan & Arabs Emirates
Cucumber (Open)	Tulkarm	2250	276.8	Arab Emirate
	Nablus	2100	216.2	
Onion	Tulkarm	2550	325.7	Jordan
	Jenin	1600	342.3	
Hot pepper	Tulkarm Hebron	2770 1159	537.2 563.2	Jordan

5.2.2 The Planning of Scenario Number Two ' the Future Circumstance of Water Resource'.

The future water circumstances will help Palestinians achieving their food self-sufficiency, and they can develop areas of those less intensive crops for exportation**.**

Up to 2012, Palestine had exported different exports, as Avocado, Orange, Onion, Potato, Tomato, Date, Guava, Cucumber, Thyme, pepper, Almond, Lemon, Grapes, Clement, and Cabbage, mainly for Jordan, Israel, Arabs Emirates, and the Gulf, the study results (VW & EA) direct the exportation toward thyme, open cucumber, cabbage, cauliflower and onion (crops with low VW), over Avocado, Guava, Plastic House, see.

5.2.3 Assessing the Strategy of the Palestinian Ministry of Agriculture

The Average Cost of importing those crops suggested to be developed in a strategy summarized in table (5.19).

Table (5.19) The Average Cost of Importing from Israel.

Range of for Importing crops from Israel ($/Kg)				
Mango	Guava	Avocado	Water melon	Musk melon
0.55	1.1	1.1	0.55	0.41
0.83	1.4	1.7	0.97	1.38
1.38	------------	2.2	0.28	---------

Source: Palestinian Ministry of Agriculture, (2012)

The average cost ($/Kg) of producing proposed crops locally summarized in table (5.20).

Table (5.20) The Cost Of Producing Proposed Crops Locally.

Target Governorate	Crop Type	Virtual water (m^3/dunum)	Cost of water cubic meter ($)	Cost of local production ($/kg)
Tulkarm	Mango	1154.7	0.580	0.592
			0.718	0.645
			0.856	0.698
			0.994	0.751
	Avocado	860.4	0.580	0.625
			0.718	0.655
			0.856	0.685
			0.994	0.715
	Water melon	333.8	0.580	0.218
			0.718	0.226
			0.856	0.234
			0.994	0.242
Qalqilia	Mango	1154.4	0.580	0.480
			0.718	0.523
	Guava	878.1	0.580	0.650
			0.718	0.705
	Avocado	860.1	0.580	0.5
			0.718	0.524
	Watermelon	334	0.580	0.164
			0.718	0.17
Jericho	Water melon	240.7	0.552	0.209
			1.38	0.242

Guava, mango, and Avocado represent some of suggested crops, and the analysis in section (5.1.1) showed that those crops have a high virtual water, but at the same time the local production is almost economically feasible than importing, and thus, at present water situation we can focus on producing the quantities required for our self-sufficiency, without export.

Water melon has less virtual water and it has an economic benefit to be produced locally rather than importing.

In future, and if Palestine goes as a state the exportation of the Mango, Guava, and Avocado, will not be benefit because of their high virtual water value, while water melon will be an effective export crops, because of its low virtual water value.

5.2.4 The Virtual water of Main Livestock

The total virtual water consists of two terms, the first term$(VWC)_{pal}$, represents the partial amount of VWC ,used from Palestinian water resources to breed animals like (drinking, servicing, and some feed type like clover ,which sometimes obtained from Jenin Governorate). While the other term $(VWC)_{out}$, represents the virtual water of some kinds of feeding like barely, wheat, and soya beans, importing from outside countries, mainly Ukraine.

The tables below summarize the virtual water for main live stock bred in West bank governorate.

1. Beef cattle

The virtual water of beef cattle analyzed for main breeding governorate; Hebron, Jenin, Nablus and Tulkarm respectively, summarized in the following tables.

Table (5.21) The Virtual Water of Beef Cattle (Calves) Breeding in Nablus.

Nablus		
Drinking	m^3/animal	48.1
servicing	m^3/animal	24.04
feeding	m^3/animal	12719
Drinking +Servicing	m^3/animal	72.14
Total Virtual Water	m^3/animal	12791
VWC	m^3/ton	**28425**
VWC pal*	m^3/ton	**2098**

Table (5.22) The Virtual Water of Beef Cattle Breeding In Jenin.

Jenin		
drinking	m^3/animal	48.2
servicing	m^3/animal	24.12
feeding	m^3/animal	12719
Drinking + Servicing	m^3/animal	72.32
Total Virtual Water	m^3/animal	12791.3
VWC	m3/ton	**28425**
VWC pal	m3/ton	**2098**

Table (5.23) The Virtual Water of Beef Cattle Breeding in Hebron

Hebron		
Drinking	m^3/animal	43.29
Servicing	m^3/animal	21.64
Feeding	m^3/animal	12719
Drinking + Servicing	m^3/animal	64.93
Total	m^3/animal	12784
VWC	m3/ton	**28409**
VWC pal	m3/ton	**2082**

Table (5.24) The Virtual Water of Beef Cattle Breeding inTulkarm

Tulkarm		
drinking	m^3/animal	45.86
servicing	m^3/animal	22.93
feeding	m^3/animal	12719
Drinking + Servicing	m^3/animal	68.79
Total Virtual Water	m^3/animal	12788
VWC	m3/ton	**28417**
VWC pal	m3/ton	**2091**

The difference of virtual water (VW_{pal}) is around sixteen cubic meters per ton between beef cattle bred in Hebron, and beef cattle breeding in the other studied governorates (Nablus, Jenin, and Tulkarm). The Primary and secondary products of beef cow, analyzed to determine their Virtual water a summarized in the following tables.

Table (5.25) Virtual Water of Beef Cow Products, in Nablus and Jenin Governorates.

Nablus and Jenin			
Product	**Unit**	**Virtual water**	**Virtual Water($_{pal}$)**
CARCASS	m^3/ton	47573	3527
Carcass frozen	m^3/ton	47573	3527
Bovine cut bone	m^3/ton	47573	3527
MEAT CURED	m^3/ton	48549	3604
OFFAL	m^3/ton	26810	1988
RAW SKIN	m^3/ton	29856	2213

Table (5.26) Virtual Water Value of Beef Cow Products, in Hebron.

Hebron			
Product	**Unit**	**Virtual water**	**Virtual Water($_{pal}$)**
CARCASS	m^3/ton	47547	3500
Carcass frozen	m^3/ton	47547	3500
Bovine cut bone	m^3/ton	47547	3500
MEAT CURED	m^3/ton	48522	3577
OFFAL	m^3/ton	26795	1973
RAW SKIN	m^3/ton	29840	2197

Table (5.27) Virtual Water Value of Beef Cow Products, in Tulkarm.

Tulkarm			
Product	**Unit**	**Virtual water**	**Virtual Water($_{pal}$)**
CARCASS	m^3/ton	47561	3515
Carcass frozen	m^3/ton	47561	3515
Bovine cut bone	m^3/ton	47561	3515
MEAT CURED	m^3/ton	48537	3591
OFFAL	m^3/ton	26803	1981
RAW SKIN	m^3/ton	29849	2206

The virtual water of carcass produced in Hebron lowered by twenty seven cubic meters per ton, than carcass produced in Nablus and Jenin. And fifteen cubic meters per ton for those produced in Tulkarm.

The virtual water of meat cured produced in Hebron lowered by twenty seven cubic meters per ton, than meat cured produced in Nablus and Jenin. And fourteen cubic meters per ton for those produced in Tulkarm.

The virtual water of offal produced in Hebron lowered by fifteen cubic meters per ton, than offal produced in Nablus and Jenin. And eight cubic meters per ton for those produced in Tulkarm.

Finally, the raw skin virtual water produced in Hebron lowered by sixteen cubic meters per ton, than those produced in Jenin and Nablus, and nine cubic meters per ton for those produced in Tulkarm.

The virtual water of beef cattle in Hebron is less than those in Tulkarm, Jenin, and Nablus respectively, and since each primary and secondary product obtained from the total virtual water of beef cattle, as a result the less beef cattle virtual water produces less products virtual water.

As noted in the previous table generally, the virtual water decreased as we move from meat cured, carcass, raw skin and offal respectively.

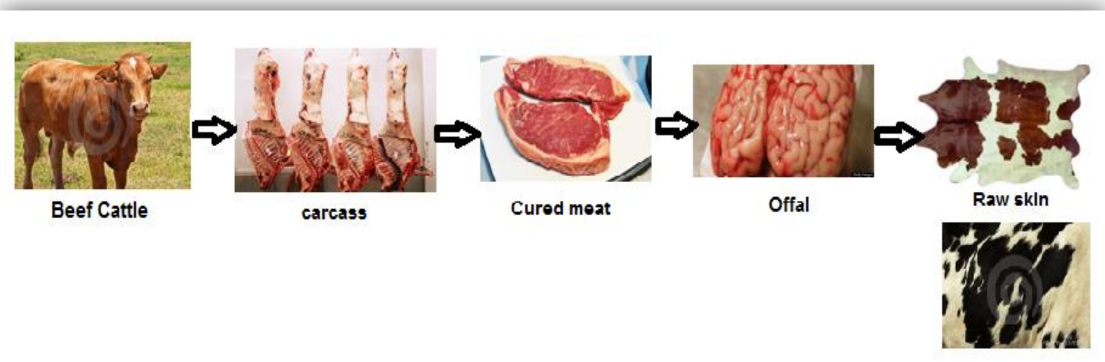

Figure (5.1): Beef cattle and Their Primary and Secondary Products.

2. Dairy cow

The virtual water of Dairy cow analyzed in main breeding governorate, and summarized in the following tables

Table (5.28) The Virtual Water of Dairy Cow in Hebron Governorate

Hebron		
drinking	m^3/animal	123.3
servicing	m^3/animal	61.65
feeding	m^3/animal	35252
Drinking + Servicing	m^3/animal	18495
VWC	m^3/animal	35437
VWC pal	m^3/ton	2349

Table (5.29) The Virtual Water of Dairy Cows Products, Breeding in Nablus Governorate.

Nablus		
drinking	m^3/animal	133.5
servicing	m^3/animal	66.75
feeding	m^3/animal	35252
Drinking + Servicing	m^3/animal	200.3
VWC	m^3/animal	**35452**
VWC pal	m^3/ton	**2383**

Table (5.30) The Virtual Water of Dairy Cows Products, Breeding in Jenin Governorate.

Jenin		
drinking	m^3/animal	142.6
servicing	m^3/animal	71.3
feeding	m^3/animal	35252
Drinking + Servicing	m^3/animal	213.9
VWC	m^3/animal	**35466**
VWC pal	m3/ton	**2413**

As noted in the previous table Hebron dairy cow virtual water is smaller than Nablus and Jenin.

The virtual water in primary and secondary products summarized in the following table, (as an example Hebron)

Table (5.31) The Virtual Water of Dairy Cows Products, Breeding inHebron Governorate.

Product	Unit	Virtual water	Local virtual water*
RAW MILK	m^3/ton	1349	89
Milk not concentrated and un sweetened, not exceeding 1% fat	m^3/ton	1461	106
Milk not concentrated and unsweetened exceeding 1%, not exceeding 6% fat	m^3/ton	1461	106
Milk and cream not concentrated and un sweetened exceeding 6% fat94	m^3/ton	2718	198
Milk and cream nes sweetened	m^3/ton	1354	94
Milk powder not exceeding 1.5% at	m^3/ton	6795	495
Milk and cream powder sweetened exceeding 1.5% fat	m^3/ton	6795	495
Milk and cream powder sweetened exceeding 1.5% fat	m^3/ton	1359	99
Cheese, fresh (including whey cheese) unfermented and cured	m^3/ton	4893	356

Cheese, grated or powder, of all kinds	m^3/ton	2157	157
Cheese processed, not grated or powdered	m^3/ton	2157	157
Cheese nes	m^3/ton	2157	157
MEAT	m^3/ton	5300	358
CARCASS	m^3/ton	8969	606
Carcass frozen	m^3/ton	8969	606
Cut bone	m^3/ton	8969	606
Meat cured	m^3/ton	8974	611
OFFAL	m^3/ton	4618	312
RAW SKIN	m^3/ton	5477	370

The carcass and some milk products in dairy cow have higher virtual water than raw skin, meat, and offal, respectively. For more detail see **APPENDIX (6).**

Figure (5.2): Dairy Cow and Their Primary and Secondary Products.

3. Sheep

The virtual water of sheep analyzed in main breeding governorate, and summarized in the following tables.

Table (5.32) The Virtual Water of Sheep, Breeding in Nablus Governorate.

Nablus		
drinking	m^3/animal	8.1
servicing	m^3/animal	4.05
feeding	m^3/animal	1414.9
Drinking + servicing	m^3/animal	12.15
VWC	m^3/ton	**26927**
VWC pal	m^3/ton	**229**

Table (5.33) The Virtual Water of Sheep, Breeding in Jenin Governorate.

Jenin		
drinking	m^3/animal	9.2
servicing	m^3/animal	4.6
feeding	m^3/animal	1414.9
Drinking + Servicing	m^3/animal	13.8
VWC	m^3/ton	**26958**
VWC pal	m^3/ton	**260**

Table (5.34) The Virtual Water of Sheep Breeding in Hebron Governorate

Hebron		
drinking	m^3/animal	4.54
servicing	m^3/animal	2.27
feeding	m^3/animal	1414.9
Drinking +Servicing	m^3/animal	6.81
VWC	m^3/ton	**26826**
VWC pal	m^3/ton	**128**

Table (5.35) The Virtual Water of Sheep Breeding in Ramallah Governorate.

Ramallah		
Drinking	m^3/animal	8.1
servicing	m^3/animal	4.05
Feeding	m^3/animal	1415
Drinking + servicing	m^3/animal	12.15
VWC	m^3/ton	**26927**
VC pal	m^3/ton	**229**

As noted in previous table Hebron sheep virtual water is the smaller than Nablus, Ramallah and Jenin.

Virtual water of primary and secondary sheep products Produced summarized in the following tables.

Table (5.36) The Virtual Water of Sheep Products in Hebron Governorate.

Product	**Unit Unit**	**Virtual water**	**Local virtual water, (VW_p)**
CARCASS	m^3/ton	32519	211
Carcass frozen	m^3/ton	32524	216
Sheep cut bone	m^3/ton	32524	216
OFFAL	m^3/ton	19416	126
RAW SKIN	m^3/ton	31119	202
Raw skin pickeld	m^3/ton	32762	218
Skin vegetable pretanned	m^3/ton	36425	264
Retanned	m^3/ton	36425	264
Skin leather	m^3/ton	36425	264
Raw skin without pickeld	m^3/ton	32757	212

Table (5.37) The Virtual Water of Sheep Products Breeding in Nablus and Ramallah Governorates.

Product	Unit	Virtual water
CARCASS	m^3/ton	32674
Carcass frozen	m^3/ton	32679
Sheep cut bone	m^3/ton	32679
OFFAL	m^3/ton	11508
RAW SKIN	m^3/ton	31267
Raw skin pickeld	m^3/ton	32918
Skin vegetable pretanned	m^3/ton	36597
Retanned	m^3/ton	36597
Skin leather	m^3/ton	36597
Raw skin without pickeled	m^3/ton	32912

As noted the pretended skin has a higher virtual water than the raw, the reason that the tanning process consume additional amount of water.

The Virtual water in primary and secondary products summarized in the following table, (Jenin)

Table (5.38) The Virtual Water of Sheep Products, Breeding in Jenin Governorate.

Product	Unit	Virtual water
CARCASS	m^3/ton	32721
Carcass frozen	m^3/ton	32726
Sheep cut bone	m^3/ton	32726
OFFAL	m^3/ton	19537
RAW SKIN	m^3/ton	31312
Raw skin pickeld	m^3/ton	32965
Skin vegetable pretanned	m^3/ton	36650
Retanned	m^3/ton	36650
Skin leather	m^3/ton	36650
Raw skin without pickeled	m^3/ton	32960

As noted in previous table regardless of governorate the carcass has the higher virtual water than raw skin, and offal respectively.

Figure (5.3): Sheep and their Products

4. Goats

The virtual water of Goats analyzed in main breeding governorate, and summarized in the following tables.

Table (5.39)The Virtual Water of Goats Breeding in Hebron Governorate

Hebron	**Unit**	**Quantity**
Drinking	m3/animal	4.29
Servicing	m3/animal	2.15
Feeding	m3/animal	865.4
VWC	m3/ton	**21796**
VWC pal	m3/ton	161

Table (5.40)The Virtual Water of Goat Breeding in Jenin Governorate

Jenin	Unit	Quantity
Drinking	m3/animal	5.13
Servicing	m3/animal	2.56
Feeding	m3/animal	865.4
VWC	m3/ton	**21827.2**
VWC pal	m3/ton	192.3

Table (5.41) The Virtual Water of Goat Breeding in Jericho Governorate

Jericho		
Drinking	m^3/animal	5.13
Servicing	m^3/animal	2.56
Feeding	m^3/animal	865.398
VWC	m^3/ton	**21827.2**
VWC pal	m^3/ton	192.25

The virtual water in primary and secondary goat products summarized in the following tables (5.43).

Table (5.42) The Virtual Water of Goat Products in Hebron Governorate.

Product	Unit	Virtual wate	Actual virtual water
MEAT	m^3/ton	35326	277
RAW SKIN	m^3/ton	50699	398
Leather vegetab pretend	m^3/ton	56354	464

Table (5.43) The Virtual Water of Goat Products in Jenin and Jericho Governorates.

Product	Unit	Virtual water	Local virtual water *
MEAT	m^3/ton	35376	327
RAW SKIN	m^3/ton	50771	470
Leather vegetab pretend	m^3/ton	56435	544

As noted below the raw skin has higher virtual than the meat regardless to the governorates.

Generally the weight of sheep is more than goat, regardless both almost consume the same water quantities for drinking and servicing, thus the (VWp) for sheep is less than goat, while if we look at the whole virtual water (VWC), the results reflected because the feed contained in calculations and sheep consumes higher quantities than goat, although the feed type is almost the same.

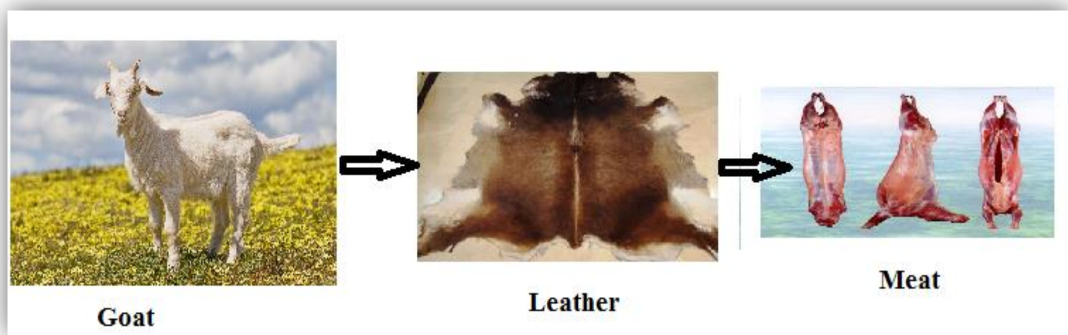

Figure (5.4): The Goat and their Products

5. Laying Hens

The virtual water of laying hens analyzed in main breeding governorates, and summarized in the following tables.

Table (5.44) The Virtual Water of Laying Hens Breeding in Hebron Governorate

Hebron	Unit	Quantity
Drinking	m3/animal	0.14
Servicing	m3/animal	0.07
Feeding	m3/animal	58
Sum	m3/animal	**58.25**
VWC	m3/ton	**58**
sum/p	m3/ton	0.21

Table (5.45) The Virtual Water of Laying Hens Breeding in Ramallah Governorate

Ramallah	Unit	Quantity
Drinking	m3/animal	0.1
Servicing	m3/animal	0.05
Feeding	m3/animal	58
Total VWC	m3/animal	**58.19**
VWC	m3/ton	**58**
VWC pal	m3/ton	**0.15**

Table (5.46) the Virtual Water of Laying Hens Breeding in Tulkarm Governorate

Tulkarm	Unit	Quantity
drinking	m3/animal	0.24
servicing	m3/animal	0.12
Feeding	m3/animal	58
Sum	m3/animal	**58.40**
VWC	m3/ton	**58**

Virtual Water in primary and secondary products summarized in the following table (5.48), (Hebron, Ramallah, and Tulkarm).

Table (5.47) The Virtual Water of Laying Hens Product in Hebron, Ramallah & Tulkarm Governorates.

Product	Unit	Total Virtual water	Local Virtual water, (VW_{pal})
EGG	m^3/ton	1550	10
Egg yolk	m^3/ton	3110	29
Egg (not in shell)	m^3/ton	1723	12
Egg yolk dried	m^3/ton	3888	36
Egg (Not in shell) dried	m^3/ton	2298	16
CARCASS	m^3/ton	1996	13
MEAT	m^3/ton	2572	29

6. Broiler chicken

The virtual water of Broiler chicken analyzed in main breeding governorate, and summarized in the following tables.

Table (5.48) The Virtual Water of Broiler Chicken and Their Products in Hebron, Ramallah, and Nablus.

Hebron &Ramallah & Nablus		
	Unit	**Virtual water**
Drinking	**m3/**/animal	5
Servicing	**m3/**/animal	2
Feeding	**m3/**animal	5364
VWC	**m3/animal**	**5371**
VWC / Palestine	**m3/**/animal	**7**
Distribution of virtual water content of broilers of its product		
Live weight	Kg	2.2
Dressed weight	Live weight **-** (30/100)	1.9
Product fraction (Pf)	Dressed weight/ Live weight	0.86
Value fraction, Vf		1
Virtual water content of broiler meat	**VWCa*Vf/Vp**	**6219 m3/ton**

Table (5.49) : The Virtual Water of Broiler Chicken and their Products in Jenin and Tulkarm Governorates.

Jenin & Tulkarm		
	Unit	Virtual water
Drinking	**m3**/animal	14
Servicing	**m3/animal**	8
Feeding	**m3/animal**	5364
VWC	**m3/animal**	**5372**
VWC / Palestine	**m3/animal**	**22**
Distribution of virtual water content of broilers of its product		
Live weight	Kg	2.2
Dressed weight	Live weight **-** (30/100)	1.9
Product fraction (Pf)	Dressed weight/ Live weight	0.86
Value fraction, Vf		1
Virtual water content of broiler meat	**VWCa*Vf/Vp**	**6220 m3//ton**

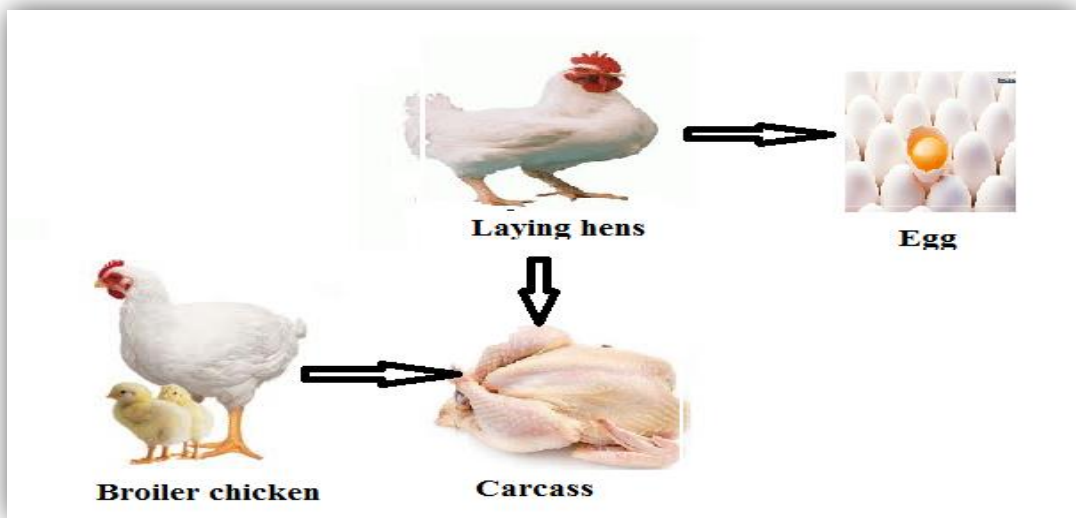

Figure (5.5): Laying hens and Broiler Chicken with Their Primary and Secondary Products

In most cases the virtual water of live stock is smaller than its products, because the products require additional water for processing to have their final form for using.

Generally as the virtual water affected by the type and size of animal, the quantities of water needed for drinking and servicing, type of feed, and the origin of producing feed are large.

The animal virtual water was larger than crops virtual water and this result compatible with what founded by Mekonen and Hoekstra, 2010.

The virtual water of meet beef was higher than sheep, goat, and chicken, in addition, the virtual water of chicken egg is higher than cow milk, and these results were compatible with what founded by Mekonen and Hoekstra, 2010,

Chapter Six

Conclusions and Recommendations

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Conclusions and Recommendation

6.1 Conclusions

This study shows the following findings:

1. The concept of virtual water can easily applied in Palestine, since it does not require high technology, and it does not connect with the political conflict.
2. The virtual water concept has a positive effect on saving the Palestinian water resources.
3. In most cases the virtual water concept has appositive effect on the Palestinian employment level.
4. The virtual water of the same product is different in the same governorate itself and from one governorate to another.
5. The present exportation pattern contains products with high virtual water value, and so there will be a negative effect on our water resources.
6. The strategy of the Palestinian Ministry of Agriculture focuses on developing some of high intensive products, as Mango, Guava, and Avocado.
7. The crops grown in green house have higher virtual water, than those in open irrigated system.
8. The virtual water of livestock is higher than crops.

9. In most cases the production of specific crops in mountain and plain governorates had less virtual water comparing to those valley governorate.

6.2 Recommendations

The following recommendations can be addressed

1. It is important to consider the concept of virtual water, and the economic analysis before any production development strategy (Ministry of agriculture).
2. It is recommended to focus generally on developing those governorates using less water in producing specific less intensive products (Ministry of agriculture).
3. Reduce the exportation of Citrus, plastic production, grapes, Guava and Avocado, because of their high virtual water values, comparing to other crops (Ministry of agriculture and Ministry of National Economy).
4. It is recommended to focus on the present water situation on self-sufficiency of those low intensive products, rather than exporting high intensive products (Ministry of agriculture).
5. In future water situation, the self-sufficiency will be the main target, in addition to developing quantities of low intensive products, as onion, potato, hot pepper, cabbage etc.., for exportation (Ministry of agriculture) .
6. It is recommended to adopt the concept of virtual water in Palestine as one method for managing water resource, but that does not mean

to forget our rights in water resources (Palestinian negotiations committee).

7. Additional studies concerning economic analysis for livestock should be applied.
8. Supplementary studies concerning the effect of a adopting the concept of virtual water on the social aspects except what discussed in this research (employment rates) should be applied.

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Appendices

Appendix One

1. Rain fall quantity in the West Bank by month and station location, (mm)

JENIN	**2011**	**2010**	**2009**	**2008**	**2007**	**2005**	**2004**	**For Previous 25 year**	**Avg**
Jan	93.5	70.9	28.1	101.5	30.1	116.1	175.9	101	**89.64**
Feb	107.7	125.3	214.7	74.3	53.3	141.5	94.6	99.8	**113.90**
March	92.8	16.4	47.8	11.1	51.9	19.5	8.1	70.7	**39.79**
April	37.4	0.4	7	0	4	3	15.1	14.3	**10.15**
May	6.5	1	0	1	0	9.8	1	2.4	**2.71**
Jun	0	1.1	0	0	0	0	0	0.7	**0.23**
July	0	0	0	0	0	0	0	0	**0.00**
Aug	0	0	0	0	0	0	0	0	**0.00**
Sep	0.4	0	0	5	0	0	0	0	**0.68**
Octo	0	4.5	58.1	15.3	0	21.7	0	14.3	**14.24**
Nov	88.8	0	88.6	17.8	70.5	42.6	86.2	58	**56.56**
Dec	32.2	116.9	148.8	58.8	22.7	76.9	43.9	107	**75.90**

Tulkarm	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**For Previous 25 year**	**Avg**
Jan	131.4	73.8	22.7	77.8	102.2	35.3	218.8	240.8	110.9	122.30
Feb	96.9	153.7	151.5	104	162	44.5	139.9	89.3	103.5	125.10
March	78.8	42	105.9	10.5	74.3	35	17.1	17.8	86.6	54.13
April	39.2	0	6.2	0	3.7	3.2	4.8	6	18.2	9.76
May	4.3	4.8	0	2.1	8.5	0	0	0.5	3.7	2.99
Jun	0	0	0	0	0	0	0	0	0.1	0.01
July	0	0	0	0	0	0	0	0	0	0.00
Aug	0	0	0	0	0	0	0	0	0	0.00
Sep	7.5	0	5.2	10.5	0.6	0	0	0	0	2.98
Octo	2.1	2	63.7	18.3	0.5	20	7.7	3	25.9	15.40
Nov	127.4	0	130.2	32.7	148.3	12.2	56.6	127.1	90.3	89.08
Dec	33.5	115.6	142.5	151	82	70	140.9	62.8	162.1	111.30

Nablus	2011	2010	2009	2008	2007	2006	2005	2004	For Previous 25 year	Avg
Jan	100.1	89.6	51.2	157.7	105.6	43.3	239.8	230	141.1	**139.39**
Feb	96.8	249.7	210.4	104.7	174.9	38	267.6	136.2	146.9	**173.40**
March	129.1	12.8	82.9	6	116.6	41.8	37.3	24.2	104	**64.11**
April	57.8	0.1	14.1	0	8.2	*	9.4	11.1	20.2	**15.11**
May	25.7	0	0	0	4.9	0	2.3	1.2	7.8	**5.24**
Jun	0	0	0	0	0	0	0	0	0	**0.00**
July	0	0	0	0	0	0	0	0	0	**0.00**
Aug	0	0	0	0	0	0	0	0	0	**0.00**
Sep	0	0	2.2	11	0	0	0	0	1.8	**1.88**
Octo	4	5.3	30	23.3	0.1	40	10.5	0.4	20.7	**11.79**
Nov	160.7	0	83.7	4.2	85.3	19.5	56.4	152.8	77.1	**77.53**
Dec	34.1	151.1	102.4	153.3	78.4	105	167.2	82.6	140.5	**113.70**

Ramallah	2011	2010	2009	2008	2007	2006	2005	2004	For Previous 25 year	Avg
Jan	109.5	113.7	30	224.8	81.2	167.3	221.6	112	143.1	**133.7**
Feb	94.8	248.5	224	144.4	130.4	130.4	235.2	122.5	117.7	**164.69**
March	82.2	35.1	98.1	1.5	146.1	144.6	42.1	15.4	96.1	**64.58**
April	51.8	3.7	4.2	0.7	5	*	14.8	3.2	26.9	**13.79**
May	3.1	0.6	0	0	16.2	0	0.5	3.1	3.6	**3.39**
Jun	0	0	0	0	0	0	0	0	0.3	**0.04**
July	0	0	0	0	0	0	0	0	0	**0.00**
Aug	0	0	0	0	0	0	0	0	0	**0.00**
Sep	2.8	0.2	0.7	10.2	0	0	0	0	0.3	**1.78**
Octo	0.2	8.9	28.2	26	1	47.8	19.5	12.8	18.3	**14.36**
Nov	95	0	81.5	11.5	106.5	24	57.1	179.2	63.8	**74.33**
Dec	86.7	91.4	108.5	84.5	57.5	144	120.8	76.1	155.3	**97.60**

JERICO	2011	2010	2009	2008	2007	2006	2005	2004	For Previous 25 year	Avg
Jan	22.2	36.8	8.7	52.5	23.5	23.5	43.1	29.8	35.8	**31.55**
Feb	17.2	57	57.8	34.3	22.5	22.5	18.3	23.1	31.2	**32.68**
March	10.3	6.4	7.8	0	26.4	31.4	12.5	8.6	24.7	**12.09**
April	16.7	0.3	0.3	0	8.2	*	1.7	1.7	10.3	**4.90**
May	3	1.2	0	0	0	0	0	2.1	1.9	**1.03**
Jun	0	0	0	0	0	0	0	0	0	**0.00**
July	0	0	0	0	0	0	0	0	0	**0.00**
Aug	0	0	0	0	0	0	0	0	0	**0.00**
Sep	10.8	0	0	0.2	0	0	0	0	7.1	**2.26**
Octo	0	0	5.1	20	0.2	9.5	0.5	7.6	21.6	**6.88**
Nov	15.6	0	11.6	6.2	19.9	5.8	12.1	26	33.4	**15.60**
Dec	3.2	22.5	24.4	5.6	14.5	36.8	28.8	29.6	166	**36.83**

Hebron	2011	2010	2009	2008	2007	2006	2005	2004	For Previous 25 year	Avg
Jan	107.4	131.2	1.2	151.1	153.1	46	153	182.6	133.6	**126.65**
Feb	93.2	146.8	189.8	108.8	109	32.2	118.3	97.7	141.6	**125.65**
March	38.2	14.9	83.9	0.6	103.2	47.2	49	24.1	91.7	**50.70**
April	28.9	2.2	12.3	0	9.4	*	12.7	1.8	25.4	**11.59**
May	3.5	0	0	0	5.8	0	0	0	4.7	**1.75**
Jun	0	0	0	0	0	0	0	0	0.5	**0.06**
July	0	0	0	0	0	0	0	0	0	**0.00**
Aug	0	0	0	0	0	0	0	0	0	**0.00**
Sep	1	0.4	1.8	7.8	0	0	0	0	1.6	**1.58**
Octo	0.1	9.6	17	35.2	0	9.2	10.4	4.2	14.6	**11.39**
Nov	42.9	0	38.6	22.5	23.4	13	48.3	211.2	66.7	**56.70**
Dec	60.3	88.6	73.6	50.3	43.9	66	84.2	49.2	115.5	**70.70**

Bitlahem	2011	2009	2006	2005	2003	2002	2001	Avg
Jan	75.2	15.4	107.3	82.7	27	64.7	259.5	**90.26**
Feb	87.1	188	93.3	71.8	41.5	237.4	52	**110.16**
March	46.8	106	86.5	12	8	130.3	*	**64.93**
April	23.6	1.2	0	107.2	0	26	*	**26.33**
May	10	0	0	0	0	0	*	**1.67**
Jun	0	0	0	0	0	0	0	**0.00**
July	0	0	0	0	0	0	0	**0.00**
Aug	0	0	0	0	0	0	0	**0.00**
Sep	4	7.4	0	0	0	0	0	**1.63**
Octo	0	12.8	19	11.8	2	10.2	4	**8.54**
Nov	88	38.4	10	36.7	11	21.2	67	**38.90**
Dec	71	59.6	112.2	113.8	90	202.1	123	**110.24**

Jerusalem	2012	2011	2010	2009	2003	2002	2001	Avg
Jan	140.9	71.3	96.5	134.1	150.8	93.5	249.3	**133.77**
Feb	209.8	74.5	193.3	117.7	122.5	319.5	51.3	**155.51**
March	165	70.5	13.8	96.1	21.6	195.6	71	**90.51**
April	1.1	28	4.8	26.1	3.2	31.6	44.5	**19.90**
May	0.3	5.4	4.2	3.6	2.8	0	0	**2.33**
Jun	0.9	1.7	0.3	0.3	0	0	0	**0.46**
July	1.8	0.9	0.6	0	0	0	0	**0.47**
Aug	1.4	5.2	2.2	0	0	0	0	**1.26**
Sep	3.9	6.6	1.5	0.3	0	0	0	**1.76**
Octo	1.8	3.9	4.7	18.3	1.9	9.5	6.5	**6.66**
Nov	46.8	125.8	0.3	63.8	41.6	23.5	48.4	**50.03**
Dec	95.9	94.5	71.3	155.3	159.3	159.8	152.1	**126.89**

QALQILIA	2006	2003	2002	2001	Avg
Jan	83.3	186.5	94	217	145.20
Feb	125.1	125.6	293	35	144.68
March	103.6	0	178	108	97.40
April	1.2	0	14	27	10.55
May	2	0	0	7	2.25
Jun	0	0	0	0	0.00
July	0	0	0	0	0.00
Aug	0	0	0	0	0.00
Sep	0	0	0	0	0.00
Octo	76	0	36	57	42.25
Nov	42.7	42.7	13	135	58.35
Dec	132.9	113.3	182	160	147.05

2. Minimum average temperature in theWest Bank by month and station location, (C^0)

Jenin	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	9.6	10.4	8.3	5.9	8.2	8.7	8.4	6.8	**9.14**
Feb	10.1	10.5	10	8.1	9.3	8.8	8.9	7.1	**9.99**
March	10.3	12.9	10.6	13.2	10.4	11.2	12.1	8.6	**12.24**
April	13.8	14.3	13.4	15.5	13.5	14.5	13.1	11.2	**15.06**
May	16.8	18	17.4	16.5	18.1	17.1	17.2	14	**18.64**
Jun	20.6	21.4	21.5	20.9	21.1	20.6	20.6	17.3	**22.66**
July	23.2	23.9	24.2	23.4	23.3	23.1	22.8	19.6	**25.39**
Aug	24.3	25.8	24.2	24.2	23.8	24.1	23.4	21.1	**26.50**
Sep	22.5	23.8	22.2	22.7	23.1	21.9	21.7	19.8	**24.69**
Octo	18.5	20.9	20.4	18.7	20.5	18.1	20	16.1	**21.16**
Nov	11	15.6	13.2	14	14.3	12.9	13.4	11.8	**14.75**
Dec	8.4	10.7	11.6	10.1	13	10.7	7.9	8.7	**11.23**

Tulkarm	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	11.5	12.7	11.6	7.7	9.2	8.9	9.8	8.6	**10.00**
Feb	11.2	13.9	11.2	9.7	9.9	8.3	9.7	8.7	**10.33**
March	12.1	14.4	11.6	14.1	10.6	10.5	12	10.8	**12.01**
April	14	15.1	14.5	16.8	13.9	13.1	13.3	13.8	**14.31**
May	18	18.1	17.7	17.7	17.8	15.7	17.1	15.9	**17.25**
Jun	19.5	21.7	21.5	21.9	21	20.5	20.3	19.4	**20.73**
July	23.5	24	24.3	23.2	23.7	23.8	22.4	22.1	**23.38**
Aug	24.7	26	24.7	24.6	24.2	24.8	22.7	22.7	**24.30**
Sep	23.4	24.3	22.7	23.2	24.3	22.8	21.4	21.2	**22.91**
Octo	20.6	21.5	21.2	19.8	20.9	19.7	18.7	19.2	**20.20**
Nov	12.4	17.3	15.2	16.9	15.4	11.7	14.2	14.3	**14.68**
Dec	11.3	13.9	13.4	12.7	12.4	11.9	8.5	10.6	**11.84**

Nablus	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	8.1	9.5	8.1	3.6	6.5	7.1	7.3	6.2	**7.05**
Feb	8.3	9.8	8.4	6.4	7.3	7.1	7.4	6.7	**7.68**
March	9.3	12	8.6	12.6	8.8	10	11	8.8	**10.14**
April	12.2	13.1	12.3	14.3	11.6	13.5	13	12.1	**12.76**
May	15.4	16.3	15.5	14.6	16.7	15.3	15.3	14.9	**15.50**
Jun	17.8	19.4	19.1	19.1	18.4	18.1	18.1	17.4	**18.43**
July	20.5	20.6	21.6	20.4	20.1	20.6	20.7	19.3	**20.48**
Aug	20.3	22.6	21	21.1	20.8	21.2	20.8	19.5	**20.91**
Sep	19.3	20.7	19.4	20	19.1	19.9	19.2	18.5	**19.51**
Octo	16	19.1	18.7	16.6	17.5	16.5	18.1	16.2	**17.34**
Nov	9	15.8	11.9	14.2	12.6	11.8	12.8	12.1	**12.53**
Dec	7.9	10.8	10.3	10.3	8.3	10.4	7	7.8	**9.10**

Ramallah	2011	2010	2009	2008	2007	2005	2004	For prevous 25 year	Avg
Jan	7.6	9.6	7.3	4	6.5	6.7	6.6	6.1	**6.80**
Feb	7.6	9.5	7.4	6.2	7.5	6.2	6.8	6.9	**7.26**
March	9	11.9	7.5	12.6	8.2	8.9	10.7	8.7	**9.69**
April	11.8	12.9	12	14.3	11	12.3	12.4	10.3	**12.13**
May	14.4	16.2	14.7	14.1	16.6	14.5	14.3	15.3	**15.01**
Jun	16.8	18.4	19	18.7	17.7	16.2	16.5	17.7	**17.63**
July	20.6	18.6	20	19.6	20.1	19.5	18.8	18.9	**19.51**
Aug	19.2	22	19.2	21.1	19.6	19.5	18.6	19	**19.78**
Sep	18.4	19.5	17.3	18.6	17.6	18.3	18.3	18.1	**18.26**
Octo	15.6	18.8	19.1	15.4	17	15.4	17.8	16.4	**16.94**
Nov	9.4	16.4	11.6	13.3	12.6	11.6	12.4	12.3	**12.45**
Dec	8.2	10.7	9.8	9.8	8.3	10.4	7.2	8	**9.05**

Jerico	**2011**	**2010**	**2009**	**2008**	**2007**	**2005**	**2004**	**For previous 25 year**	**Avg**
Jan	11.3	11.6	8.9	6.8	9	7.7	8.8	7.4	**8.94**
Feb	12.3	12.3	10.7	9.2	11.3	8.8	9.3	8.3	**10.28**
March	12.9	15.1	12.4	14.6	12.2	11	12.5	10.5	**12.65**
April	16.5	17.3	16.5	17.5	16.4	15.5	15.5	14.2	**16.18**
May	20.1	20.9	20.2	19.2	21.3	17.1	18.6	17.6	**19.38**
Jun	23.4	24.5	23.9	24.1	23.4	21	21.5	20.4	**22.78**
July	25.7	26.2	25.9	25.2	25.4	23.8	21.3	22.1	**24.45**
Aug	26.1	28.7	25.9	26.4	25.7	23.9	23.6	22.4	**25.34**
Sep	24.6	26.2	24.1	24.7	24.1	22.9	22.2	21.2	**23.75**
Octo	20.6	23.5	22.4	20.5	21.4	18.9	20.1	17.9	**20.66**
Nov	12.5	16.4	15.1	15.3	14.5	13	14.8	12.9	**14.31**
Dec	9.4	11.4	12.7	10.9	10.2	10.7	7.5	9	**10.23**

Hebron	**2011**	**2010**	**2009**	**2008**	**2007**	**2005**	**2004**	**For previous 25 year**	**Avg**
Jan	6.3	8.4	5.9	2.8	4.9	5.6	5	4	**5.36**
Feb	6.5	8.5	6.4	4.7	6.3	5.2	5.1	4.7	**5.93**
March	7.8	11.1	6.3	11.5	7.1	8.1	9.5	6.5	**8.49**
April	10.9	12.2	10.8	12.9	8.9	11	10.9	9.9	**10.94**
May	13.8	15.8	13.9	13.4	15.6	13.2	14	13.2	**14.11**
Jun	16.1	18.8	17.9	17.9	17.1	15.7	16	15.8	**16.91**
July	20.3	18.9	19.3	18.8	19	18.9	19.1	17	**18.91**
Aug	19	22.6	18.4	19.6	18.6	18.6	17.6	17	**18.93**
Sep	17.8	18.8	16.7	17.7	16.3	17	17	15.9	**17.15**
Octo	14.3	18.2	18.2	14.1	16	14.1	16.7	14	**15.70**
Nov	8.4	15.7	10.8	12	11	10.1	11.3	9.9	**11.15**
Dec	6.9	9.6	9	8.4	7.1	9.8	6	5.6	**7.80**

Bitlahem	2011	2010	2009	Avg
Jan	5.8	9.4	7.1	**7.43**
Feb	2.8	8.9	7.2	**6.30**
March	3.3	11.3	7.5	**7.37**
April	7.5	12.3	11.7	**10.50**
May	10.5	15.6	14.7	**13.60**
Jun	14	18.7	19.3	**17.33**
July	15.9	19.5	20.7	**18.70**
Aug	17.7	22.6	19.9	**20.07**
Sep	17.1	19.7	18.2	**18.33**
Octo	11.8	18.6	19.1	**16.50**
Nov	4.4	15	11.8	**10.40**
Dec	4.4	9.5	10	**7.97**

2. Maximum average temperature in the West Bank by month and station location, (C^0)

Jenin	2011	2010	2009	2008	2007	2005	2004	for previous25 year	Avg
Jan	17.7	19.5	17.9	14.1	17.4	16.6	19.4	17.4	**17.50**
Feb	18	20.2	18.3	17.5	18.2	16.3	17.6	18.2	**18.04**
March	20.8	22.7	19.6	24.7	21.6	21.4	22.6	21.6	**21.88**
April	24.2	26.5	25.2	27.2	28.3	25.5	25.1	28.3	**26.29**
May	27.6	29.6	28.4	28.1	31	27.8	27.9	31	**28.93**
Jun	30.1	32.2	33	32.6	32.9	30.3	29.8	32.9	**31.73**
July	33.9	33.2	33.2	33	33.6	32.8	33.5	33.6	**33.35**
Aug	32.9	35.7	33.5	33.7	34.2	33.4	32.4	34.2	**33.75**
Sep	31.9	33.5	31.3	32.1	33.2	32	32	33.2	**32.40**
Octo	28.6	31.8	31.7	28.3	30.6	28.1	31	30.6	**30.09**
Nov	20.8	29.3	22.9	25.1	25	22.7	22.1	25	**24.11**
Dec	18.9	21.3	19.2	19.5	18.8	20.2	17.2	18.8	**19.24**

Tulkarm	2011	2010	2009	2008	2007	2005	2004	for previous 25 year	Avg
Jan	18.1	20.9	19.3	15.6	13.3	18.6	17.8	13.3	**17.11**
Feb	18.2	21.8	20.1	17.4	13.8	17.9	19.1	13.8	**17.76**
March	19.9	24	20.3	24	16.7	22.4	22.5	16.7	**20.81**
April	23.1	25.8	25.1	27.2	21.5	26	25.5	21.5	**24.46**
May	26.7	28.1	27.5	27.3	24.6	27.8	28.5	24.6	**26.89**
Jun	32.4	31.5	30.8	31	27.2	30.7	30.2	27.2	**30.13**
July	31.6	31.4	32.8	32.4	29	33.1	32.9	29	**31.53**
Aug	31.4	33.7	32.3	32.6	29.6	33.2	32.6	29.6	**31.88**
Sep	30	31.9	30.9	31.2	28.2	32.2	31.5	28.2	**30.51**
Octo	27.6	31.6	31.1	27.3	26.8	28.9	30.6	26.8	**28.84**
Nov	21	28.7	23.9	26.6	20.8	23.7	25.4	20.8	**23.86**
Dec	20.3	23.2	20.6	20.5	15.9	21.2	19.2	15.9	**19.60**

Nablus	2011	2010	2009	2008	2007	2005	2004	for previous 25 year	Avg
Jan	15.6	16.8	14.8	10.9	13.1	13.6	12.9	13.1	**13.85**
Feb	15.5	17.3	14.9	14.4	14.4	13.2	14.7	14.4	**14.85**
March	19.2	21	16.5	22.2	17.2	18.5	19.7	17.2	**18.94**
April	21.9	23.5	22.4	25.2	22.2	22.7	22.8	22.2	**22.86**
May	22.5	27.1	25.8	25.8	25.7	25.3	26	25.7	**25.49**
Jun	28.5	29.9	30.6	30.3	27.9	28	28.1	27.9	**28.90**
July	32.5	30.8	31.4	31.1	29.1	30.8	31.3	29.1	**30.76**
Aug	30.6	33.5	30.7	31.2	29.4	30.7	29.8	29.4	**30.66**
Sep	29.1	30.6	28.5	29.3	28.4	29.2	29.5	28.4	**29.13**
Octo	25.7	29.2	28.8	25.5	25.8	25.3	27.5	25.8	**26.70**
Nov	17.7	26.7	19.7	21.5	20.2	19.8	20.3	20.2	**20.76**
Dec	15.9	18.9	16.8	16.9	14.6	18.2	14.2	14.6	**16.26**

Ramallah	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	12.5	15	12.7	8.5	8.7	11.6	11.9	11.4	**11.54**
Feb	12.5	15.2	13.2	11.9	9.9	11.6	13.8	12.9	**12.63**
March	15.7	19	13.6	19.9	12.3	16.4	18.9	16	**16.48**
April	18.8	21.4	20	25.2	15.6	20.8	21.4	20.9	**20.51**
May	22.9	24.9	23.7	22.9	20	23	24.5	24.8	**23.34**
Jun	24.6	27.4	28	27.9	22.5	25.8	26.8	27.3	**26.29**
July	29.3	28.3	28.4	28.4	23.6	28.3	28.7	28.4	**27.93**
Aug	27.7	31	28.1	28.9	23.8	28.4	27.4	28.6	**27.99**
Sep	26.5	28.3	25.9	27	22.8	26.6	27.5	27.5	**26.51**
Octo	22.8	26.5	26.3	22.3	20.4	22.9	25.7	24.5	**23.93**
Nov	15.1	23.9	17.5	19.6	15.5	17.9	18	18.7	**18.28**
Dec	13.7	16.3	14.8	14.6	10.6	16.6	12.5	13.3	**14.05**

Jerico	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	21.9	22.2	21.6	17.4	19.1	19.7	19.6	19.1	**20.08**
Feb	22	23.9	22.7	20.7	20.9	20.6	21.6	20.9	**21.66**
March	25.6	26.8	23.5	29	24.3	25.4	27.4	24.3	**25.79**
April	29	31	30.1	32.4	29.3	30.4	30.6	29.3	**30.26**
May	33.4	35	34.1	33.9	33.7	33.6	33.8	33.7	**33.90**
Jun	36.9	38.5	39.3	38.8	36.7	37.2	37	36.7	**37.64**
July	40.5	39.6	39.8	39.4	37.8	39.6	40.1	37.8	**39.33**
Aug	38.9	41.3	39.2	39.7	37.6	39.4	38.2	37.6	**38.99**
Sep	36.7	38.2	36.2	37.3	36.1	37	36.7	36.1	**36.79**
Octo	32.5	35.4	35.1	31.9	32.3	32.3	33.8	32.3	**33.20**
Nov	32.9	31.2	26.6	27.9	26.4	25.8	26.5	26.4	**27.96**
Dec	22	24	22.8	23.1	20.5	22.6	19.4	20.5	**21.86**

Hebron	**2011**	**2010**	**2009**	**2008**	**2007**	**2005**	**2004**	**For previous 25 year**	**Avg**
Jan	12.4	14.9	12.2	8.6	10.2	11.6	10.5	10.2	**11.33**
Feb	12.4	15.4	13.3	11.3	11.5	11.2	12.1	11.5	**12.34**
March	15.8	19	13.5	20	14.6	16.1	17.9	14.6	**16.44**
April	19.3	22.1	19.7	22.9	19.6	20.5	20.5	19.6	**20.53**
May	23.2	25.3	23.8	23.5	23.6	23.3	23	23.6	**23.66**
Jun	25.7	27.9	28.2	28.4	25.9	26.1	26.8	25.9	**26.86**
July	30	28.9	28.5	28.7	27.2	29.5	29.6	27.2	**28.70**
Aug	28.1	31.6	28.5	29.2	27.2	29.2	28.1	27.2	**28.64**
Sep	26.9	28.4	25.9	27.2	26	27.6	28	26	**27.00**
Octo	22.9	26.8	26.1	22.3	23.2	23.1	25.5	23.2	**24.14**
Nov	15.3	24.1	17.4	18.6	17.5	17.3	17.4	17.5	**18.14**
Dec	14.4	16.7	14.7	14.2	12.1	16.8	12.4	12.1	**14.18**

Bitlahem	2011	2010	2009	**Avg**
Jan	18.3	17.1	14.6	**16.67**
Feb	20.8	17.3	15.6	**17.90**
March	26.7	20.7	16.2	**21.20**
April	31	24.3	22.7	**26.00**
May	32.3	27.3	26.1	**28.57**
Jun	31.8	30.6	31.4	**31.27**
July	37.4	31.5	31.7	**33.53**
Aug	32.7	34.6	31.7	**33.00**
Sep	32.2	31.1	29.1	**30.80**
Octo	33.8	29	29.1	**30.63**
Nov	22.7	25.3	20.2	**22.73**
Dec	20.5	18	17.2	**18.57**

4. Average Humidity in the West Bank by month and station location, (%)

Jenin	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	77	75	65	65	66	70	77	80	**71.88**
Feb	79	73	71	67	71	75	74	84	**74.25**
March	72	69	66	58	67	67	63	76	**67.25**
April	70	62	61	52	61	61	59	67	**61.63**
May	70	60	58	59	59	58	58	60	**60.25**
Jun	68	57	60	57	60	65	62	63	**61.50**
July	64	66	69	62	62	65	61	63	**64.00**
Aug	69	63	70	66	64	64	64	65	**65.63**
Sep	67	63	70	64	65	63	65	64	**65.13**
Octo	60	60	55	68	65	61	62	65	**62.00**
Nov	70	57	70	64	68	65	67	66	**65.88**
Dec	68	65	75	68	74	67	70	74	**70.13**

Tulkarm	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	62	59	52	55	62	64	72	72	**62.25**
Feb	65	55	60	64	66	71	70	76	**65.88**
March	63	57	59	51	61	63	60	75	**61.13**
April	58	55	57	49	55	52	61	65	**56.50**
May	59	55	57	55	61	58	57	62	**58.00**
Jun	65	56	61	56	55	58	60	69	**60.00**
July	65	63	59	56	56	60	60	68	**60.88**
Aug	65	63	60	63	61	60	61	74	**63.38**
Sep	66	59	58	58	58	57	60	70	**60.75**
Octo	54	52	51	63	58	53	60	67	**57.25**
Nov	56	47	58	49	58	59	60	64	**56.38**
Dec	51	44	62	62	58	69	62	71	**59.88**

Nablus	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	70	69	59	64	66	67	74	67	**67.00**
Feb	73	65	68	65	74	71	71	67	**69.25**
March	63	63	69	52	68	57	57	62	**61.38**
April	61	60	60	49	62	50	49	53	**55.50**
May	61	53	58	58	54	54	51	51	**55.00**
Jun	66	55	53	53	56	60	60	55	**57.25**
July	59	70	61	62	57	59	56	61	**60.63**
Aug	69	68	68	65	62	65	66	65	**66.00**
Sep	72	70	68	67	69	61	63	64	**66.75**
Octo	65	55	53	68	65	57	59	57	**59.88**
Nov	68	46	69	58	61	60	61	57	**60.00**
Dec	63	55	72	62	69	61	62	67	**63.88**

Ramallah	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	73	79	70	76	76	74	81	67	**74.50**
Feb	75	75	78	76	83	79	79	66	**76.38**
March	60	71	82	59	78	69	61	59	**67.38**
April	61	68	66	57	70	57	58	50	**60.88**
May	55	61	68	64	59	63	58	45	**59.13**
Jun	63	67	57	60	65	68	66	48	**61.75**
July	49	81	72	71	63	62	63	53	**64.25**
Aug	65	73	80	72	73	72	71	57	**70.38**
Sep	65	81	83	77	85	72	66	58	**73.38**
Octo	62	68	62	84	76	68	65	56	**67.63**
Nov	61	48	81	68	68	70	73	59	**66.00**
Dec	55	62	82	69	79	63	69	66	**68.13**

Jerico	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	53	60	53	59	62	70	71	70	**62.25**
Feb	58	53	60	62	66	66	67	65	**62.13**
March	45	50	59	47	57	55	52	57	**52.75**
April	43	38	45	41	45	42	42	45	**42.63**
May	38	34	43	44	43	43	41	38	**40.50**
Jun	40	36	40	40	42	44	45	38	**40.63**
July	36	43	42	45	41	43	42	40	**41.50**
Aug	41	40	48	47	46	47	48	44	**45.13**
Sep	45	44	50	50	52	47	49	47	**48.00**
Octo	42	40	42	57	54	48	51	51	**48.13**
Nov	51	35	53	56	61	59	61	60	**54.50**
Dec	45	46	60	55	66	66	69	70	**59.63**

Hebron	2011	2010	2009	2008	2007	2005	2004	For previous 25 year	Avg
Jan	79	66	59	72	65	69	78	74	**70.25**
Feb	79	64	68	68	74	71	74	72	**71.25**
March	65	59	73	54	74	62	65	66	**64.75**
April	64	53	54	55	62	51	64	55	**57.25**
May	57	49	56	56	54	55	60	48	**54.38**
Jun	64	53	46	52	52	55	64	51	**54.63**
July	46	60	60	57	52	52	61	57	**55.63**
Aug	61	51	64	60	52	59	65	60	**59.00**
Sep	63	66	71	71	61	63	65	62	**65.25**
Octo	70	56	54	78	75	61	64	59	**64.63**
Nov	72	38	72	63	66	65	65	64	**63.13**
Dec	65	55	69	66	61	57	65	73	**63.88**

Beithlahem	**2011**	**2010**	**2009**	**Avg**
Jan	70	62	55	**62.33**
Feb	71	58	61	**63.33**
March	57	52	63	**57.33**
April	56	50	50	**52.00**
May	49	45	49	**47.67**
Jun	54	46	42	**47.33**
July	40	55	50	**48.33**
Aug	56	49	56	**53.67**
Sep	57	58	59	**58.00**
Octo	60	49	44	**51.00**
Nov	62	39	61	**54.00**
Dec	56	48	61	**55.00**

Jenin	**2011**	**2010**	**2009**	**2008**	**2007**	**2005**	**2004**	**For previous 25 year)(km/h)**	**Avg Km/h**	**Km/day**	**conversion to 2m**
Jan	5.3	6.6	5.6	6.8	7.5	3.3	3.9	7.5	5.81	139.50	**104.35**
Feb	6.9	6.9	8	7.1	7.9	3.9	3.8	7.9	6.55	157.20	**117.59**
March	6.3	6.8	8.3	6.4	7.9	3.6	2.9	7.9	6.26	150.30	**112.42**
April	7.5	7.5	7.4	7.9	7.9	2.9	3.9	7.9	6.61	158.70	**118.71**
May	7.2	8.2	8.4	8	9	4	4.6	9	7.30	175.20	**131.05**
Jun	10.1	8.8	7	6.8	9.4	4.1	5	9.4	7.58	181.80	**135.99**
July	9.2	8.4	8.8	7	9.7	3.9	5.3	9.7	7.75	186.00	**139.13**
Aug	12.1	7.7	6.9	7.6	8.6	3.8	4.8	8.6	7.51	180.30	**134.86**
Sep	7.4	6.7	6.1	6	7.2	3.5	3.7	7.2	5.98	143.40	**107.26**
Octo	5.7	5.4	4.9	5.6	5.4	2.9	3	5.4	4.79	114.90	**85.95**
Nov	4.8	3.6	5.2	5.2	6.1	2.1	3.5	6.1	4.58	109.80	**82.13**
Dec	4.9	3.1	6.9	6.1	7.5	2.4	1.9	7.5	5.04	120.90	**90.43**

Tulkarm	2011	2010	2009	2008	2007	2005	2004	For previous 25 yeay (Km/h)	Avg	Km/d	conversion to 2m
Jan	6.3	1.7	6.8	6.9	4.3	3.7	5	4.3	4.88	117.00	**87.52**
Feb	6.7	1.6	7.6	5.7	4.1	3.6	4	4.1	4.68	112.20	**83.93**
March	6.3	1.7	7.2	5.4	3.8	3.3	3.3	3.8	4.35	104.40	**78.09**
April	6.6	1.5	6.4	6	3.4	3.8	3.6	3.4	4.34	104.10	**77.87**
May	6.6	1.7	6.8	6.1	3.3	4.2	3.7	3.3	4.46	107.10	**80.11**
Jun	6.8	1.7	6.8	5.3	2.9	3.6	3.8	2.9	4.23	101.40	**75.85**
July	6.5	1.8	7.2	5	2.9	3.4	3.5	2.9	4.15	99.60	**74.50**
Aug	6.7	1.6	6.8	5.3	2.7	3.3	3.5	2.7	4.08	97.80	**73.15**
Sep	5.9	1.6	6.8	4.5	2.6	3.4	2.5	2.6	3.74	89.70	**67.10**
Octo	5.9	1.5	5.6	3.9	2.9	2.6	2.8	2.9	3.51	84.30	**63.06**
Nov	5.8	1.2	6.4	4.1	3.8	4.9	4	3.8	4.25	102.00	**76.30**
Dec	3	3.1	6.8	4.6	4	1.8	2.9	4	3.78	90.60	**67.77**

Nablus	2011	2010	2009	2008	2007	2005	2004	For previous 25 year (Km/h)	Avg	Km/d	to 2m
Jan	5.6	5.8	5.6	7.9	8.7	8.2	9.5	8.7	7.50	180.00	**134.64**
Feb	6.8	6.1	6.8	2.8	9.5	8.1	8.6	9.5	7.28	174.60	**130.60**
March	6	6.6	6	6.4	10	8.1	9	10	7.76	186.30	**139.35**
April	6.3	6	6.3	7.4	10.2	9.5	9	10.2	8.11	194.70	**145.64**
May	6.6	6.7	6.6	7.5	10.7	9.4	9.8	10.7	8.50	204.00	**152.59**
Jun	7.6	7.1	7.6	7.4	12	10	10.3	12	9.25	222.00	**166.06**
July	6.6	8	6.6	6.7	12.4	10.6	9.8	12.4	9.14	219.30	**164.04**
Aug	7.2	6.2	7.2	7	11.7	10.2	10	11.7	8.90	213.60	**159.77**
Sep	6.3	6.2	6.3	6.4	10.3	8.9	9	10.3	7.96	191.10	**142.94**
Octo	5.2	5.4	5.2	6.2	7.7	7.5	6.7	7.7	6.45	154.80	**115.79**
Nov	4.1	3.8	4.1	4.6	7.8	7.1	8	7.8	5.91	141.90	**106.14**
Dec	8.1	6.8	8.1	6.7	7.7	7.1	6.9	7.7	7.39	177.30	**132.62**

Ramallah	2011	2010	2009	2008	2007	2005	2004	For previous 25 year (Km/h)	Avg	Km/d	Conversion to 2m
Jan	9.6	9.4	9.6	9.1	16.3	12.1	6.4	16.3	**11.10**	266.40	**199.27**
Feb	11.2	10.4	11.2	8.9	18	13.4	10.8	18	**12.74**	305.70	**228.66**
March	10.5	10.8	10.5	8.5	18.4	13.4	9.7	18.4	**12.53**	300.60	**224.85**
April	10.4	10.2	10.4	9.2	18.5	14.7	8.8	18.5	**12.59**	302.10	**225.97**
May	11.6	12.4	11.6	15.4	18	14.6	12	18	**14.20**	340.80	**254.92**
Jun	14.2	12.5	14.2	8.2	19.4	15.6	9.3	19.4	**14.10**	338.40	**253.12**
July	13.4	13.7	13.4	7.5	20.4	16.3	10	20.4	**14.39**	345.30	**258.28**
Aug	13	11.3	13	7.4	18.6	15.8	12.9	18.6	**13.83**	331.80	**248.19**
Sep	12	11.8	12	7.6	17	14.4	13	17	**13.10**	314.40	**235.17**
Octo	10	9	10	6.5	13	12.7	10.5	13	**10.59**	254.10	**190.07**
Nov	7.7	7	7.7	5	14.1	9.7	12.2	14.1	**9.69**	232.50	**173.91**
Dec	9.3	10.1	9.3	8.4	16	10.2	10.6	16	**11.24**	269.70	**201.74**

Jerico	2011	2010	2009	2008	2007	2005	2004	For previous 25 year (Km/h)	Avg	Km/d	Conversion to 2m
Jan	3.9	3.1	3.9	7.6	8.9	4.3	5.2	8.9	5.73	137.40	**102.78**
Feb	5.1	3.5	5.1	5.6	10.4	6.7	6.3	10.4	6.64	159.30	**119.16**
March	5.7	4.3	5.7	6.5	13.1	6.6	7.8	13.1	7.85	188.40	**140.92**
April	5.5	4.8	5.5	8.2	16.2	8.9	10.2	16.2	9.44	226.50	**169.42**
May	6.4	6.1	6.4	8.7	15.8	9	10.2	15.8	9.80	235.20	**175.93**
Jun	6.7	5.9	6.7	9.1	15.3	9.9	8.6	15.3	9.69	232.50	**173.91**
July	6.7	6.3	6.7	8.8	16	8.7	8.4	16	9.70	232.80	**174.13**
Aug	5.6	4.8	5.6	9.1	14.8	8.1	7.6	14.8	8.80	211.20	**157.98**
Sep	4.9	5	4.9	7.5	12.5	7	6.4	12.5	7.59	182.10	**136.21**
Octo	3.8	4.3	3.8	4.8	9.4	6.6	5.4	9.4	5.94	142.50	**106.59**
Nov	**3.3**	1.8	3.3	4.3	7.9	3.9	5.4	7.9	4.73	113.40	**84.82**
Dec	3.4	3.6	3.4	5.1	7.6	4.3	3.4	7.6	4.80	115.20	**86.17**

Hebron	2011	2010	2009	2008	2007	2005	2004	For previous 25 year (Km/h)	Avg	Km/d	to 2m
Jan	9.1	8.3	9.1	7.1	12.4	13.8	11	12.4	10.40	249.60	**186.70**
Feb	10	9.4	10	7.9	12.8	13.6	6.4	12.8	10.36	248.70	**186.03**
March	10	9.9	10	2.8	12.6	10.8	6	12.6	9.34	224.10	**167.63**
April	9.1	9	9.1	2.9	11.5	13.5	6.3	11.5	9.11	218.70	**163.59**
May	9.8	9.5	9.8	2.3	9.3	12	9	9.3	8.88	213.00	**159.32**
Jun	10.6	10.2	10.6	4.8	9.3	11.6	12.9	9.3	9.91	237.90	**177.95**
July	9.6	10.5	9.6	4.8	9.2	12	13	9.2	9.74	233.70	**174.81**
Aug	10.2	9.2	10.2	2	8.7	11.7	13.6	8.7	9.29	222.90	**166.73**
Sep	9.5	9.6	9.5	2.3	8.1	12.1	11.7	8.1	8.86	212.70	**159.10**
Octo	9.5	8.1	9.5	4.6	8	11.3	9.8	8	8.60	206.40	**154.39**
Nov	8.9	6.8	8.9	5	8.8	11.5	13	8.8	8.96	215.10	**160.89**
Dec	9.5	17.7	9.5	6.6	10.1	11.6	12.4	10.1	10.94	262.50	**196.35**

4. Average Wind speed in the West Bank by hour and station location, (Km/day)

Bitlahem	2011	2010	2009	Avg	**Km/d**	**to 2m**
Jan	6.6	2.1	6.6	**5.10**	122	**91.56**
Feb	7.4	2.2	7.4	**5.67**	136	**101.73**
March	6.8	2.2	6.8	**5.27**	126	**94.55**
April	6.9	1.7	6.9	**5.17**	124	**92.75**
May	6.7	1.7	6.7	**5.03**	121	**90.36**
Jun	7.2	1.9	7.2	**5.43**	130	**97.54**
July	6.5	1.9	6.5	**4.97**	119	**89.16**
Aug	6.9	1.6	6.9	**5.13**	123	**92.15**
Sep	6.1	1.6	6.1	**4.60**	110	**82.58**
Octo	5.2	1.5	5.2	**3.97**	95.2	**71.21**
Nov	5.5	1.2	5.5	**4.07**	97.6	**73.00**
Dec	5.4	3.7	5.4	**4.83**	116	**86.77**

5. Mean monthly Sun shine hours in the West Bank by hour and station location, (hr /day)

JENIN	Avg
Jan	5.58
Feb	5.28
March	7.45
April	8.53
May	9.68
Jun	11.63
July	11.50
Aug	10.83
Sep	9.43
Octo	8.03
Nov	6.73
Dec	5.68

Tulkarm	Avg
Jan	5.20
Feb	5.50
March	6.50
April	7.70
May	9.00
Jun	10.30
July	9.70
Aug	8.90
Sep	8.30
Octo	7.60
Nov	6.70
Dec	5.30

Nablus	Avg
Jan	4.70
Feb	4.80
March	6.40
April	8.20
May	8.90
Jun	8.40
July	9.60
Aug	10.90
Sep	10.20
Octo	0.00
Nov	7.00
Dec	4.50

Ramallah	Avg
Jan	5.90
Feb	5.88
March	7.41
April	8.90
May	10.36
Jun	12.14
July	12.08
Aug	11.44
Sep	10.05
Octo	8.39
Nov	7.40
Dec	6.44

Jericho	Avg
Jan	5.96
Feb	6.31
March	7.69
April	8.90
May	9.96
Jun	11.73
July	11.70
Aug	11.20
Sep	9.99
Octo	8.29
Nov	7.20
Dec	6.15

Hebron	Avg
Jan	5.50
Feb	12.06
March	6.99
April	8.38
May	10.04
Jun	11.51
July	11.78
Aug	11.36
Sep	9.51
Octo	8.23
Nov	6.88
Dec	5.55

Jerusalem	**Avg**
Jan	**5.40**
Feb	**7.10**
March	**7.40**
April	**9.40**
May	**11.40**
Jun	**12.40**
July	**12.10**
Aug	**11.80**
Sep	**10.10**
Octo	**7.30**
Nov	**6.50**
Dec	**5.90**

Appendix two

The type of crops, planting date, crop coefficient, and days of each growth stage as input Data required for CROPWAT program.

1. Jenin

crop type	planting date late	K1	K2	K3	initial	development	mid	Late
Irrigated								
Olive	**1//3**	0.6	0.7	0.6	30	90	180	65
Cherry	**1//1**	0.4	0.8	0.7	45	70	160	90
Plum	**1//1**	0.6	0.95	0.75	60	90	120	95

Irrigated Vegetables								
Tomato	**1//3**	0.6	1.15	0.8	25	40	60	30
cucumber	**1//3**	0.6	1.15	0.75	15	25	40	20
squash 1	**15//2**	0.5	1.15	0.75	25	35	35	25
squash2	**15//6**	0.5	1.15	0.75	25	35	35	25
Eggplant	**1//3**	0.6	1.15	0.8	15	40	120	20
cauliflower1	**1//2**	0.7	1.05	0.85	15	30	30	20
cauliflower2	**15//4**	0.7	1.05	0.85	15	30	30	25
cauliflower3	**15//10**	0.7	1.05	0.85	15	40	30	15
hotpepper 1	**1//2**	0.7	1.15	0.95	15	30	70	15
hotpepper2	**15//4**	0.7	1.15	0.95	15	30	70	15
Onion	**1//11**	0.7	1.05	0.75	20	35	70	45
jewsmallow	**1//4**	0.6	1.15	0.7	20	30	75	1
muskmelon	**15//3**	0.6	1.05	0.7	10	30	35	10
Okra	**15//2**	0.7	1	0.7	30	40	60	30

Plastic house								
tomato1	**1//4**	0.5	1.15	0.7	15	40	180	20
tomato2	**1//9**	0.5	1.15	0.7	15	40	180	20
cucumber1	**1//9**	0.6	1.15	0.75	15	30	60	20
cucumber 2	**15//11**	0.6	1.15	0.75	15	40	60	20
cucumber 3	**15//2**	0.6	1.15	0.75	15	30	60	20
cucumber 4	**1//5**	0.6	1.15	0.75	10	30	70	20
Eggplant	**1//12**	0.6	1.1	0.7	15	40	70	15
hotpepper	**1//2**	0.65	1.1	0.7	10	30	75	15
jews mallow	**1//4**	0.6	1.15	0.7	15	25	75	1

Field Crops								
Wheat	**15/11**	0.7	1.15	0.3	20	70	80	40
Clover	**15/10**	0.6	1.15	0.7	30	80	60	30
Barely	**1//11**	0.3	1.15	0.25	25	75	60	30
potato1	**15//8**	0.4	1.15	0.75	20	30	45	30
potato 2	**1//11**	0.4	1.15	0.75	20	30	45	30
potato 3	**15//1**	0.4	1.15	0.75	20	30	45	30

2. Tulkarm

crop type	planting date	K1	K2	K3	initial	development	Mid	Late
Irrigated crops								
Olive	**1//4**	0.6	0.7	0.6	30	90	180	65
Lemon	**1//1**	0.7	0.65	0.7	60	75	170	60
clement	**1//1**	0.7	0.65	0.7	60	90	120	95
Orange	**1//1**	0.7	0.65	0.7	60	90	120	95

Irrigated Vegetables								
tomato1	**1//3**	0.6	1.15	0.8	25	40	60	30
tomato2	**1//5**	0.6	1.15	0.8	25	40	60	30
tomato3	**1//9**	0.6	1.15	0.8	25	40	60	30
cucumber1	**1//2**	0.6	1.15	0.75	15	25	40	20
cauliflower1	**1//4**	0.7	1.05	0.85	15	30	30	20
cauliflower2	**15//11**	0.7	1.05	0.85	15	30	30	25
cabbage 1	**1//4**	0.7	1.05	0.99	20	30	60	15
cabbage2	**15//11**	0.7	1.05	0.99	20	30	60	15
squash 1	**15//2**	0.5	1.15	0.75	25	35	35	25
squash2	**15//4**	0.5	1.15	0.75	25	35	35	25
squash 3	**15//7**	0.5	1.15	0.75	25	35	35	25
squash 4	**15//9**	0.5	1.15	0.75	25	35	35	25
eggplant	**1//3**	0.6	1.15	0.8	15	40	120	20
hotpepper 1	**1//3**	0.7	1.15	0.95	15	30	70	15
jewsmallow	**1//2**	0.6	1.15	0.7	20	30	75	1

Plastic House								
tomato1	**1//5**	0.5	1.15	0.7	15	40	180	20
tomato2	**1//8**	0.5	1.15	0.7	15	40	180	20
cucumber1	**1//2**	0.6	1.15	0.75	15	30	60	20
cucumber 2	**1//10**	0.6	1.15	0.75	15	40	60	20
cucumber 3	**1//8**	0.6	1.15	0.75	15	30	60	20
hotpepper	**1//9**	0.65	1.1	0.7	10	30	75	15
jews mallow	**1//2**	0.6	1.15	0.7	15	25	75	1

Field Crops								
Wheat	**15/11**	0.7	1.15	0.3	20	70	80	40
Clover	**15/10**	0.6	1.15	0.7	30	80	60	30
Barely	**1//11**	0.3	1.15	0.25	25	75	60	30
potato1	**15//8**	0.4	1.15	0.75	20	30	45	30
potato 2	**1//11**	0.4	1.15	0.75	20	30	45	30
potato 3	**15//1**	0.4	1.15	0.75	20	30	45	30
Onion	**1//11**	0.7	1.05	0.75	20	35	70	45

3. Nablus

crop type	planting date	K1	K2	K3	initial	development	mid	Late
Irrigated Fruit								
Olive	**1//2**	0.6	0.7	0.6	30	90	180	65
Lemon	**1//1**	0.7	0.65	0.7	60	75	170	60
Clement	**1//1**	0.7	0.65	0.7	60	90	120	95
Orange	**1//1**	0.7	0.65	0.7	60	90	120	95
Graps	**1//6**	0.3	0.85	0.45	75	40	125	125

Irrigated Vegetables								
Tomato	**1//3**	0.6	1.15	0.8	25	40	60	30
squash 1	**15//2**	0.5	1.15	0.75	25	35	35	25
squash2	**15//5**	0.5	1.15	0.75	25	35	35	25
squash 3	**15//9**	0.5	1.15	0.75	25	35	35	25
cauliflower1	**1//2**	0.7	1.05	0.85	15	30	30	20
cauliflower2	**15//9**	0.7	1.05	0.85	15	30	30	25
Cucumber	**1//1**	0.6	1.15	0.75	15	25	40	20
Eggplant	**1//6**	0.6	1.15	0.8	15	40	120	20

Plastic house								
Tomato	**15//8**	0.5	1.15	0.7	15	40	180	20
cucumber1	**15//8**	0.6	1.15	0.75	15	30	60	20
cucumber 2	**15//11**	0.6	1.15	0.75	15	40	60	20

Field Crops								
Wheat	**15/11**	0.7	1.15	0.3	20	70	80	40
Barely	**1//11**	0.3	1.15	0.25	25	75	60	30
potato1	**15//8**	0.4	1.15	0.75	20	30	45	30
Onion	**1//11**	0.7	1.05	0.75	20	35	70	45

4. Ramallah

crop type	**planting date**	**K1**	**K2**	**K3**	**Initial**	**development**	**Mid**	**Late**
Irrigated Vegetables								
tomato	**1//1**	0.6	1.15	0.8	25	40	60	30
squash	**1//1**	0.5	1.15	0.75	25	35	35	25
onion	**1//11**	0.7	1.05	0.75	20	35	70	45
broad beans	**1//11**	0.5	1.15	1.1	90	45	40	1

Plastic House								
tomato1	**15//3**	0.5	1.15	0.7	15	40	180	20
tomato2	**15//5**	0.5	1.15	0.7	15	40	180	20
cucumber1	**15//3**	0.6	1.15	0.75	15	30	60	20
cucumber 2	**15//5**	0.6	1.15	0.75	15	40	60	20
cucumber 3	**15//8**	0.6	1.15	0.75	15	40	60	20
eggplant	**1//5**	0.6	1.15	0.8	15	40	120	20

5. Jerusalem

crop type	**planting date**	**K1**	**K2**	**K3**	**Initial**	**development**	**Mid**	**late**
Irrigated vegetables								
tomato	**1//1**	0.6	1.15	0.8	25	40	60	30
squash	**1//1**	0.5	1.15	0.75	25	35	35	25
cauliflower	**15/10**	0.7	1.05	0.85	15	30	30	20
cucumber	**15/3**	0.6	1.15	0.75	15	25	40	20

6. Hebron

crop type	**planting date**	**K1**	**K2**	**K3**	**initial**	**development**	**Mid**	**Late**
Irrigated Fruit								
graps	**15//1**	0.3	0.85	0.45	75	40	125	125
apple	**15//2**	0.3	0.85	0.45	30	60	150	125
plum	**15//2**	0.6	0.95	0.75	60	90	120	95
apricot	**15//2**	0.55	0.9	0.65	60	90	120	95
peach	**15//2**	0.6	0.95	0.75	60	90	120	95
almond	**15//2**	0.3	0.85	0.45	30	60	120	155

Irrigated Vegetables								
tomato1	**15//5**	0.6	1.15	0.8	25	40	60	30
tomato2	**15//7**	0.6	1.15	0.8	25	40	60	30
cucumber1	**15//5**	0.6	1.15	0.75	15	25	40	20
cucumber	**15//7**	0.6	1.15	0.75	15	25	40	20
squash 1	**15//5**	0.5	1.15	0.75	25	35	35	25
squash2	**15//7**	0.5	1.15	0.75	25	35	35	25
cabbage1	**15//5**	0.7	1.05	0.99	20	30	60	15
cabbage2	**15//7**	0.7	1.05	0.99	20	30	60	15
cauliflower1	**15//5**	0.7	1.05	0.85	15	30	30	20
cauliflower2	**15//7**	0.7	1.05	0.85	15	30	30	25

7. Bethlehem

crop type	**planting date**	**K1**	**K2**	**K3**	**initial**	**development**	**Mid**	**Late**
Irrigated Fruit								
graps	**15//1**	0.3	0.85	0.45	75	40	125	125

Irrigated Vegetables								
tomato	**15//5**	0.6	1.15	0.8	25	40	60	30
cucumber	**15//5**	0.6	1.15	0.75	15	25	40	20
cauliflower	**15//5**	0.7	1.05	0.85	15	30	30	20
cabbage	**15//5**	0.7	1.05	0.99	20	30	60	15
eggplant	**15//5**	0.6	1.15	0.8	15	40	120	20

Plastic House								
tomato1	**15//5**	0.5	1.15	0.7	15	40	180	20
tomato2	**15//7**	0.5	1.15	0.7	15	40	180	20
cucumber1	**15//5**	0.6	1.15	0.75	15	30	60	20
cucumber 2	**15//7**	0.6	1.15	0.75	15	40	60	20
eggplant	**15//5**	0.6	1.1	0.7	15	40	70	15
eggplant	**15//7**	0.6	1.1	0.7	15	40	70	15

8. Qalqilia

crop type	**planting date**	**K1**	**K2**	**K3**	**initial**	**development**	**Mid**	**late**
Irrigated Fruit								
Lemon	**1//3**	0.7	0.65	0.7	60	75	170	60
clement	**1//3**	0.7	0.65	0.7	60	90	120	95
Orange	**1//3**	0.7	0.65	0.7	60	90	120	95
jawava	**15//1**	0.6	0.85	0.75	60	90	120	95
	15//6							
Irrigated Vegetables								
tomato1	**1//3**	0.6	1.15	0.8	25	40	60	30
tomato2	**1//5**	0.6	1.15	0.8	25	40	60	30
tomato3	**1//9**	0.6	1.15	0.8	25	40	60	30
cucumber1	**1//2**	0.6	1.15	0.75	15	25	40	20
cauliflower1	**1//4**	0.7	1.05	0.85	15	30	30	20
cauliflower2	**15//11**	0.7	1.05	0.85	15	30	30	25
cabbage 1	**1//4**	0.7	1.05	0.99	20	30	60	15
cabbage2	**15//11**	0.7	1.05	0.99	20	30	60	15
Plastic house								
tomato1	**1//5**	0.5	1.15	0.7	15	40	180	20
tomato2	**1//8**	0.5	1.15	0.7	15	40	180	20
cucumber1	**1//2**	0.6	1.15	0.75	15	30	60	20
cucumber 2	**1//10**	0.6	1.15	0.75	15	40	60	20
cucumber 3	**1//8**	0.6	1.15	0.75	15	30	60	20
Field Crops								
Wheat	**15/11**	0.7	1.15	0.3	20	70	80	40
Thyme								
Barely	**1//11**	0.3	1.15	0.25	25	75	60	30
potato1	**15//8**	0.4	1.15	0.75	20	30	45	30
potato 2	**1//11**	0.4	1.15	0.75	20	30	45	30
potato 3	**15//1**	0.4	1.15	0.75	20	30	45	30

Appendix Three

The value of product fraction (P_f) and value fraction (V_f)

Product	**Product fraction (P_f)**	**Value fraction (V_f)**
Bovine, live except pure-breeding	1	1
Bovine, carcass and half carcasses , fresh or chilled	0.52	0.87
Bovine, edible, offal, fresh or chilled	0.07	0.07
Bovine skins, whole, raw	0.06	0.06
Bovine hides, raw, nes	0.06	0.06
Equine hides and skins, raw	0.06	0.06
Bovine cuts bone in, fresh or chilled	1	1
Bovine carcasses and half carcasses,frozen	1	1
Bovine meat cured	0.98	1
Bovine cuts boneless, fresh or chilled	0.71	1
Bovine cuts bone in, frozen	1	1
Bovine cuts boneless, frozen	1	1
Bovine tongues, edible offal, frozen	0.1	0.24
Bovine livers, edible offal, frozen	0.60	0.42
Bovine edible offal, frozen nes	0.30	0.34
Bovine meat and meat offal nes, excluding livers	0.40	0.58
Bovine skin leather, whole	0.40	1
Bovine leather, vegetable, pre-tanned, nes	0.50	1
Bovine leather, otherwise pre-tanned, nes	0.50	1
Bovine and equine leather, nes	0.40	1
Goat, live	1	1
Goat meat, fresh, chilled or frozen	0.50	0.81
Goat or kid hides and skins, raw, nes	0.08	0.19
Goat or kid skin leather, vegetable pre-tanned	0.9	1
Goat or kid skin leather , otherwise pre-tanned	0.9	1
Goat or kid skin leather, nes	0.90	1
Egg, bird, in shell fresh preserved or cooked	1	1
Egg, yolk ,nes	0.5	1
Egg, bird, not inshell nes	0.90	1
Egg, yolks, dried	0.80	1
Egg, bird not in shell, dried	0.75	1

Milk and cream nes sweetened	1	1
Milk and cream powder sweetened exceeding 1.5% fat	1	1
Cheese, grated or powdered, of all kinds	0.63	1
Cheese, processed, not grated or powdered	0.63	1
Cheese, nes	0.63	1
Milk not concentrated and unsweetened exceeding 1%, not exceeding 6% fat	0.90	1
Milk and cream not concentrated and unsweetened exceeding 6% fat	0.50	1
Milk powder not exceeding 1.5% fat	0.20	1
Milk and cream powder unsweetened exceeding 1.5% fat	0.20	1
Milk and cream unsweetened, nes	0.50	0.82
Sheep, live	1	1
Sheep,carcasses and half carcasses, fresh or chilled	0.53	0.81
Sheep or lamb skins, raw, with wool on, nes	0.08	0.12
Lamb carcass and half carcasses, frozen	1	1
Sheep, cuts bone in, fresh or chilled	1	1
Sheep, carcasses, and half carcasses, frozen	1	1
Sheep cuts, boneless, fresh or chilled	0.80	1
Sheep cuts, bone in, frozen	1	1
Sheep, goats, asses mules or hinnies edible, offal, frozen	1	1
Sheep or lamb skins, pickled, without wool on	0.95	1
Sheep or lamb skins, raw, pickled, without wool on	0.95	1
Sheep or lamb skin leather, vegetables, pre-tanned	0.90	1
Sheep or lamb skin leather, other wise pre-tanned	0.90	1
Sheep or lamb skin leather, nes	0.90	1
Olive, oil virgin	0.20	0.96

Main source, FAO(2003h) and Chapagain and Hoekstra (2003 a,b,c)

Appendix Four

The cost of agricultural production requirements depending on geographical configuration

A) Semi - Coastal Region

Open Irrigated Eggplant

	Unit	Quantity	Price (nis)	Total (nis)
TOTAL GROSS OUTPUT	NIS			4,600.00
SEED / SEEDLING	KG/No.	1,120.00	0.12	128.80
WATER REQUIREMENTS	CM	512.00	1.90	972.80
MULCH	KG	17.00	11.00	187.00
FERTILIZERS – TOTAL	NIS			534.32
- MANURE	CM	2.08	77.50	161.46
- NITROGEN	KG	67.75	2.65	179.54
- PHOSPHATE	KG	16.80	3.15	52.92
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	26.00	5.40	140.40
CHEMICALS – TOTAL	NIS			394.93
- PESTICIDES	Liter	1.51	202.17	304.93
- HERBICIDES	Liter			-
- FUNGICIDES	Liter	0.60	150.00	90.00
HIRED MACHINERY – TOTAL	Dunum			161.67
- LAND PREPARATION	Dunum	1.00	161.67	161.67
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			751.50
- LAND PREPARATION	labor day	0.38	50.00	19.13
- PLANTING (SOWING)	labor day	0.49	50.00	24.38
- CROP HUSBANDRY	labor day	3.76	50.00	188.00
- HARVESTING	labor day	10.40	50.00	520.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			3,131.02
GROSS MARGIN	NIS			1,468.98
FIXED COSTS				
- DEPRECIATION	NIS			50.42
- INTEREST ON CAPITAL	NIS			143.50
- LAND RENT	NIS			151.25
TOTAL FIXED COSTS	NIS			345.17
TOTAL COSTS	NIS			3,476.19
PROFIT	NIS			1,123.81

Open Irrigated Tomato

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	6,200.00	0.88	5,435.33
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			5,435.33
SEED / SEEDLING	KG/No.	1,742.86	0.41	722.04
WATER REQUIREMENTS	CM	437.50	2.45	1,071.88
MULCH	KG	17.00	11.00	187.00
FERTILIZERS – TOTAL	NIS			830.23
- MANURE	CM	2.41	136.67	329.37
- NITROGEN	KG	56.25	2.50	140.63
- PHOSPHATE	KG	41.67	3.13	130.56
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	43.75	5.25	229.69
CHEMICALS – TOTAL	NIS			245.25
- PESTICIDES	Liter	0.46	343.64	159.32
- HERBICIDES	Liter			-
- FUNGICIDES	Liter	0.33	257.78	85.93
HIRED MACHINERY – TOTAL	Dunum			150.00
- LAND PREPARATION	Dunum	1.00	150.00	150.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			931.56
- LAND PREPARATION	labor day	0.50	50.00	25.00
- PLANTING (SOWING)	labor day	1.00	56.67	56.67
- CROP HUSBANDRY	labor day	6.57	58.57	384.90
- HARVESTING	labor day	9.30	50.00	465.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			4,137.96
GROSS MARGIN	NIS			1,297.37
FIXED COSTS				
- DEPRECIATION	NIS			41.25
- INTEREST ON CAPITAL	NIS			155.17
- LAND RENT	NIS			123.75
TOTAL FIXED COSTS	NIS			320.17
TOTAL COSTS	NIS			4,458.14
PROFIT	NIS			977.20

Protected Irrigated Tomato

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	21,360.00	1.60	34,176.00
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			34,176.00
SEED / SEEDLING	KG/No.	2,255.00	0.83	1,864.13
WATER REQUIREMENTS	CM	922.00	1.88	1,733.36
MULCH	KG	23.00	11.00	253.00
FERTILIZERS – TOTAL	NIS			1,862.96
- MANURE	CM	3.94	95.00	374.06
- NITROGEN	KG	150.00	2.60	390.00
- PHOSPHATE	KG	68.50	4.92	337.02
- POTASH	KG			-
- Iron	KG	3.25	70.00	227.50
- COMPOUND FERTILIZERS	KG	93.75	5.70	534.38
CHEMICALS – TOTAL	NIS			588.12
- PESTICIDES	liter	1.00	360.00	360.00
- HERBICIDES	liter			-
- FUNGICIDES	liter	1.63	140.00	228.12
HIRED MACHINERY – TOTAL	Dunum			218.00
- LAND PREPARATION	Dunum	1.00	218.00	218.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			3,903.40
- LAND PREPARATION	labor day	1.00	50.00	50.00
- PLANTING (SOWING)	labor day	1.40	56.00	78.40
- CROP HUSBANDRY	labor day	23.50	50.00	1,175.00
- HARVESTING	labor day	65.00	40.00	2,600.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			10,422.97
GROSS MARGIN	NIS			23,753.03
FIXED COSTS				
- DEPRECIATION	NIS			2,035.83
- INTEREST ON CAPITAL	NIS			868.58
- LAND RENT	NIS			458.33
TOTAL FIXED COSTS	NIS			3,362.75
TOTAL COSTS	NIS			13,785.72
PROFIT	NIS			20,390.28

Open Irrigated Green beans

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	1,466.67	3.77	5,524.44
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			5,524.44
SEED / SEEDLING	KG/No.	1.50	60.00	90.00
WATER REQUIREMENTS	CM	111.67	1.00	111.67
MULCH	KG	17.00	11.00	187.00
FERTILIZERS – TOTAL	NIS			324.44
- MANURE	CM	0.50	120.00	60.00
- NITROGEN	KG	33.33	2.60	86.67
- PHOSPHATE	KG			-
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	33.33	5.33	177.78
CHEMICALS – TOTAL	NIS			199.93
- PESTICIDES	Liter	0.33	245.00	79.93
- HERBICIDES	Liter			-
- FUNGICIDES	Liter	0.50	240.00	120.00
HIRED MACHINERY – TOTAL	Dunum			180.00
- LAND PREPARATION	Dunum	1.00	180.00	180.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			775.00
- LAND PREPARATION	labor day	1.50	50.00	75.00
- PLANTING (SOWING)	labor day	1.00	50.00	50.00
- CROP HUSBANDRY	labor day	3.00	50.00	150.00
- HARVESTING	labor day	10.00	50.00	500.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			1,868.04
GROSS MARGIN	NIS			3,656.40
FIXED COSTS				
- DEPRECIATION	NIS			30.25
- INTEREST ON CAPITAL	NIS			51.37
- LAND RENT	NIS			27.50
TOTAL FIXED COSTS	NIS			109.12
TOTAL COSTS	NIS			1,977.16
PROFIT	NIS			3,547.28

Protected Irrigated Green Beans

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	2725	3.2	8,651.88
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			8,651.88
SEED / SEEDLING	KG/No.	1.33	190.00	253.33
WATER REQUIREMENTS	CM	590.60	1.94	1,145.76
MULCH	KG	5.00	14.00	70.00
FERTILIZERS – TOTAL	NIS			931.78
- MANURE	CM	1.08	94.33	102.19
- NITROGEN	KG	58.33	2.73	159.44
- PHOSPHATE	KG	55.00	4.25	233.75
- POTASH	KG			-
- Iron	KG	1.67	73.33	122.22
- COMPOUND FERTILIZERS	KG	54.17	5.80	314.17
CHEMICALS – TOTAL	NIS			312.02
- PESTICIDES	liter	0.66	208.33	138.02
- HERBICIDES	liter			-
- FUNGICIDES	liter	0.60	290.00	174.00
HIRED MACHINERY – TOTAL	Dunum			165.00
- LAND PREPARATION	Dunum	1.00	165.00	165.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			1,151.04
- LAND PREPARATION	labor day	1.33	50.00	66.67
- PLANTING (SOWING)	labor day	1.83	48.33	88.61
- CROP HUSBANDRY	labor day	6.25	47.50	296.88
- HARVESTING	labor day	12.33	56.67	698.89
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			4,028.94
GROSS MARGIN	NIS			4,622.94
FIXED COSTS				
- DEPRECIATION	NIS			732.90
- INTEREST ON CAPITAL	NIS			120.87
- LAND RENT	NIS			165.00
TOTAL FIXED COSTS	NIS			1,018.77
TOTAL COSTS	NIS			5,047.71
PROFIT	NIS			3,604.17

Open Irrigated Paprika

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	3,525.00	1.63	5,728.13
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			5,728.13
SEED / SEEDLING	KG/No.	1,900.00	0.44	836.00
WATER REQUIREMENTS	CM	283.33	2.33	661.11
MULCH	KG	17.00	11.00	187.00
FERTILIZERS – TOTAL	NIS			726.39
- MANURE	CM	2.00	120.00	240.00
- NITROGEN	KG	50.00	2.40	120.00
- PHOSPHATE	KG	41.67	3.00	125.00
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	45.83	5.27	241.39
CHEMICALS – TOTAL	NIS			412.61
- PESTICIDES	Liter	0.91	252.50	230.41
- HERBICIDES	Liter			-
- FUNGICIDES	Liter	1.03	177.14	182.20
HIRED MACHINERY – TOTAL	Dunum			110.00
- LAND PREPARATION	Dunum	1.00	110.00	110.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			1,954.17
- LAND PREPARATION	labor day	1.00	50.00	50.00
- PLANTING (SOWING)	labor day	1.00	50.00	50.00
- CROP HUSBANDRY	labor day	8.33	50.00	416.67
- HARVESTING	labor day	28.75	50.00	1,437.50
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			4,887.28
GROSS MARGIN	NIS			840.85
FIXED COSTS				
- DEPRECIATION	NIS			51.33
- INTEREST ON CAPITAL	NIS			228.07
- LAND RENT	NIS			154.00
TOTAL FIXED COSTS	NIS			433.41
TOTAL COSTS	NIS			5,320.68
PROFIT	NIS			407.44

Winter Protected Irrigated Cucumber

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	10,780.00	1.54	16,601.20
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			16,601.20
SEED / SEEDLING	KG/No.	1,925.00	0.70	1,347.50
WATER REQUIREMENTS	CM	380.00	2.20	836.00
MULCH	KG	5.00	14.00	70.00
FERTILIZERS – TOTAL	NIS			1,057.78
- MANURE	CM	2.00	102.50	205.00
- NITROGEN	KG	116.67	2.47	287.78
- PHOSPHATE	KG	50.00	3.10	155.00
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	68.33	6.00	410.00
CHEMICALS – TOTAL	NIS			605.42
- PESTICIDES	liter	1.17	330.00	386.10
- HERBICIDES	liter			-
- FUNGICIDES	liter	1.06	207.78	219.32
HIRED MACHINERY – TOTAL	Dunum			163.33
- LAND PREPARATION	Dunum	1.00	163.33	163.33
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			3,517.08
- LAND PREPARATION	labor day	1.50	65.00	97.50
- PLANTING (SOWING)	labor day	1.50	57.50	86.25
- CROP HUSBANDRY	labor day	26.67	50.00	1,333.33
- HARVESTING	labor day	33.33	60.00	2,000.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			7,597.12
GROSS MARGIN	NIS			9,004.08
FIXED COSTS				
- DEPRECIATION	NIS			855.05
- INTEREST ON CAPITAL	NIS			265.90
- LAND RENT	NIS			192.50
TOTAL FIXED COSTS	NIS			1,313.45
TOTAL COSTS	NIS			8,910.56
PROFIT	NIS			7,690.64

Spring Protected Irrigated Cucumber

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	11,900.00	1.10	13,090.00
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			13,090.00
SEED / SEEDLING	KG/No.	1,750.00	0.75	1,312.50
WATER REQUIREMENTS	CM	316.67	2.50	791.67
MULCH	KG	5.00	14.00	70.00
FERTILIZERS – TOTAL	NIS			1,378.57
- MANURE	CM	2.00	102.50	205.00
- NITROGEN	KG	75.00	2.60	195.00
- PHOSPHATE	KG	54.33	3.90	211.90
- POTASH	KG			-
- Iron	KG	3.00	60.00	180.00
- COMPOUND FERTILIZERS	KG	100.00	5.87	586.67
CHEMICALS – TOTAL	NIS			313.10
- PESTICIDES	liter	1.00	170.00	170.00
- HERBICIDES	liter			-
- FUNGICIDES	liter	0.90	159.00	143.10
HIRED MACHINERY – TOTAL	Dunum			190.00
- LAND PREPARATION	Dunum	1.00	190.00	190.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			2,525.00
- LAND PREPARATION	labor day	2.00	50.00	100.00
- PLANTING (SOWING)	labor day	1.00	50.00	50.00
- CROP HUSBANDRY	labor day	14.50	50.00	725.00
- HARVESTING	labor day	33.00	50.00	1,650.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			6,580.83
GROSS MARGIN	NIS			6,509.17
FIXED COSTS				
- DEPRECIATION	NIS			855.05
- INTEREST ON CAPITAL	NIS			230.33
- LAND RENT	NIS			192.50
TOTAL FIXED COSTS	NIS			1,277.88
TOTAL COSTS	NIS			7,858.71
PROFIT	NIS			5,231.29

Autumn Protected Irrigated Cucumber

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	10,250.00	1.40	14,350.00
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			14,350.00
SEED / SEEDLING	KG/No.	2,000.00	0.67	1,333.33
WATER REQUIREMENTS	CM	330.00	2.00	660.00
MULCH	KG	5.00	14.00	70.00
FERTILIZERS – TOTAL	NIS			807.38
- MANURE	CM	2.00	55.00	110.00
- NITROGEN	KG	93.75	2.60	243.75
- PHOSPHATE	KG	37.00	4.00	148.00
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	56.25	5.43	305.63
CHEMICALS – TOTAL	NIS			163.33
- PESTICIDES	liter	1.00	80.00	80.00
- HERBICIDES	liter			-
- FUNGICIDES	liter	1.67	50.00	83.33
HIRED MACHINERY – TOTAL	Dunum			147.50
- LAND PREPARATION	Dunum	1.00	147.50	147.50
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			2,566.67
- LAND PREPARATION	labor day	2.00	50.00	100.00
- PLANTING (SOWING)	labor day	1.00	50.00	50.00
- CROP HUSBANDRY	labor day	15.00	50.00	750.00
- HARVESTING	labor day	33.33	50.00	1,666.67
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			5,748.21
GROSS MARGIN	NIS			8,601.79
FIXED COSTS				
- DEPRECIATION	NIS			712.54
- INTEREST ON CAPITAL	NIS			167.66
- LAND RENT	NIS			160.42
TOTAL FIXED COSTS	NIS			1,040.61
TOTAL COSTS	NIS			6,788.82
PROFIT	NIS			7,561.18

Summer Protected Irrigated Cucumber

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	11,191.50	1.10	12,310.65
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			12,310.65
SEED / SEEDLING	KG/No.	1,533.33	0.77	1,175.56
WATER REQUIREMENTS	CM	450.00	2.40	1,080.00
MULCH	KG	5.00	14.00	70.00
FERTILIZERS – TOTAL	NIS			1,383.70
- MANURE	CM	2.17	55.00	119.17
- NITROGEN	KG	122.00	2.73	333.47
- PHOSPHATE	KG	70.50	3.30	232.65
- POTASH	KG			-
- Iron	KG	2.45	75.00	183.75
- COMPOUND FERTILIZERS	KG	96.20	5.35	514.67
CHEMICALS – TOTAL	NIS			976.85
- PESTICIDES	liter	1.86	270.00	501.43
- HERBICIDES	liter			-
- FUNGICIDES	liter	1.75	271.67	475.42
HIRED MACHINERY – TOTAL	Dunum			176.00
- LAND PREPARATION	Dunum	1.00	176.00	176.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			2,893.13
- LAND PREPARATION	labor day	1.50	50.00	75.00
- PLANTING (SOWING)	labor day	2.25	52.50	118.13
- CROP HUSBANDRY	labor day	16.67	60.00	1,000.00
- HARVESTING	labor day	28.33	60.00	1,700.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			7,755.23
GROSS MARGIN	NIS			4,555.42
FIXED COSTS				
- DEPRECIATION	NIS			610.75
- INTEREST ON CAPITAL	NIS			193.88
- LAND RENT	NIS			137.50
TOTAL FIXED COSTS	NIS			942.13
TOTAL COSTS	NIS			8,697.36
PROFIT	NIS			3,613.29

Winter Irrigated Squash

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	3,360.00	2.45	8,232.00
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			8,232.00
SEED / SEEDLING	KG/No.	1,075.00	0.50	537.50
WATER REQUIREMENTS	CM	116.67	1.67	194.44
MULCH	KG	17.00	11.00	187.00
FERTILIZERS – TOTAL	NIS			481.92
- MANURE	CM	1.22	103.33	126.30
- NITROGEN	KG	56.25	2.70	151.88
- PHOSPHATE	KG	37.50	2.50	93.75
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	25.00	4.40	110.00
CHEMICALS – TOTAL	NIS			371.81
- PESTICIDES	liter	1.00	196.67	196.67
- HERBICIDES	liter			-
- FUNGICIDES	liter	1.08	161.67	175.14
HIRED MACHINERY – TOTAL	Dunum			150.00
- LAND PREPARATION	Dunum	1.00	150.00	150.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			1,895.83
- LAND PREPARATION	labor day	2.67	50.00	133.33
- PLANTING (SOWING)	labor day	1.25	50.00	62.50
- CROP HUSBANDRY	labor day	4.00	50.00	200.00
- HARVESTING	labor day	30.00	50.00	1,500.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			3,818.50
GROSS MARGIN	NIS			4,413.50
FIXED COSTS				
- DEPRECIATION	NIS			41.25
- INTEREST ON CAPITAL	NIS			143.19
- LAND RENT	NIS			123.75
TOTAL FIXED COSTS	NIS			308.19
TOTAL COSTS	NIS			4,126.70
PROFIT	NIS			4,105.30

Autumn Irrigated Squash

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	2,680.00	2.77	7,414.67
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			7,414.67
SEED / SEEDLING	KG/No.	1,066.67	0.47	497.78
WATER REQUIREMENTS	CM	136.00	0.83	112.20
MULCH	KG	17.00	11.00	187.00
FERTILIZERS – TOTAL	NIS			472.22
- MANURE	CM	1.17	80.00	93.33
- NITROGEN	KG	50.00	2.50	125.00
- PHOSPHATE	KG	25.00	3.40	85.00
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	33.33	5.07	168.89
CHEMICALS – TOTAL	NIS			380.61
- PESTICIDES	liter	0.63	333.33	211.11
- HERBICIDES	liter			-
- FUNGICIDES	liter	0.60	282.50	169.50
HIRED MACHINERY – TOTAL	Dunum			161.67
- LAND PREPARATION	Dunum	1.00	161.67	161.67
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			1,962.50
- LAND PREPARATION	labor day	2.00	50.00	100.00
- PLANTING (SOWING)	labor day	1.25	50.00	62.50
- CROP HUSBANDRY	labor day	9.33	50.00	466.67
- HARVESTING	labor day	26.67	50.00	1,333.33
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			3,773.98
GROSS MARGIN	NIS			3,640.69
FIXED COSTS				
- DEPRECIATION	NIS			32.08
- INTEREST ON CAPITAL	NIS			110.07
- LAND RENT	NIS			96.25
TOTAL FIXED COSTS	NIS			238.41
TOTAL COSTS	NIS			4,012.39
PROFIT	NIS			3,402.28

Irrigated Orange

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	3,393.33	1.58	5,372.78
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			5,372.78
SEED / SEEDLING	KG/No.			-
WATER REQUIREMENTS	CM	674.00	0.78	525.72
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			386.84
- MANURE	CM	1.00	115.00	115.00
- NITROGEN	KG	53.75	2.83	151.84
- PHOSPHATE	KG	37.50	3.20	120.00
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG			-
CHEMICALS – TOTAL	NIS			283.43
- PESTICIDES	liter	0.98	242.22	236.84
- HERBICIDES	liter	0.76	61.67	46.59
- FUNGICIDES	liter			-
HIRED MACHINERY – TOTAL	Dunum			136.00
- LAND PREPARATION	Dunum	1.00	136.00	136.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			1,036.64
- LAND PREPARATION	labor day			-
- PLANTING (SOWING)	labor day			-
- CROP HUSBANDRY	labor day	4.36	69.00	300.84
- HARVESTING	labor day	11.32	65.00	735.80
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			2,368.64
GROSS MARGIN	NIS			3,004.14
FIXED COSTS				
- DEPRECIATION	NIS			110.00
- INTEREST ON CAPITAL	NIS			236.86
- LAND RENT	NIS			330.00
TOTAL FIXED COSTS	NIS			676.86
TOTAL COSTS	NIS			3,045.50
PROFIT	NIS			2,327.28

Grape

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	1,662.50	2.88	4,779.69
SUB_PRODUCT	KG	93.00	5.00	465.00
TOTAL GROSS OUTPUT	NIS			5,244.69
SEED / SEEDLING	KG/No.			-
WATER REQUIREMENTS	CM			-
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			510.00
- MANURE	CM	2.30	75.00	172.50
- NITROGEN	KG			-
- PHOSPHATE	KG			-
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	75.00	4.50	337.50
CHEMICALS – TOTAL	NIS			263.47
- PESTICIDES	liter	1.50	65.00	97.50
- HERBICIDES	liter			-
- FUNGICIDES	liter	0.83	199.17	165.97
HIRED MACHINERY – TOTAL	Dunum			236.00
- LAND PREPARATION	Dunum	1.00	236.00	236.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			550.00
- LAND PREPARATION	labor day			-
- PLANTING (SOWING)	labor day			-
- CROP HUSBANDRY	labor day	6.00	55.00	330.00
- HARVESTING	labor day	4.00	55.00	220.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			1,559.47
GROSS MARGIN	NIS			3,685.22
FIXED COSTS				
- DEPRECIATION	NIS			200.00
- INTEREST ON CAPITAL	NIS			155.95
- LAND RENT	NIS			330.00
TOTAL FIXED COSTS	NIS			685.95
TOTAL COSTS	NIS			2,245.42
PROFIT	NIS			2,999.27

Almond

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	165.33	16.33	2,700.44
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			2,700.44
SEED / SEEDLING	KG/No.			-
WATER REQUIREMENTS	CM			-
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			311.70
- MANURE	CM	2.75	97.50	268.13
- NITROGEN	KG	17.67	2.47	43.58
- PHOSPHATE	KG			-
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG			-
CHEMICALS – TOTAL	NIS			126.09
- PESTICIDES	liter	0.97	71.88	69.48
- HERBICIDES	liter	0.88	33.75	29.53
- FUNGICIDES	liter	0.42	65.00	27.08
HIRED MACHINERY – TOTAL	Dunum			186.67
- LAND PREPARATION	Dunum	1.00	186.67	186.67
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			342.70
- LAND PREPARATION	labor day			-
- PLANTING (SOWING)	labor day			-
- CROP HUSBANDRY	labor day	2.75	50.00	137.50
- HARVESTING	labor day	3.80	54.00	205.20
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			967.16
GROSS MARGIN	NIS			1,733.28
FIXED COSTS				
- DEPRECIATION	NIS			-
- INTEREST ON CAPITAL	NIS			96.72
- LAND RENT	NIS			330.00
TOTAL FIXED COSTS	NIS			426.72
TOTAL COSTS	NIS			1,393.88
PROFIT	NIS			1,306.56

Wheat

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	269	1.45	389.69
SUB_PRODUCT	KG	317	0.60	190.00
TOTAL GROSS OUTPUT	NIS			579.69
SEED / SEEDLING	KG/No.	21	1.82	37.54
WATER REQUIREMENTS	CM			-
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			143.53
- MANURE	CM			-
- NITROGEN	KG	28	2.59	72.03
- PHOSPHATE	KG	28	2.60	71.50
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG			-
CHEMICALS – TOTAL	NIS			42.16
- PESTICIDES	liter			-
- HERBICIDES	liter	0	124.00	42.16
- FUNGICIDES	liter			-
HIRED MACHINERY – TOTAL	Dunum			104.00
- LAND PREPARATION	Dunum	1	58.00	58.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum	1	46.00	46.00
HIRED LABOUR – TOTAL	labor day			117.17
- LAND PREPARATION	labor day			-
- PLANTING (SOWING)	labor day	1	50.00	53.33
- CROP HUSBANDRY	labor day			-
- HARVESTING	labor day	1	57.00	63.84
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			444.41
GROSS MARGIN	NIS			135.28
FIXED COSTS				
- DEPRECIATION	NIS			-
- INTEREST ON CAPITAL	NIS			24.07
- LAND RENT	NIS			178.75
TOTAL FIXED COSTS	NIS			202.82
TOTAL COSTS	NIS			647.23
PROFIT	NIS			(67.54)

Barley

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	240.60	1.28	307.97
SUB_PRODUCT	KG	303.33	0.87	262.89
TOTAL GROSS OUTPUT	NIS			570.86
SEED / SEEDLING	KG/No.	17.00	1.46	24.77
WATER REQUIREMENTS	CM			-
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			115.22
- MANURE	CM			-
- NITROGEN	KG	24.00	2.50	60.00
- PHOSPHATE	KG	23.33	2.37	55.22
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG			-
CHEMICALS – TOTAL	NIS			23.57
- PESTICIDES	liter			-
- HERBICIDES	liter	0.39	60.00	23.57
- FUNGICIDES	liter			-
HIRED MACHINERY – TOTAL	Dunum			110.00
- LAND PREPARATION	Dunum	1.00	62.00	62.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum	1.00	48.00	48.00
HIRED LABOUR – TOTAL	labor day			108.33
- LAND PREPARATION	labor day	0.67	50.00	33.33
- PLANTING (SOWING)	labor day			-
- CROP HUSBANDRY	labor day			-
- HARVESTING	labor day	1.50	50.00	75.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			381.90
GROSS MARGIN	NIS			188.96
FIXED COSTS				
- DEPRECIATION	NIS			-
- INTEREST ON CAPITAL	NIS			20.37
- LAND RENT	NIS			176.00
TOTAL FIXED COSTS	NIS			196.37
TOTAL COSTS	NIS			578.27
PROFIT	NIS			(7.41)

Autumn Irrigated Potato

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	2,040.00	2.40	4,896.00
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			4,896.00
SEED / SEEDLING	KG/No.	106.67	4.67	497.78
WATER REQUIREMENTS	CM	250.00	1.30	325.00
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			1,072.13
- MANURE	CM	3.33	98.33	327.78
- NITROGEN	KG	80.00	2.57	205.33
- PHOSPHATE	KG	78.33	2.97	232.39
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	55.00	5.58	306.63
CHEMICALS – TOTAL	NIS			70.56
- PESTICIDES	liter	0.10	180.00	18.00
- HERBICIDES	liter	0.20	150.00	30.00
- FUNGICIDES	liter	0.19	118.75	22.56
HIRED MACHINERY – TOTAL	Dunum			140.00
- LAND PREPARATION	Dunum	1.00	140.00	140.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			400.00
- LAND PREPARATION	labor day	1.50	50.00	75.00
- PLANTING (SOWING)	labor day	1.50	50.00	75.00
- CROP HUSBANDRY	labor day	2.00	50.00	100.00
- HARVESTING	labor day	3.00	50.00	150.00
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			2,505.47
GROSS MARGIN	NIS			2,390.53
FIXED COSTS				
- DEPRECIATION	NIS			29.79
- INTEREST ON CAPITAL	NIS			67.86
- LAND RENT	NIS			89.38
TOTAL FIXED COSTS	NIS			187.02
TOTAL COSTS	NIS			2,692.49
PROFIT	NIS			2,203.51

Spring Irrigated Potato

	Unit	Quantity	Price (nis)	Total (nis)
MAIN PRODUCT	KG	3,570.00	1.80	6,426.00
SUB_PRODUCT	KG			-
TOTAL GROSS OUTPUT	NIS			6,426.00
SEED / SEEDLING	KG/No.	118.33	4.80	568.00
WATER REQUIREMENTS	CM	333.33	1.77	588.89
MULCH	KG			-
FERTILIZERS – TOTAL	NIS			1,436.00
- MANURE	CM	3.33	98.33	327.78
- NITROGEN	KG	116.67	2.48	289.72
- PHOSPHATE	KG	175.00	2.93	511.88
- POTASH	KG			-
- Iron	KG			-
- COMPOUND FERTILIZERS	KG	55.00	5.58	306.63
CHEMICALS – TOTAL	NIS			466.63
- PESTICIDES	liter	1.22	190.00	231.80
- HERBICIDES	liter	1.80	123.33	222.00
- FUNGICIDES	liter	0.22	58.33	12.83
HIRED MACHINERY – TOTAL	Dunum			145.00
- LAND PREPARATION	Dunum	1.00	145.00	145.00
- PLANTING (SOWING)	Dunum			-
- FERTILIZATION	Dunum			-
- CROP HUSBANDRY	Dunum			-
- HARVESTING	Dunum			-
HIRED LABOUR – TOTAL	labor day			583.33
- LAND PREPARATION	labor day	1.67	50.00	83.33
- PLANTING (SOWING)	labor day	1.90	50.00	95.00
- CROP HUSBANDRY	labor day	3.77	50.00	188.33
- HARVESTING	labor day	4.33	50.00	216.67
- IRRIGATION	labor day			
TOTAL VARIABLE COSTS	NIS			3,787.86
GROSS MARGIN	NIS			2,638.14
FIXED COSTS				
- DEPRECIATION	NIS			33.92
- INTEREST ON CAPITAL	NIS			116.79
- LAND RENT	NIS			101.75
TOTAL FIXED COSTS	NIS			252.46
TOTAL COSTS	NIS			4,040.31
PROFIT	NIS			2,385.69

Central high+ Semi Coastal: Jenin, Tulkarm, Qalqilia

Central high: Hebron, Bethlehem, Nablus, Ramallah

Jordan Vally: Jericho.

For more detail referring to Referance # 45

Appendix Five

2012

Region	Governorate	Population (Year)	Agricultural demand (Mm^3/ year)	**Total source-AG use (Mm^3/year)**
North WB	Jenin	288533.00	5.50	**3.50**
North WB	Nablus	357152.00	10.00	**4.30**
North WB	Tubas	58128.00	15.00	**13.30**
Northwest WB	Tulkarm	173405.00	9.00	**6.00**
Northwest WB	Qalqilyia	102635.00	7.20	**5.00**
Northwest WB	Salfit	66310.00	7.06	**1.00**
Jordan Valley WB	Jericho	47943.00	24.50	**24.50**
Central WB	Ramallah -Al Bireh	318355.00	0.60	**0.60**
Central WB	Jerusalem	400681.00	0.43	**0.00**
South WB	Hebron	636692.00	2.50	**0.00**
South WB	Bethlehem	199186.00	1.73	**0.50**
Sub-Total	**West Bank**	**2649020.00**	**84**	**58.70**

2017

Region	Governorate	Population (Year)	Agricultural demand (Mm^3/ year)	**Total source-AG use (Mm^3/year)**
North WB	Jenin	378,311	28	**5.2**
North WB	Nablus	468,280	15	**7.5**
North WB	Tubas	76,215	25	**17.8**
Northwest WB	Tulkarm	227,360	9.9	**6**
Northwest WB	Qalqilyia	134,570	8	**5**
Northwest WB	Salfit	86,942	7.1	**1**
Jordan Valley WB	Jericho	62,861	30	**24.5**
Central WB	Ramallah -Al Bireh	417,412	5	**1.5**
Central WB	Jerusalem	525,353	0.43	**0**
South WB	Hebron	834,800	19.8	**0.4**
South WB	Bethlehem	261,163	1.7	**0.5**
Sub-Total	**West Bank**	**3,473,267**	**150**	**69.4**

2022

Region	Governorate	Population (Year)	Agricultural demand (Mm^3/ year)	**Total source-AG use (Mm^3/year)**
North WB	Jenin	516,567	33.6	**9.5**
North WB	Nablus	639,416	18.0	**13**
North WB	Tubas	104,068	30.0	**22.5**
Northwest WB	Tulkarm	310,450	11.9	**7.5**
Northwest WB	Qalqilyia	183,750	9.6	**7**
Northwest WB	Salfit	118,716	8.5	**2.5**
Jordan Valley WB	Jericho	85,834	36.0	**25.5**
Central WB	Ramallah -Al Bireh	569,958	6.0	**3.8**
Central WB	Jerusalem	717,347	0.5	**0.0**
South WB	Hebron	1,139,883	23.8	**9**
South WB	Bethlehem	356,607	2.1	**2.5**
Sub-Total	**West Bank**	**4,742,596**	**180**	**102.8**

2027

Region	Governorate	Population (Year)	Agricultural demand (Mm^3/ year)	**Total source-AG use (Mm^3/year)**
North WB	Jenin	622,276	40.3	**33.5**
North WB	Nablus	770,265	21.6	**27**
North WB	Tubas	125,364	36.0	**45**
Northwest WB	Tulkarm	373,980	14.3	**10.5**
Northwest WB	Qalqilyia	221,352	11.5	**10**
Northwest WB	Salfit	143,010	10.2	**5**
Jordan Valley WB	Jericho	103,399	43.2	**57.6**
Central WB	Ramallah -Al Bireh	686,593	7.3	**5.1**
Central WB	Jerusalem	864,144	0.6	**2**
South WB	Hebron	1,373,147	28.5	**17**
South WB	Bethlehem	429,582	2.5	**3.5**
Sub-Total	**West Bank**	**5,713,112**	**216**	**216.2**

2032

Region	Governorate	Population (Year)	Agricultural demand (Mm^3/ year)	**Total source-AG use (Mm^3/year)**
North WB	Jenin	713,213	55.0	**87.5**
North WB	Nablus	882,829	35.9	**76**
North WB	Tubas	143,684	43.2	**105**
Northwest WB	Tulkarm	428,632	17.1	**14.5**
Northwest WB	Qalqilyia	253,700	13.8	**13.5**
Northwest WB	Salfit	163,909	12.2	**10**
Jordan Valley WB	Jericho	118,509	60.0	**134.6**
Central WB	Ramallah-Al Bireh	786,929	8.7	**10.6**
Central WB	Jerusalem	990,427	0.7	**6**
South WB	Hebron	1,573,813	45.0	**25.5**
South WB	Bethlehem	492,359	3.0	**9.5**
Sub-Total	**West Bank**	**6,548,004**	295	**492.7**

Appendix Six

Kind of animal: Dairy cow

Virtual water content of alive animal (VWC_a)

$= VWC_{drink} + VWC_{service} + VWC_{feed}$

= Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Live weight of amature Dairy cow = 0.5 ton/animal

1. **Water from drinking and servicing .**

A. Water from drinking

Hebron	**Water from drinking**			
		Calve	**Heifers**	**Milking Cows**
	Age (year)	0-1	1__3	3__10
	Range of daily consumption (L/day / animal)	14.52	27.40	38.36
	Average daily conumption (L/day/animal)			
	Total drinking water required=	**123300.00**	**L/animal =**	**123.30 m3/animal**

B. Water from Servicing

Hebron	**water for servicing**	
= (50/100)* drinking water	**61.65**	**m3/animal**

A. Water from drinking

	Water from drinking			
Nablus		**Calve**	**Heifers**	**Milking cows**
	Age (month)	0-1	1___3	3__10
	Range of daily consumption (L/day / animal)	17.81	30.14	41.10
	Average daily conumption (L/day/animal)			
	Total drinking water required=	**133500.00**	**L/animal**	**133.50 m3/animal**

B. Water from Servicing

Nablus	**Water for servicing**	
= (50/100)* drinking water	**66.75**	**m3/animal**

A. Water from drinking

	Water from drinking			
Jenin		**Calve**	**Heifers**	**Milking cows**
	Age (month)	0-1	1__3	3__10
	Range of daily consumption (L/day / animal)	18.08	32.88	43.84
	Average daily conumption (L/day/animal)			
	Total drinking water required	**142600.00**	**L/animal**	**142.60 m3/ animal**

B. Water for servicing

Jenin	**Water for servicing**	
= (50/100)* drinking water	**71.30**	**m3/animal**

2. Water from feed

Feed type	**Avgfeed quantities (ton/animal/year)**	**SWD(m3/ton)**	**Crop water (m3/animal /year)**
Barley	**0.3212**	**894**	**287**
Wheat	**0.1703**	**720**	**190**
Wheat bran	**0.0937**		
Maize	**0.3833**	**1362**	**522**
Soya bean	**0.2981**	**4273**	**1274**
Clover/straw	**7.5000**	**872**	**6540**
Total water consumption in the form of feed per year		**8813**	
VWC of feed		35252	**M3/ton**

The virtual water (VWC_a) =

Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Nablus		
Drinking	M^3/animal	133.5
Servicing	M^3/animal	66.75
Feeding	M^3/animal	35252
	M^3/animal	
VWC	M^3/ton	35452
VWC pal*	m3/ton	2383

Jenin		
Drinking	M^3/animal	142.6
Servicing	M^3/animal	71.3
Feeding	M^3/animal	35252
VWC	M^3/ton	35466
VWC pal*	m3/ton	2413

Hebron		
Drinking	M^3/animal	123.3
Servicing	M^3/animal	61.65
Feeding	M^3/animal	35252
VWC	M^3/animal	35437
VWC pal	m3/ton	2349

Calculation tree for Virtual Water content of ' Dairy cow'

Hebron				
1. Raw Milk				
pf	24.5			
V	700			
vf	0.933			
VWC	**1349**	**m3/ton**		
Milk not concentrated and unsweetened not exceeding 1% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	**0.93**	**1**	**1461**
Milk not conctrated & unsweetened exceeding 1% not exceeding 6% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.93	1	**1461**
Milk and cream not concentrated and unsweetened exceeding 6% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.5	1	**2718**
Milk and cream nes sweetened				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
5	1354	1	1	**1354**
Milk powder not exceeding 1.5% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.2	1	**6795**
Milk and cream powder unsweetened exceeding 1.5% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.2	1	**6795**
Milk and cream powder sweetened exceeding 1.5% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	1	1	**1359**
Cheese, fresh (including whey cheese) unfermented, and curd				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.15	0.54	**4893**
Cheese, grated or powdered, of all kinds				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.63	1	**2157**
Cheese processed, not grated or powdered				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.63	1	**2157**
Cheese nes				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	1359	0.63	1	**2157**

2. Meat	VWC	5300	m3/ton	
carcass	pf	v ($/ton)	vf	VWC (m3/ton)
	0.52	3568	0.88	**8969**
	Carcass frozen			
	PWR	0		
	PWR+VWC	8969		
	pf	1		
	vf	1		
	VWC	**8969**		
	Cut bone			
	PWR	0		
	PWR+VWC	8969		
	pf	1		
	vf	1		
	VWC	**8969**		
	Meat cured			
	PWR	5		
	PWR+VWC	8974		
	pf	1		
	vf	1		
	VWC	**8974**		
offal	pf	v ($/ton)	vf	VWC (m3/ton)
	0.07	1834	0.061	**4618**
Raw skin	pf	v ($/ton)	vf	VWC (m3/ton)
	0.06	2172	0.062	**5477**

Hebron				
1. Raw Milk				
pf	24.5			
v	700			
vf	0.933			
VWC	89	m3/ton		
Milk not concentrated and unsweetened not exceeding 1% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	**0.93**	**1**	**106**
Milk not conctrated & unsweetened exceeding 1% not exceeding 6% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.93	1	**106**
Milk and cream not concentrated and unsweetened exceeding 6% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.5	1	**198**
Milk and cream nes sweetened				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
5	94	1	1	**94**
Milk powder not exceeding 1.5% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.2	1	**495**
Milk and cream powder unsweetened exceeding 1.5% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.2	1	**495**
Milk and cream powder sweetened exceeding 1.5% fat				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	1	1	**99**
Cheese, fresh (including whey cheese) unfermented, and curd				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.15	0.54	**356**
Cheese, grated or powdered, of all kinds				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.63	1	**157**
Cheese processed, not grated or powdered				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.63	1	**157**
Cheese nes				
PWR	PWR+VWC	pf	vf	VWC (m3/ton)
10	99	0.63	1	**157**

2. Meat	VWC	358		
carcass	pf	v ($/ton)	vf	VWC (m3/ton)
	0.52	3568	0.88	**606**
	Carcass frozen			
	PWR	0		
	PWR+VWC	606		
	pf	1		
	vf	1		
	VWC	**606**		
	Cut bone			
	PWR	0		
	PWR+VWC	606		
	pf	1		
	vf	1		
	VWC	**606**		
	Meat cured			
	PWR	5		
	PWR+VWC	611		
	pf	1		
	vf	1		
	VWC	**611**		
offal	pf	v ($/ton)	vf	VWC (m3/ton)
	0.07	1834	0.061	**312**
Raw skin	pf	v ($/ton)	vf	VWC (m3/ton)
	0.06	2172	0.062	**370**

Kind of animal: Beef cattle

Virtual water content of alive animal (VWC_a)

= $VWC_{drink} + VWC_{service} + VWC_{feed}$

= Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Live weight of amature Beef cattle = 0.45 ton/animal

1. **Water from drinking and servicing .**

A. **Water from drinking**

Nablus	**Water from drinking**			
		Calve	**Adult Cow**	
	Age (month)	5	36	
	Range of daily consumption (L/day / animal)	17.81	71.23	
	Average daily conumption (L/day/animal)	**44.52**		
	Total drinking water required	48082.19	L/animal	**48.08 m3 /animal**

B. **Water from servicing**

Nablus	Unit	Water from servicing
=(50/100)* drinking	**M3/animal**	**24.04**

A. **Water from drinking**

Jenin	**Water from drinking**			
		Calve	**Adult Cow**	
	Age (month)	5	36	
	Range of daily consumption (L/day / animal)	18.08	71.23	
	Average daily conumption (L/day/animal)	**44.66**		
	Total drinking water required	48230.14	L/animal	**48.23 m3/animal**

B. Water from servicing

Jenin	Unit	**Water from servicing**
= (50/100)* drinking quantity	**m3/animal**	**24.12**

A. Water from drinking

Tulkarm	**Water from drinking**			
		Calve	**Adult Cow**	
	Age (month)	5	36	
	Range of daily consumption (L/day / animal)	16.44	68.49	
	Average daily conumption (L/day/animal)	**42.47**		
	Total drinking water required	45863.01	L/animal	**45.86 m3/ animal**

B. Water from Servicing

Tulkarm	Unit	**Water from servicing**
= (50/100)* drinking quantity	**m3/animal**	**22.93**

A. Water from drinking

Hebron	**Water from drinking**			
		Calve	**Adult Cow**	
	Age (month)	5	36	
	Range of daily consumption (L/day / animal)	14.41	65.75	
	Average daily conumption (L/day/animal)	**40.08**		
	Total drinking water required	43288.25	L/animal	**43.29 m3/animal**

B. Water from Servicing

Hebron	**Unit**	**Water from servicing**
=(50/100)* drinking quantity	**m3/animal**	**21.64**

2. Water from feed

Feed type	**Ton/animal/year**	**SWD (m3/ton)**	**Crop water (m3/yr)**
Barely	0.15	894.00	130.52
Wheat	0.38	720.00	271.56
Wheat bran			
Maize	0.55	1362.00	745.01
Soya beans	0.43	4273.00	1819.44
Clover (Straw)	1.46	872.00	1273.12
		Sum	4239.66

Total water consumption in the form of feed per year =	4239.66	
Table volume of water from feed = Age * water volume	**12718.9842**	m3/animal

The virtual water (VWC_a) =

Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Nablus	Unit	Quantity
Drinking	m3/animal	48.10
Servicing	m3/ animal	24.04
Feeding	m3/animal	12718.98
Drinking + Servicing	m3/animal	72.14
Total	m3/animal	12791.12
VWC	m3/ton	**28424.72**
VWC pal*	m3/ton	**2098.09**

(*):VWC Pal: the partial quantity of VW using Palestenian resource

Jenin	Unit	Quantity
Drinking	M3/animal	48.20
Servicing	m3/ animal	24.12
Feeding	m3/animal	12718.98
Drinking+Servicing	m3/animal	72.32
Total	m3/animal	12791.30
VWC	m3/ton	**28425.12**
VWC pal*	m3/ton	**2098.49**

(*):VWC Pal: the partial quantity of VW using Palestenian resource

Tulkarm	Unit	Quantity
Drinking	m3/animal	45.86
Servicing	m3/ animal	22.93
Feeding	m3/animal	12718.98
Drinking + servicing	m3/animal	68.79
Total	m3/animal	12787.77
VWC	m3/ton	**28417.28**
VWC pal	m3/ton	**2090.64**

(*):VWC Pal: the partial quantity of VW using Palestenian resource

Hebron	Unit	Quantity
Drinking	m3/animal	43.29
Servicing	m3/ animal	21.64
Feeding	m3/animal	12718.98
Drinking + servicing	m3/animal	64.93
Total	m3/animal	12783.91
VWC	m3/ton	**28408.70**
VWC pal	m3/ton	**2082.07**

(*):VWC Pal: the partial quantity of VW using Palestenian resource

Calculation tree for Virtual Water content of ' Beef cow'

Nablus & Jenin — **Beef cattle**

VWC[a]	m3/ton	28425
PWR[a]	m3/ton	10
VW+PWR	m3/ton	28434.7204

		Carcass	offal	Raw skin
pf	ton of product per ton of live animal	0.52	0.07	0.06
price	US$/ton	2233	2018	2233
Vf		0.87	0.066	0.063
VWC	**m3/ton of primary product**	**47573**	**26810**	**29856**

	carcass frozen	Bovin cut bone	Meat cured
PWR	0	0	5
VW+PWR	47573	47573	47578
pf	1	1	0.98
vf	1	1	1
VWC	**47573**	**47573**	**48549**

Hebron — **Beef cattle**

VWC[a]	m3/ton	28409
PWR[a]	m3/ton	10
VW+PWR	m3/ton	28418.6982

		Carcass	offal	Raw skin
pf	ton of product per ton of live animal	0.52	0.07	0.06
price	US$/ton	2233	2018	2233
Vf		0.87	0.066	0.063
VWC	**m3/ton of primary product**	**47547**	**26795**	**29840**

	carcass frozen	Bovin cut bone	Meat cured
PWR	0	0	5
VW+PWR	47547	47547	47552
pf	1	1	0.98
vf	1	1	1
VWC	**47547**	**47547**	**48522**

Tulkarm		Beef cattle		
		VWC[a]	m3/ton	28417
		PWR[a]	m3/ton	10
		VW+PWR	m3/ton	28427.276

		Carcass	offal	Raw skin
pf	ton of product per ton of live animal	0.52	0.07	0.06
price	US$/ton	2233	2018	2233
Vf		0.87	0.066	0.063
VWC	**m3/ton of primary product**	**47561**	**26803**	**29849**

	carcass frozen	Bovin cut bone	Meat cured
PWR	0	0	5
VW+PWR	47561	47561	47566
pf	1	1	0.98
vf	1	1	1
VWC	**47561**	**47561**	**48537**

Kind of animal : Sheep

Virtual water content of alive animal (VWC_a)

$= VWC_{drink} + VWC_{service} + VWC_{feed}$

$=$ Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Live weight of amature Beef cattle = 0.053 ton/animal

1. **Water from drinking and servicing .**

A. Water for drinking

Hebron	**Water from drinking**				
		Lambs	**Adult Ewes**		
	Age (month)	0-2	24.00		
	Range of daily consumption (L/day / animal)	4.11	8.49		
	Average daily conumption (L/day/animal)	**6.30**			
	Total drinking water required=	**4536.99**	**L/animal =**	**4.54**	**m3/animal**

B. Water from servicing

Hebron	Unit	water for servicing
=(50/100)* drinking quantity	m3/animal	**2.27**

A. Water from drinking

Nablus	Water from drinking			
		Lambs	**Adult Ewes**	
	Age (month)	0-2	24.00	
	Range of daily consumption (L/day / animal)	4.11	9.04	
	Average daily conumption (L/day/animal)	**6.58**		
	Total drinking water required=	**8100.00**	**L/animal**	**8.10 m3/animal**

B. Water for servicing

Nablus	Unit	Water for servicing
=(50/100)* drinking quantity	m3/animal	**4.05**

A. Water from drinking

Jenin	Water from drinking			
		Lambs	**Adult Ewes**	
	Age (month)	0-2	24.00	
	Range of daily consumption (L/day / animal)	4.93	10.14	
	Average daily conumption (L/day/animal)	**7.53**		
	Total drinking water required	**9200.00**	**L/animal**	**9.20 m3/anima**

B. Water from servicing

Jenin	Unit	Water for servicing
=(50/100)* drinking quantity	m3/animal	**4.60**

A. Water from drinking

Ramallah	Water from drinking			
		Lambs	**Adult Ewes**	
	Age (month)	0-2	24.00	
	Range of daily consumption (L/day / animal)	4.11	9.04	
	Average daily conumption (L/day/animal)	**6.58**		
	Total drinking water required	**8100.00**	**L/animal**	**8.10 m3/animal**

B. Water from servicing

Ramallah	Unit	Water for servicing
=(50/100)* drinking quantity	m3/animal	**4.05**

2. Water from feed

Feed Type	Ton/year/animal	Ton/animal/year	SWD (m3/ton)	Crop water m3/yr
Wheat	0.1150	0.1506	720.00	108.41
Wheat bran	0.0356			
Maize	0.1437	0.1437	1362.00	195.72
Soya	0.0944	0.0944	4273.00	403.37

Total water consumption in the form of feed pear year =	707.4956	
Total volume of water from feed = Age in years * water per year	**1414.991**	**m3/animal**

The virtual water (VWC_a)

Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

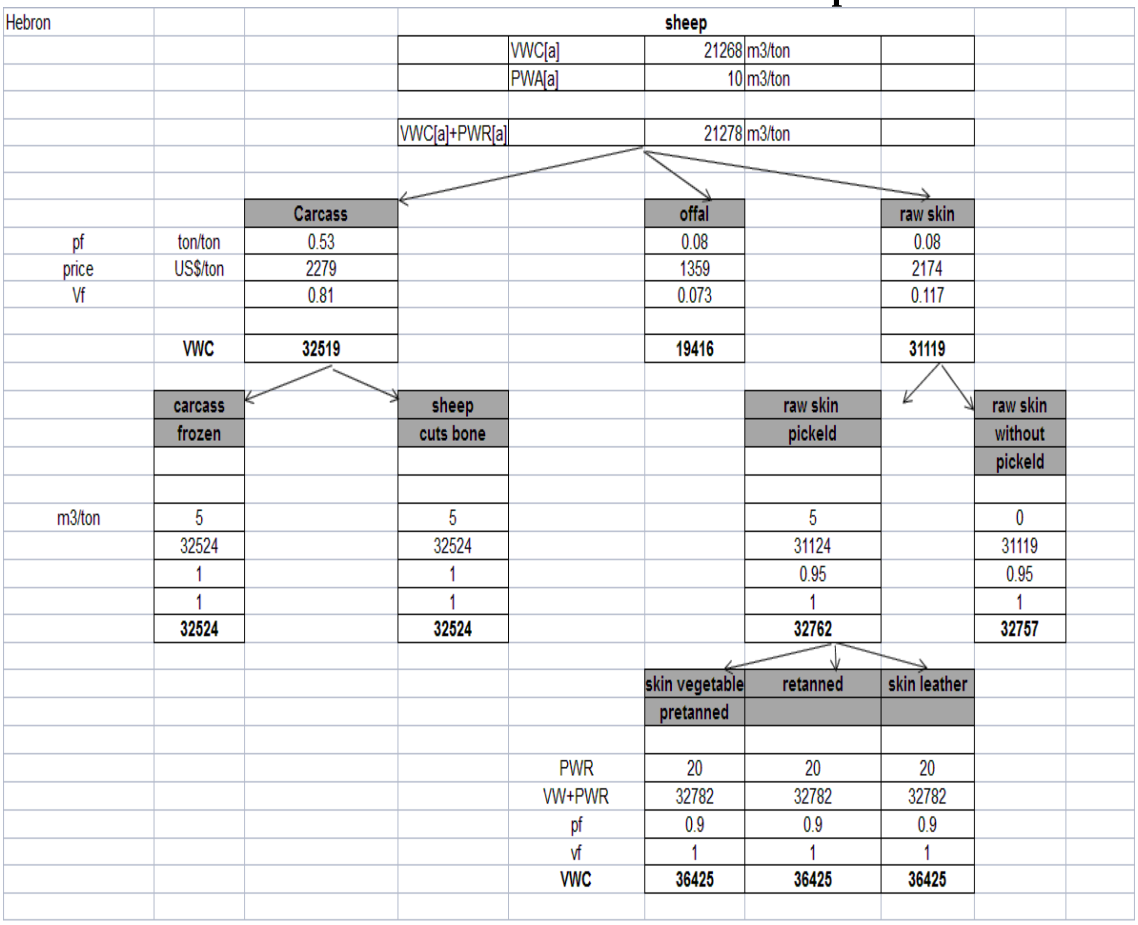
Nablus	unit	Quantity
drinking	M3	8.1
servecing	M3	4.05
feeding	M3	1414.9912
Drinking + servecing	M3	12.15
VWC	M3/ton	26927
VWC pal	M3/ton	229

Jenin	Unit	Quantity
drinking	M3	9.2
servecing	M3	4.6
feeding	M3	1414.9912
Drinking + Servicing	M3/ton	13.8
VWC	M3/ton	26958.32453
VWC pal		260

Hebron	unit	Quantity
drinking	M3	4.54
servecing	M3	2.27
feeding	M3	1414.9912
Drinking +Servecing	M3/ton	6.81
VWC	M3/ton	26826
VWC pal		128

Ramallah	Unit	Quantity
drinking	M3	8.1
servecing	M3	4.05
feeding	M3	1414.9912
Drinking + servecing	M3	12.15
VWC	M3/ton	26927
VWC pal	M3/ton	229

Calculation tree for Virtual Water content of ' Sheep'



	Actual		sheep						
	Hebron			VWC[a]	128	m3/ton			
				PWA[a]	10	m3/ton			
			VWC[a]+PWR[a]		138	m3/ton			
			Carcass		offal		raw skin		
	pf	ton/ton	0.53		0.08		0.08		
	price	US$/ton	2279		1359		2174		
	Vf		0.81		0.073		0.117		
	VWC	m3/ton	**211**		**126**		**202**		
		carcass		sheep		raw skin		raw skin	
		frozen		cuts bone		pickeld		without	
								pickeld	
PWR	m3/ton	5		5		5		0	
VW+PWR		216		216		207		202	
pf		1		1		0.95		0.95	
Vf		1		1		1		1	
VWC		**216**		**216**		**218**		**212**	
					skin vegetable	retanned	skin leather		
					pretanned				
				PWR	20	20	20		
				VW+PWR	238	238	238		
				pf	0.9	0.9	0.9		
				vf	1	1	1		
				VWC	**264**	**264**	**264**		

Nablus & Ramallah			sheep						
				VWC[a]	21369	m3/ton			
				PWA[a]	10	m3/ton			
			VWC[a]+PWR[a]		21379	m3/ton			
			Carcass		offal		raw skin		
	pf	ton/ton	0.53		0.08		0.08		
	price	US$/ton	2279		1359		2174		
	Vf		0.81		0.073		0.117		
	VWC		**32674**		**19508**		**31267**		
		carcass		sheep		raw skin		raw skin	
		frozen		cuts bone		pickeld		without	
								pickeld	
PWR	m3/ton	5		5		5		0	
VW+PWR		32679		32679		31272		31267	
pf		1		1		0.95		0.95	
Vf		1		1		1		1	
VWC		**32679**		**32679**		**32918**		**32912**	
					skin vegetable	retanned	skin leather		
					pretanned				
				PWR	20	20	20		
				VW+PWR	32938	32938	32938		
				pf	0.9	0.9	0.9		
				vf	1	1	1		
				VWC	**36597**	**36597**	**36597**		

	Jenin				**sheep**				
				VWC[a]	21400	m3/ton			
				PWA[a]	10	m3/ton			
			VWC[a]+PWR[a]		21410	m3/ton			
			Carcass		**offal**		**raw skin**		
	pf	ton/ton	0.53		0.08		0.08		
	price	US$/ton	2279		1359		2174		
	Vf		0.81		0.073		0.117		
	VWC		**32721**		**19537**		**31312**		
		carcass		**sheep**		**raw skin**		**raw skin**	
		frozen		**cuts bone**		**pickeld**		**without**	
								pickeld	
PWR	m3/ton	5		5		5		0	
VW+PWR		32726		32726		31317		31312	
pf		1		1		0.95		0.95	
Vf		1		1		1		1	
VWC		**32726**		**32726**		**32965**		**32960**	
					skin vegetable	**retanned**	**skin leather**		
					pretanned				
				PWR	20	20	20		
				VW+PWR	32985	32985	32985		
				pf	0.9	0.9	0.9		
				vf	1	1	1		
				VWC	**36650**	**36650**	**36650**		

Kind of animal: Goats

Virtual water content of alive animal (VWC_a)

= $VWC_{drink} + VWC_{service} + VWC_{feed}$

= Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Live weight of amature Beef cattle = 0.04 ton/animal

1. **Water from drinking and servicing .**

A. Water from drinking

Hebron	**Water from drinking**			
		Kids	**Adult**	
	Age (month)	0.2	30.00	
	Range of daily consumption (L/day / animal)	3.51	6.03	
	Average daily conumption (L/day/animal)	**4.77**		
	Total drinking water required=	**4290.41**	**L/animal =**	**4.29 M3/anima**

B. Water from servicing

Hebron	**Unit**	**water for servicing**
=(50/100)*drinking quantity	m3/animal	**2.15**

A. Water from drinking

Jenin	**Water from drinking**			
		Kids	**Adult**	
	Age (month)	0.2	30	
	Range of daily consumption (L/day / animal)	4.19	7.21	
	Average daily conumption (L/day/animal)	**5.70**		
	Total drinking water required=	**5128.77**	**L/animal**	**5.13 m3/animal**

B. Water from servicing

Jenin	Unit	Water for servicing
=(50/100)*drinking quantity	m3/animal	**2.56**

A Water from drinking

Jericho	Water from drinking			
		Kids	**Adult**	
	Age (month)	0.2	30	
	Range of daily consumption (L/day / animal)	4.19	7.21	
	Average daily conumption (L/day/animal)	**5.70**		
	Total drinking water required	**5128.77**	**L/animal**	**5.13 M3/animal**

B Water from servicing

Jerico	Unit	Water for servicing
=(50/100)*drinking quantity	m3/animal	**2.56**

2. Water from feed

Feed Type	Ton/animal/year	Ton/animal/year	SWD (m3/ton)	Crop water m3/year
Wheat	0.0562	0.0736	720	52.998
Wheat Bran	0.0174			
Maize	0.0703	0.0703	1362	95.7486
Soya beans	0.0462	0.0462	4273	197.4126

Total water consumption in the form of feed per year	346.16	
Total volume of water from feed =Age * water Volum	**865.398**	**m3/animal**

The virtual water (VWC_a)

Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Hebron=	**Unit**	**Quantity**
drinking	m3/animal	4.29
servicing	m3/animal	2.15
feeding	m3/animal	865.398
VWC	m3/ton	**21795.95**
VWC pal	m3/ton	161

Jenin	**Unit**	**Quantity**
drinking	m3/animal	5.13
servicing	m3/animal	2.56
feeding	m3/animal	865.398
VWC	m3/ton	**21827.2**
VWC pal	m3/ton	192.25

Calculation tree for Virtual Water content of ' Goat '

Jericho	**Unit**	**Quantity**
drinking	m3/animal	5.13
servicing	m3/animal	2.56
feeding	m3/animal	865.398
VWC	m3/ton	**21827.2**
VWC pal	m3/ton	192.25

Hebron	Calculation tree for virtual water content of 'goat products'		
	Goat		
	VWC	21795.95	m3/ton
	PWR	10	m3/ton
	VWC[a]+PWR	21805.95	
	Meat		Raw skin
	0.500		0.080
	2664.000		3862
	0.810		0.186
	35326		50699
			leather vegetable pretend
PWR			20.000
VWC[p] +PWR			50719
Pf [p]			0.900
V[p]			1.000
Vf[p]			56354
VWC[p]			

Actual Hebron	Calculation tree for virtual water content of 'goat products'		
	Goat		
	VWC	161	m3/ton
	PWR	10	m3/ton
		VWC[a]+PWR	171
	Meat		Raw skin
Pf [p]	0.500		0.080
V[p]	2664.000		3862
Vf[p]	0.810		0.186
VWC[p]	277		398
			leather vegetable pretend
		PWR (m3/ton)	20.000
		VWC[p]+PWR[p]	418
		pf(ton/ton)	0.900
		Vf	1.000
		VWC[p](m3/ton)	464

Jenin & jericho — Calculation tree for virtual water content of 'goat products'

Goat		
VWC	21827.2	m3/ton
PWR	10	m3/ton
VWC[a]+PWR	**21837.2**	

Symbol	Equation	Meat	Raw skin
Pf [p]		0.500	0.080
V[p]		2664.000	3862
Vf[p]		0.810	0.186
VWC[p]		35376	50771

	leather vegetable pretend
PWR (m3/ton)	20.000
VWC[p]+PWR[p]	50791
pf(ton/ton)	0.900
Vf	1.000
VWC[p](m3/ton)	56435

Actual

Jenin & jericho — Calculation tree for virtual water content of 'goat products'

Goat		
VWC	192	m3/ton
PWR	10	m3/ton
VWC[a]+PWR	**202**	

Symbol	Equation	Meat	Raw skin
Pf [p]		0.500	0.080
V[p]		2664.000	3862
Vf[p]		0.810	0.186
VWC[p]		327	470

	leather vegetable pretend
PWR (m3/ton)	20.000
VWC[p]+PWR[p]	490
pf(ton/ton)	0.900
Vf	1.000
VWC[p](m3/ton)	544

Kind of animal : Laying hens

Virtual water content of alive animal (VWC_a)

= $VWC_{drink} + VWC_{service} + VWC_{feed}$

= Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Live weight of amature Beef cattle = 0.002 ton/animal

1. **Water from drinking and servicing .**

A. Water from drinking

Ramallah	**Water from drinking**			
		Chick	**Start Laying eggs**	**Adult**
	Age (**Weeks**)	1	25.00	75.00
	Range of daily consumption (L/day / animal)	0.02	0.30	0.21
	Average daily conumption (L/day/animal)		**0.16**	0.21
	Total drinking water required=	**101.50**	**L/animal =**	**0.10 M3/anima**

B. Water from servicing

Ramallah	**Unit**	**water for servicing**
=(50/100)* drinking quantity	m3/animal	**0.05**

A. Water from drinking

Hebron	**Water from drinking**			
		Chick	**Start laying eggs**	**Adult**
	Age (**Weeks**)	1	25	75.00
	Range of daily consumption (L/day / animal)	0.02	0.30	0.21
	Average daily conumption (L/day/animal)		**0.16**	0.21
	Total drinking water required=	**138.25**	**L/animal**	**0.14 M3/animal**

B.**Water from servicing**

Hebron	**Unit**	**Water for servicing**
=(50/100)* drinking quantity	m3/animal	**0.07**

A. Water from drinking

	Water from drinking			
Tulkarm		**Chick**	**Start laying eggs**	**Adult**
	Age (**Weeks**)	1	25	75.00
	Range of daily consumption (L/day / animal)	0.02	0.30	0.40
	Average daily conumption (L/day/animal)	**0.16**		0.40
	Total drinking water required	**238.00**	**L/animal**	**0.24 M3/anima**

B. Water from servicing

Tulkarm	**Unit**	**Water for servicing**
	m3/animal	**0.12**

2. Water from feed

Feed Type	Kg/animal/yr	Ton/animal/year	**SWD (m3/ton)**	Crop water (m3/yr)
Wheat	4.38	0.00438	720	3.15
Maize	18.3	0.01825	1362	24.86
Soya	4.75	0.004745	4273	20.28
			Total water con.feed	48.29
			For growing period	11.61
			For laying period	46.43
Total VW of feed/bird= 58.04				

The virtual water (VWC_a)

Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Hebron	**Unit**	**Quantity**
drinking	m3/animal	0.14
servecing	m3/animal	0.07
feeding	m3/animal	58
Sum	m3/animal	**58.25**
VWC	m3/ton	**58**
sum/p	m3/ton	0.21

Ramallah	**Unit**	**Quantity**
drinking	m3/animal	0.1
servicing	m3/animal	0.05
feeding	m3/animal	58
sum	m3/animal	**58.19**
VWC	m3/ton	**58**
sum/p	m3/ton	0.15

Ramallah	**Unit**	**Quantity**
drinking	m3/animal	0.1
servicing	m3/animal	0.05
feeding	m3/animal	58
sum	m3/animal	**58.19**
VWC	m3/ton	**58**
sum/p	m3/ton	0.15

Calculation tree for Virtual Water content of ' Laying hens'

	Quantity (ton/animal)	Market Price (Us $/ton)	Value from individual product(US$)	Total Value (US$/animal)	Value fraction(Vf)	VWC (m3/ton)
Product						
Egg	0.035	1209	42.315	45.43	0.93	1550
Carcass	0.002	1557	3.114		0.07	1996

1.Egg		**300**	(assumption every day one chicken generally produce 1 egg)
Nobs of eggs produced (egg/bird/year)	200		
Weight of one egg (grm/egg)	35	grm/egg	
Total egg produced(Kg/egg)	7	kg/bird	
Product fraction (ton/ton bird) **pf**	3.5	ton/ton of bird	
2.Carcass	0.002		
Live weight of bird (ton/bird)			

Layer hen			
VWC (m3/ton)	58	m3/bird	

Symmbol	Unit	Equation	Eggs
pf[p]	Ton of product per bird		0.0042
V[p]	US$/ton of product		1209
Vf[p]			0.68
VWC	m3/t of Primary Product		1550

		Egg Yolks		Egg (not in shell)
m3/ton of primary product		5		1
m3/ton primary product		1555		1551
Ton of product per ton of primary product		0.5		0.9
Value fraction		1		1
m3/ton of secondary produ	VWC (m3/ton)	3110	VWC(m3/ton)	1723

	Egg Yolk dried		Egg (not in shell)dried
	0	0	
	3110	1723	
	0.8	0.75	
	1	1	
VWC (m3/ton)	3888	VWC	2298

Symmbol	Unit	Equation	carcass
pf[p]	Ton of product per bird		0.0015
V[p]	US$/ton of product		1557
Vf[p]			0.32
VWC	m3/t of Primary Product		1996

	Meat
PWR	10
VWC+PWR	2006
pf	0.78
Vf	1
VWC	2572

Actual amount of virtual water taken from Palestenian water resources:-

	Quantity (ton/animal)	Market Price (Us $/ton)	Value from individual product (US$)	Total Value (US$/animal)	Value fraction (Vf)	VWC (m3/ton)
Product						
Egg	0.035	1209	42.315	45.429	0.93	**10**
Carcass	0.002	1557	3.114		0.07	**13**

Layer hen		
VWC (m3/ton)	**0.36**	**m3/bird**

Symmbol	Unit	Equation	Eggs
pf[p]	on of product per bird		0.0042
V[p]	US$/ton of product		1209
Vf[p]			0.68
VWC	3/t of Primary Product		10

		Egg Yolks		Egg (not in shell)
m3/ton of primary product		5		1
m3/ton primary product		15		11
Ton of product per ton of primary product		0.5		0.9
Value fraction		1		1
m3/ton of secondary product	**VWC (m3/ton)**	**29**	**VWC(m3/t**	**12**

	Egg Yolk dried		Egg (not in shell)dried
	0	0	
	29	12	
	0.8	0.75	
	1	1	
VWC (m3/ton)	**36**	**VWC**	**16**

Symmbol	Unit	Equation	carcass
pf[p]	on of product per bird		0.0015
V[p]	US$/ton of product		1557
Vf[p]			0.32
VWC	3/t of Primary Product		**13**

	Meat
PWR	10
VWC+PWR	23
pf	0.78
Vf	1
VWC	29

Kind of animal: Broiler chicken

Virtual water content of alive animal (VWC_a)

$= VWC_{drink} + VWC_{service} + VWC_{feed}$

= Water from drinking/ W_a + Water from servicing / W_a + Water from feed/ W_a

Live weight of amature Beef cattle = 0.0022 ton/animal

1. **Water from drinking and servicing .**

A. **Water from drinking**

Hebron	**Water from drinking**			
		Chick	**Adult**	
	Age (**Weeks**)	5	7.00	
	Range of daily consumption (L/day / animal)	0.16	0.25	
	Average daily conumption (L/day/animal)		**0.21**	
	Total drinking water required=	**10.05**	**L/animal**	**0.01 M3/animal**

B. **Water from servicing**

Hebron	Unit	water for servicing
=(50/100)* drinking quantity	m3/animal	**0.01**

A. **Water from drinking**

Ramallah	**Water from drinking**			
		Chick	**Adult**	
	Age (**Weeks**)	4	7	
	Range of daily consumption (L/day / animal)	0.16	0.25	
	Average daily conumption (L/day/animal)		**0.21**	
	Total drinking water required=	**10.05**	**L/animal**	**0.01 m3/animal**

B. Water from servicing

Ramallah	Unit	water for servicing
=(50/100)* drinking quantity	**m3/animal**	**0.005**

A. Water from drinking

Nablus	**Water from drinking**			
		Chick	**Adult**	
	Age (**Weeks**)	4	7	
	Range of daily consumption (L/day / animal)	0.16	0.25	
	Average daily conumption (L/day/animal)		**0.21**	
	Total drinking water required	**10.05**	**L/animal**	**0.01 M3/animal**

B. Water from servicing

Nablus	Unit	water for servicing
=(50/100)* drinking quantity	**m3/animal**	**0.005**

A. Water from drinking

Jenin	**Water from drinking**			
		Chick	**Adult**	
	Age (**Weeks**)	4	7	
	Range of daily consumption (L/day / animal)	0.16	0.50	
	Average daily conumption (L/day/animal)		**0.33**	
	Total drinking water required	**34.65**	**L/animal**	**0.03 m3/animal**

B. Water from servicing

Jenin	Unit	Water for servicing
=(50/100)* drinking quantity	m3/animal	**0.017**

A. Water from drinking

Tulkarm	**Water from drinking**			
		Chick	**Adult**	
	Age (**Weeks**)	________	15	
	Range of daily consumption (L/day / animal)	0.16	0.50	
	Average daily conumption (L/day/animal)		**0.33**	
	Total drinking water required	**34.65**	**L/animal**	**0.03 m3/animal**

B. **Water from servicing**

Tulkarm	**Unit**	**Water for servicing**
=(50/100)* drinking quantity	m3/animal	**0.017**

2. Water from feed

Feed Type	**Average (Ton/animal/year)**	**Ton/animal/year**	**SWD (m3/ton)**	**Crop water m3/year**
Barely	14.6700	0.0147	894	13.11498
Wheat	27.7200	0.0280	720	20.16
Wheat Bran				
Maize	36.1000	0.0290	1362	39.498
Soya beans	17.1000	0.0240	4273	102.552

Total water consumption in the form of feed per year =	**175.32**		
For growing period =	total yearly/52 *Age/2	**=11.80**	**m3/bird**
total virtual water of feed= per bird(m3/bird)		**11.80**	**m3/bird**

Calculation tree for Virtual Water content of ' Laying hens'

Hebron & ramallah & Nablus			
drinking	M3/animal	5	
servicing	M3/animal	2	
feeding	M3/animal	5364	
VWC	**m3/animal**	**5371**	
sum/palestine		7	
Distribution of virtual water content of broilers of its product			
Live weight	Kg	2.2	
Dressed weight	Live weight - (30/100)	1.9	
Product fraction (Pf)	Dressed weight/ Live weight	0.86	
Value fraction, Vf		1	
Virtual water content of broiler meat	**VWCa*Vf/Vp**	**6219**	m3/ton

Jenin & tulkarm			
	Wa	0.0022	ton/animal
drinking	13.63636364		
servicing	8		
feeding	5364		
VWC	**5372**	**m3/ton**	
Distribution of virtual water content of broilers of its product			
Live weight	2.2	Kg	
Dressed weight	1.9	Equation: live weight - (30/100)	
Product fraction (Pf)	Dressed weight/ Live weight	0.86	
Value fraction, Vf		1	
Virtual water content of broiler meat	**VWCa*Vf/Vp**	**6220**	m3/ton

جامعة النجاح الوطنية
كلية الدراسات العليا

تأثير تجارة المياه الإفتراضيه على مستقبل إدارة المياه في فلسطين
(حالة الدراسه الضفه الغربيه)

إعداد
برديس طلال أصلان

اشراف
أ.د. مروان حداد

قدمت هذه الأطروحة استكمالا لمتطلبات الحصول على درجة الماجستير في هندسة المياه والبيئة بكلية الدراسات العليا في جامعة النجاح الوطنية، نابلس، فلسطين

2014

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اشراف

أ.د. مروان حداد

الملخص

شهدت فلسطين خلال عدة سنوات مشكله حقيقيه في مصادرها المائيه ويعود السبب في ذلك لعدة عوامل تتمثل بالعوامل الإجتماعية، الإقتصادية، المناخية والسياسية ، لعدة سنوات ماضيه اعتمد الفلسطينيون طرق مختلفه لتخفيف مشكلة ندرة المياه، لكن لم تدرك أي طريقه سابقه أهمية تقييم وإدارة كميات المياه المستخدمه في عملية إنتاج منتج معين وهو مايسمى بمفهوم المياه الإفتراضية.

اقتصرت هذه الأطروحه التركيز على محافظات الضفة الغربية، وتلخصت أهدافها في تطبيق مفهوم المياه الإفتراضية كوسيلة حديثة لإدارة وتخفيف ندرة المياه، كما قدرت كميات المياه الإفتراضية للمنتجات الزراعية والحيوانية الرئيسة المنتجة محليا في محافظات الضفة الغربية، وقارنت الجدوى الإجتماعية–المالية لإنتاج المنتجات الزراعية محليا مقابل الإستيراد، أخيرا اقترحت خطة زراعية لإستخدام المياه بالطريقة الأفضل ضمن سيناريوهيين متوقعين للمياه.

النهج الأساسي المتبع في هذه الأطروحه تمثل ب جمع بيانات وإستخدامها كمدخلات رئيسه لبرامج الكمبيوتر التحليليه المستخدمه وهما Excel and CROPWAT.

تبين من نتائج الأطروحه أن هناك محاصيل رئيسيه تنتج في الضفة الغربية بقيم مياه افتراضية مرتفعة وهذه المحاصيل تمثلت ب البندوره المزروعة في البيوت المحميه (750–1300م3/دونم)، اللوزيات (850–1100م3/دونم)، التمر (850–1500 م3/دونم)، الموز (2000م3/دونم)، الحمضيات (700–1200 م3/دونم)، مانجو (1200 م3/دونم)، الأفوكادو(800–900 م3/دونم)، الجوافه (800–900 م3/دونم)، العنب (700–940 م3/دونم)، في حين أن بعض المحاصيل الرئيسيه الأخرى المنتجه في الضفة الغربية شهدت قيم مياه إفتراضية منخفضة مثل، البطاطا

(250−500 م3/دونم)، الزهرة (150−500 م3/دونم)، الملفوف (200−600 م3/دونم)، البصل (300−470 م3/دونم)، البطيخ (200−400 م3/دونم).

محافظتي طولكرم وقلقيليه كانتا من المحافظات الرئيسية المنتجة للمحاصيل التي شهدت عجزا في (2012) و بأقل مياه إفتراضية مقارنة بباقي المحافظات، حيث تقدر قيم المياه الإفتراضية في محافظة طولكرم للبطاطا،البصل، البطيخ، والبرتقال ب740,343,326,260 على التوالي ، وتقدر ب 967.6,740.3,343,260 للبطاطا، البطيخ، البرتقال، الكالمنتينا والدراق المنتجة في محافظة قلقيليه على التوالي، في كل من المحافظتين اعتمد مبدأ الإستبدال والذي يقوم على إستبدال الفائض وبمياه افتراضية عالي بمحاصيل العجز ذات المياه الإفتراضية المنخفضة، وقد تبين أن إنتاج العجز محليا مهما تفاوت سعر كوب الماء من (0,580−0,994 $/م^3)، (0,580−0,718 $/م^3) في طولكرم وقلقيليه على التوالي يحمل أثر إيجابي على معدل العمالة (إحدى الجوانب الإجتماعية)، ويحقق جدوى مالية أفضل مقارنة بالإستيراد.

تم تقدير المياه الافتراضية للثروة الحيوانية من خلال التركيز على الحيوانات الرئيسة التي يتم تربيتها في محافظات الضفة الغربية، وقد تبين أن محافظة الخليل تحتاج إلى أقل قيمة مياه افتراضية لإنتاج العجول، البقر الحلوب، الماعز، الأغنام ومنتجاتها ، وتبين أن المواشي لاتعتمد بشكل رئيسي في قيمة المياه الإفتراضية على الموارد الفلسطينية فقط بل إن معظم المياه الإفتراضية في غذائها يتم استيراده، في حين أن مياه الشرب والخدمة وبعض الأنواع القليلة جدا من الغذاء تعتمد على المصادر المائية الفلسطينية ٬ هذه الأطروحة عرضت كل من المياه الإفتراضية المحلية باستثناء المياه الإفتراضية للأعلاف المستورده، والمياه الإفتراضية الكلية والتي تشتمل على المياه الإفتراضية للأعلاف المستورده، تركيز الدراسة الأكبر كان حول المياه الإفتراضية المحلية.

نتائج المياه الافتراضية المحلية أي المعتمده على المصادر المائية الفلسطينية في التربية تلخصت ب 2349,2082,161,128م^3/طن للأغنام،الماعز،العجول، والأبقار الحلوب التي يتم تربيتها بالخليل على التوالي.

وتتمثل قيمة المياه الإفتراضية ب 3577,3500,2197,1973 م^3/طن للأحشاء، الجلد، الذبيحة ، ولحم العجول على التوالي، في حين تبلغ 606,89,370,358,312 م^3/ طن للأحشاء، اللحم،

الجلد ، الحليب ، وذبيحة البقر الحلوب على التوالي، لذبيحة الأغنام ، الأحشاء و الجلد تقدر ب 202,126,211م^3/طن على التوالي، أخيرا للحوم الماعز والجلد 398,277م^3/طن على التوالي.

تبين أن محافظة رام الله تنتج الدجاج البياض بأقل قيمة مياه إفتراضية وتتمثل ب 0,15,10,13,29 م^3/ طن للحوم، ذبيحة، البيض ، والدجاجه حيه على التوالي .

في الخليل ونابلس ورام الله كانت نتائج المياه الافتراضية المحلية 7م^3/طن و8 م^3/طن للدجاجه اللاحمة ولحمها على التوالي.

النتيجة الرئيسية في هذه الدراسة تمثلت في أهمية أخذ مبدأ المياه الإفتراضية وجانب التحليل المالي والإجتماعي بعين الإعتبار لتقييم إستراتيجيات الإنتاج الحالية والتي في معظم حالاتها بحاجة لتعديل، ولتحسين أي إستراتيجية إنتاج تطويرية مستقبلية لتحقيق إدارة أفضل لمصادر المياه وتخفيف ندرتها في الضفة الغربية.