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Estimation of Water Requirements for Livestock Production in Palestine

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Committee Decision

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DEDICATION

TO

MY PARENTS, MY

UNCLE QASSEM AL-SALEH

AND MY FAMILY

Acknowledgment

First of all, I thank my GOD for every thank I had achieved, I wish to express my cordial thanks to my advisor Dr. Jamal Abu Omar, and examination committee, Dr. Hassan Abu Qaoud, Dr. Rateb Aref, and Dr. Zakaria Salawdeh, so I thank all my colleagues for their guidance, encouragement and support.

I want to hank my colleagues Mr. Omar Daraghmeh, and Fawwaz Al-Fased.

Thanks also to my parents, sister, brothers, my brother Ragheb, and my grandmother for their encouragement.

List of Contents

List of tables

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List of Abbreviations

D No.	District number
D No.1	Jerusalem
D No.2	Nablus
D No.3	Jenin
D No.4	Tulkarm
D No.5	Jericho
D No.6	Hebron
D No.7	Ramalla
ET	Evapo- Transpiration
WI	Water intake
DWI	Direct water intake
TWI	Total water intake
DM	Dry matter
DMI	Dry matter intake
WU	Water use
WUE	Water use efficiency
Kc	Crop coefficient
Mm^3	Million cubic meter
WB	West Bank
PWA	Palestinian Water authority
PMoA	Palestinian ministry of agriculture

Abstract

This study was conducted to estimate water consumption by local livestock. The animals concerned were cattle, sheep and goats. For each species the estimation was based on its physiological stages (age, pregnancy, and lactation), the geographic location, ecological zone and dry matter intake. Three types of water were estimated in order to reach total water use. The direct water intake (drinking water), water indirectly consumed (water used by the different field crops) and water used in processing local livestock carcasses. Regression equations and nutrition tables were applied in the estimation of DWI. The indirect water consumed by animals through feeds were estimated again, according to the physiological stages of animals, district and ecological zone. The water use efficiency of each crop concerned (wheat, barley, vetch, sorghum, sern, was determined. A proposed ration was suggested for each animal species and total amount of water was then estimated. The amounts of water spent in processing of animal carcasses were estimated. The study showed that the daily direct water intake by cattle classes was: 71, 16, 29 and 41L/day for a lactating cow, a calf, a heifer, and bulls, respectively. The direct water intake per day for sheep and goats classes were 9.1, 4.4, 4.1, 7.4, 8.5, 3.7, 3.72 and 6.32 L/day for a lactating ewe, a lamb, a replacement ewe, a

ram, a doe, a replacement doe, a kid and a buck, respectively. It was suggested by this study that a 1kg of cattle ration required about 0.903 cubic meter for concentrated ration and 0.934 cubic meter for hay of water, while the water requirement for 1kg of sheep and goats ration was 0,920 cubic meter. The daily water requirement per day (ration requirements) for classes of cattle were-17.18 9.89, 3.58, and 17 cubic meter for, lactating cow, a heifer, a calf and a bull, respectively. While this value for classes of sheep and goats were 1.9, 1.62, 1.62, 3.02, 1.62, 1.52, 0.97 and 2.6 cubic meter for a lactating ewe, replacement ewe, a lamb, a ram, a lactating doe, a replacement ewe, a kid and a buck, respectively. The total water requirement (direct water intake and water consumed through feed) per day was estimated by study to be 17.25, 9.92, 3.59 and 17.1 cubic meter for a lactating cow, heifer, a calf and a bull, respectively. While it was 1.93, 1.63, 1.63, 3.03, 1.63, 1.53, 0.98 and 2.61 for a lactating ewe, a replacement ewe, a lamb, a ram, a lactating doe, a replacement doe, a kid and a buck, respectively. The water used in processing was estimated to be 1100 liters per beef carcass and 270 liter per one carcass of sheep and goats. The total water requirements for all carcasses were 61580 cubic meters.

CHAPTER ONE

INTODUCTION

CHAPTER ONE
INTODUCTION

1.1 General Introduction

The Palestinian territories (West bank and Gaza Strip) are located between 29^{o} and 33^{o} north latitude and 35 ^{o} and 39 ^{o} longitude, with an area of 6245 km^{2} as a total area (area of west bank include east Jerusalem is 5572 km²). Palestine has a Mediterranean climate with a cold rainy winter and hot dry summer. The precipitation is ranging from 150 mm in the south east to 700 mm in the northern part of the West Bank. West Bank (research area) consists of four agro-ecological zones; semi coastal, central highlands, eastern slopes, and Jordan valley (Palestinian Ministry of Agriculture (PMoA): 2000).

Palestine is suffering from a severe water shortage due to uncontrolled water resources. The available and accessible main water resource are the groundwater and the precipitation (2700 - 2900 Mm^{3}) (PmoA, 2003). The total amount of water utilized in different sectors in Palestine is around *269* Mm$^{3.}$ (PWA: 1997) where agriculture has the highest percentage of water consumption (70 %) (PMoA, 2000). About 1.7% of which is used by livestock sector (Palestinian Water Authority (PWA, 1997)).

The total forage area in WB is about 366947 dunums that produce about 124360 tons per year. It contributes about 32% of the total animal feeds (PMoA, 2002). It is clear that forage produced under irrigation can be an important feed reserve for livestock especially in drought seasons, when range forage is scarce. Large volume of water is utilized in the production of forages. Nearly 95% of local forages are rain fed (PMoA, 2002).

Numbers of livestock are increasing in the whole territories of Palestine. Recent data showed that the population of sheep, goats and cattle were 500, 400 and 30 thousand heads, respectively (Abu Omar, 1999). Internationally, published data on water intake rates of different species of farm animals have been reviewed by several researchers; however, these estimates are inaccurate as always-based on faulty assumptions (Beckett and Oltjen, 1994), this was due to over simplifications that result from basing estimates on one typical production scenario.

It was reported by (Bergman, 1932), that 3.5 liters of water was consumed for each one kg milk produced under temperate conditions, but french recommendations showed that 145.6 g water per kg metabolic weight were needed for maintenance, and an animal should consume about 1.43 kg water to produce 1 kg of milk (Morand- Fehr and Sauvart, 1978),

however, Devandra (1967) reported that penned goats in tropics needed about 680 g of water, of which 80% was consumed during day light.

In any case, no data available on the needs of local livestock, however, such information is very important for farmers engineers governmental staff. Such information will help decision-makers how to deal with the limited resources, especially in setting plans related to livestock sector. Providing estimates about water requirements will be of great importance. More attention will be focused on this vital resource, however, correct decisions can be reached in planning for local livestock sector.

The objective of this research is to quantify the water requirements for the production of one kg meat under the prevailing farm practices in Palestine dividing water use into that for drinking, feed production, and processing. In areas of limited water supply, as is the case in Palestine, quantitative information on water intake rates of farm animals is an important information on the animals other nutrient requirements.

This study aims to estimate water requirements for livestock production and processing in Palestine. The study will investigate the three different water sources requirements: direct consumption (drinking water),

water for feed crops production and water spent in processing at slaughter houses and water spent in controlling external parasites.

1.2 Direct water consumption

Water consumption by livestock varies according to species also, it varies within a species. Several factors can affect direct water consumption. Factors as animal weight, physiological status, dry matter intake and the prevailing temperature have role in this regard. Heck (1995) had estimated water consumption for different classes of livestock as shown in Table 1. These values were compared to what was reported by another study (Table 2).

Table 1. Livestock direct water consumption (l/ day)

Type of livestock	**Average daily consumption**	**Peck daily consumption**
Sheep	Litre /head	Litre/head
Nursing ewes	9	11.5
Fattening lambs	2.2	4.5
Cattle		
Diary cow in milk	70	85
Diary cow, dry	45	60
Beef cattle	45	60
Calves	22	30

(Heck, 1995)

Table 2. Livestock direct water consumption (l/ day)

Type of stock	Litre per head per day
Beef cattle	28-48
Dairy cattle	40-64
Sheep and goats	4-16

The heat-stress caused by sever weather conditions was shown to increase water consumption by 20-30% (Devendra, 1967). Special care should be taken in estimation water intake of goats. These animals are very sensitive to water quality and are efficient in water utilization. Goats needs for water ranges from zero to several liters of water per day, depend on grazing and nature of nutrients (National academy press, 1981). It was estimated by local authorities that livestock requirements of water to be 4.5 M cubic meter (AMoP, 2002).

1.2.1 Water in animal feeds

Water is the lifeblood for all aspects of life including plants. Plants can transpire daily an amount of water nearly equal to their total water content, or may use several times its own mass of water (Wild, 1988). Most of water taken up by plants is lost to the atmosphere; nearly about 1% of water is used for the metabolic activities (Wild, 1988; Allen *et al.*, 1998).

Different crops use different amounts of water to produce the same amount of yield units. Different factors may affect the crop water

requirements, especially crop environment and plant species (De Wit, 1958). Dorenbos and Pruitt (1977) also found when studying the yield response to water that the climate has important effects on both the yield and the amount of water needed to satisfy the plant requirements.

Plants lose water by transpiration, which consists of vaporisation of liquid water contained in plant tissues and the vapour removal to the atmosphere (Wild *et al.*, 1998). This process involves change in water phase from liquid to vapour; this make it depends on energy supply, vapour pressure gradient, and wind. Hence, radiation, air temperature, humidity and wind speed should be considered in assessing transpiration amount.

Transpiration often occurs simultaneously with evaporation from soil surface and there is no easy way to separate these sources of water vapour they combined as evapo-transpiration (Wild, 1988; Wild *et al.*, 1998). The crop type, variety and development stage should be considered when assessing the evapo-transpiration from crops grown in large, well-managed fields. Differences in resistance to transpiration, crop height, crop roughness, reflection, ground cover and crop rooting characteristics result in different ET levels in different types of crops under identical environmental conditions (FAO, 1998).

Reference evapo-transpiration (ET_o) is defined by Doorenbos and Pruitt (1977) as "the rate of evapo-transpiration from an extensive surface of 8 to 15 cm tall, green cover of uniform height, actively growing, completely shading the ground and not short of water". Crop evapo-transpiration under standard conditions (ET_c) refers to the evaporating demand from crops that are grown in large fields under optimum soil water, excellent management and environmental conditions, and achieve full production under the given climatic conditions (FAO, 1998) .

Several equations were used to estimate the reference evapo-transpiration amount, FAO Penman-Monteith equation is used in this research. The FAO-Penman-Monteith method is recommended as the sole method for determining ET_o (FAO, 1998). It is closely approximates grass ET_o at location evaluated, is physically based, and explicitly incorporates both physiological and aerodynamic parameters. The amount of water required to compensate the evapo-transpiration loss from the cropped field is defined as crop water requirement (FAO, 1998).

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

Where…… ET_o reference evapo-transpiration {mm /day},

R_n 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^{o}},

u_2 wind speed at 2 m height {m s^{-1}},

e_s saturation vapour pressure {kPa},

e_a actual vapour pressure {kPa},

e_s-e_a saturation vapour pressure deficit {kPa},

Δ slope vapour pressure curve {kPa $^{o}C^{-1}$},

γ psychometric constant } kPa $^{o}C^{-1}$}.

The equation uses standard climatological records of solar radiation (sunshine), air temperature, humidity and wind speed. To ensure the integrity of computations, the weather measurements should be made at 2m (or converted to that height) above an extensive surface of green grass, shading the ground and not short of water.

Factors such as soil salinity, poor land fertility, limited application of fertilizers, the presence of hard or impenetrable soil horizons, the absence of control of diseases and pests and poor soil management may limit the crop development and reduce the evapotranspiration. Farm management practices should be take into consideration, when assessing the ET rate, they may act on climatic and crop factors that affecting ET process (FAO, 1998).

The evapotranspiration from a reference surface, not short of water, is called the reference crop evapotranspiration or reference evapotranspiration ET_o (FAO, 1998). The only factors affecting ET_o are climatic parameters. Consequently, ET_o is a climatic parameter and can be computed from weather data. ET_o expresses the evaporating power of the atmosphere at specific location and time of the year and does not consider the crop characteristics and soil factors.

Crop evapotranspiration can be calculated from climatic data and by integrating directly the crop resistance, albedo and air resistance factors in the Penman-Monteith approach. Experimentally determined ratios of ET_c / ET_o, called crop coefficients (K_c), are used to relate ET_c to ET_o or $ET_c = Kc\ ET_o$.

Owing to the difficulty of obtaining accurate field measurements, ET is commonly computed from weather data. A large number of more or less empirical methods have been developed by numerous scientists and specialist worldwide to estimate evapotranspiration from different climatic variables. The FAO Penman-Monteith method is recommended as the sole ET_o method for determining reference evapotranspiration (FAO, 1998).

To accommodate users with different data availability, four methods were presented to calculate the reference crop evapotranspiration ET_o: the

Blany -Griddle, radiation, modified Penman and pan evaporation methods. The modified Penman method was considered to offer the best results with minimum possible error in relation to a living grass reference crop.

Where water is available for irrigation, high yields of quality forage can be successfully produced provided certain requirements are selected, these are: proper choice of forage crop or crops mixture to be grown; good management practices including adequate seedbed preparation, application of fertilizers, proper grazing, and proper irrigation management (ICARDA, 1988).

In West Bank the range land covers about 2,180, 000 dunums, while the accessible area is around 700,000 dunums. Areas of irrigated forages are restricted because irrigation water is limited. Al-Juneidi and Isaac (1997) tested the application efficiency in Palestine. They reported that application efficiency is relatively high and this high efficiency was not due to good management but due to the shortage of water. Water use efficiency i.e. the amount of water required to produce one unit of dry matter also varies among forage crops. A study in Iraq found different water requirement and water use efficiency for alfalfa, clover, fodder corn, fodder ssorghum, and fodder parley, as (1800, 0.52), (600, 0.94), (625, 1.05), (625, 0.70), and (250, 1.11) respectively (ICARDA, 1988). A thesis result

showed those fodder corn and barely produce more dry matter for each unit of irrigation water than alfalfa (Ali *et al*., 1990).

Palestine has limited water resources, and it is already suffering from water crises. Ground water is the only source of water in Palestine. The average precipitation is about 600 mm/year, giving 726 Mm^3 as a total recharge for the groundwater (PHG, 1999). The total available water resources are estimated to be 269- 275 Mm^3 (PHG, 1999: and PMoA, 1999). The annual water consumption per capita in the year 1994 was estimated to be 93 m^3 per capita. Agriculture has the highest percentage of water consumption 64-70 % (PMoA, 1999).

Crop evapo-transpiration under standard conditions (ET_c) refers to the evaporating demand from crops that are grown in large fields under optimum soil water, excellent management and environmental conditions, and achieve full production under the given climatic conditions (FAO, 1998).

The FAO-Penman-Monteith method is recommended as the sole method for determining ET_o, we will use in this study. It is closely approximates grass ET_o at location evaluated, is physically based, and explicitly incorporates both physiological and aerodynamic parameters (FAO, 1998). The amount of water required to compensate the evapo-

transpiration loss from the cropped field is defined as crop water requirement (FAO, 1998). All weather parameters used in the calculation of reference evapo-transpiration (ETo) were collected from the different meteorological station distributed all over the West Bank territories.

1.3 Description of major feed crops in WB

1.3.1 Wheat: *Triticum estivum* and *Triticum durum*

It is a winter crop, it is from Gramineae family, and mono coteledon crop. It has broad spectrum planting in semi arid area, this crop is very suitable for WB conditions. Wheat needs rainy cold winter in the growth stage and hot dry weather in the seed formation stage. Wheat is planted in areas of 250mm to 1750mm annual rainfall, rain fall time and distributions are very important (Arab Organization for Agriculture Development, 1976)

1.3.2 Barley: *Hordeum vulgare*

It is the most important feed crop in local livestock rations. It is used at rate of 50-90% of livestock rations as an energy source, and has from 9% to 12% crude protein (CP). It is a main rain fed crop, common in arid and semiarid areas. Barley cultivation starts at winter to be harvest at the begining of summer.

1.3.3 Alfalfa*: Medicago sativa*

Limited area of this crop is available in WB because of its high water requirement. It can stand in field for15 to 20 years, but it is more efficient in the first 6 years.

1.3.4 Berseem (clover)*: Trifolium alexendrinum L*

It is a legume fodder, and important winter forage crop for several Mediterranean countries. It is mainly grown under irrigation and to a lesser extent as a rain feed crop. It is highly productive, used as green and dry feed (hay). It is very sensitive to low and high temperature and can be grown under rain fed conditions where annual rain fall is 300 mm or more. Berseem is highly productive in black heavy soil (AL-Ani and Rashed,1983)

1.3.5 Corn broom*: Sorghum*

Corn is the principle silage crop in the world with water requirement of 300 - 700 mm. (AL-Fakhry, 1981)

1.3.6 Vetch and sern*: Vicia spp.*

It includes 150 types through the world. It needs about 300 to 350mm of water. Table 3 shows the major WB crops, areas and distribution.

Table 3. Major WB forage crops, areas and distribution.

Crop	**Rain fed**			**Grain produc-tivity**	**Hay produ c-tivity**	**Total produc -tivity**
	Area dunum	Production kg/dunum		Ton	Ton	Ton
		Grain	Hay			
Wheat	174914	92	260	16092	45478	61570
Barley	96463	116	260	11190	25080	36270
Clover	21300	-	575	-	12248	12248
Vetch	22304	-	461	-	10282	10282
Sern	18414	74	130	1336	2394	3757
Broom	3552	95	-	337	-	337
T	366947			28982	96845	125827

(Amo P., 2000)

The water use efficiency varies from crop to another and for the same crop according to area of cultivation. Table 4 shows the different water use efficiencies by different forage crops.

Table 4. Water use efficiency (WUE) by different forage crops.

Forage crop	**WUE Kg hay/m^3 water**
Alfalfa	0.52
Clover	0.94
Fodder corn	1.05
Fodder sorghum	0.70
Fodder barley	1.1

(ICARDA, 1988)

CHAPTER TWO
MATERIALS AND METHODS

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Materials and Methods

2.1 Estimation of animal direct WI

The estimation of direct water consumption has taken in consideration the following sections:

Section (1): direct consumption by cattle.

Section (2): direct consumption by sheep.

Section (3): direct consumption by goats.

2.1.1 Direct water consumption by cattle

The following stages of cattle to be considered:

1. Lactation (milking) cows.
2. Dry cows.
3. Pregnant cows.
4. Calves.
5. Replacement heifers.
6. Pregnant heifers.
7. Active bulls.

Estimation of direct water intake was based on Morris equation and regression (Becket and Oltjen, 1993).

Morris equation:

Daily Water intake (DWI) = b0 + (b1*wt) + (b2*temp) + (b3*temp^2).

Bo, b2, and b3: constants vary from age to age

Temperature: average temperature of annual degrees

The regression equation and constant values for several physiological status in cattle is shown in table 5.

Table 5. Polynomial coefficients for DWI equation.

Regression coefficients				
Animal class (b)	**Intercept, L**	**Weight kg**	**Temp, c**	**Temp square**
	Bo	b1	b2	b3
Maintenance	-0.28	0.034	-0.38	0.030
Lactation	37	0.0	1.2	0.00088
Pregnant	39	-0.034	-0.013	0.026
Wintering	34	-0.028	0.015	0.026
Calve and heifers	0.90	0.067	0.0034	0.017
Bull	9.5	0.038	-0.68	0.052

(Journal of Animal Sci., 1993)

2.1.1.1 Water consumption by milking cows (L /day)

An average body weight of 476 kg was considered for lactating cows in Palestine with average milk production of 6000 kg/year. The lactation period was estimated to be 305 days. In estimation of direct water

consumption by lactating cows .88 litres of water is added for each kg of milk produced.

2.1.1.2 Water consumption by calves DWI (L/day)

An average body weight of 136 kg was considered. The total number of calves is the crop of 85% of cows minus 5% mortality.

2.1.1.3 Water consumption by heifers (Pregnant heifer), DWI (L/day)

To estimate direct water consumption a correction value (weight) for heifers was used:

(Adult cow body weight + growing heifer body weight) / 2

476 + 272 = 374 kg.

2.1.1.4 Non pregnant heifers DWI (L/day)

A body weight of 272 kg was considered.

2.1.1.5 Water consumption by bulls DWI (L/day)

The bulls considered were of an average body weight of 680 kg. Number is 5% of total cows.

2.1.1.6 Water consumption by pregnant cows and heifers (L/day)

Pregnant cows at last 65 days prenatal. An average body weight of 476 kg was used in the estimation. About 85% of total cows were considered to be pregnant.

2.1.2 Direct water consumption by sheep branch

The following stages were considered:

- Ewes.
- Replacement ewes.
- Fattening male and female lambs.
- Rams.

The estimation of direct water intake was based on Winchester and Morris (1956), see appendix 2, assuming the following status of sheep and goats:

1. Maintenance.
2. Pregnancy.
3. Dry.
4. Flushing.
5. Rams and bucks.
6. Yearlings.

While for offspring the following status were considered:

1. Suckling period.
2. Ripening period.
3. Fattening period.

2.1.2.1 DWI for sheep and goats at the first four months of lactation

The following equation was used in estimation of direct water consumption:

DIW L/kg DMI = (0.18 ((+, -0.03)) (average temp+1.25) (Harb & Taba´, 2000).*

2.1.2.2 DWI for non pregnant sheep and goat

The following equation was used:

*DWI=3.86+-75 *DMI- 0.99. (Harb and Al Taba', 2000).*

2.1.2.3 DWI for dries sheep and goats

The following equation was used:

*TWI/day [dry ewes]= 13.86+-[.75] * DMI/day - 0.99].(Harb and Al Taba',2000).*

In computing DWI and TWI (total water intake) number of factors were assumed:

1 Average body weight is 50 kg at dry and lactation stages.

2 Average body weight is 60 kg at pregnancy.

3 Kids percent is about 150 kids per 100 does.

4 90% of adult does had 50% twin bearing.

5 Milking season is about 240 days for goats and 180 days for sheep.

6 Milk yield is about 300-400 litre's per year for goats and 150-200 litre per year for sheep.

In doing the estimations many important factors and parameters were considered: number of livestock according to districts (seven different districts), the different ecological zones and annual average temperature by each district. The ecological zones considered were:

1 Jordan valley: (Jericho).

2 Southern hills: (Hebron, Beth Lehem ,Jerusalem and ramalla).

3 Northern hills: (Nablus, Jinin, Tubas and Salfit).

4 Sub coastal area: (Tulkarm and Qalqelia).

2.2 Indirect water intake (IWI)

It is the water consumed through consuming different feeds in livestock rations. The estimation of the amount of this type of water utilized the following parameters:

1. The major local crops cultivated and used in animal rations.
2. The crops areas and productivity.
3. The amount of dry matter in each crop.
4. The amount of dry matter intake.
5. A proposed ration for each type of animals concerned in the study.

6. The water requirement by each crop concerned, which was determined through crop water, use efficiency.
7. The ecological zones and the variation in temperature.

The crops concerned were wheat, barley, vetch, sern, broom (sorghum), lentils, alfalfa, and clover. The amount of water used in cultivation of each crop was determined, by knowing the applied water per dunum, however, all rain fed crops was estimated.

The different climatic parameters were used on monthly basis. The following parameters were used for calculating the reference evapo-transpiration; mean monthly minimum and maximum temperature, mean monthly relative humidity, mean monthly wind speed and sunshine hours.

The wind speed in the meteorological station of Hebron, Jericho, Jerusalem, and Nablus were measured at 10 meter above the surface, therefore needs to be adjusted at 2 meters to be used in the FAO Penman-Monteith equation to calculate the reference evapo-transpiration.

$U_2 = (4.87\ U_{10}) / (\ln (67.8 * 10 - 5.42)$

$U_2 = U_{10} * 0.748$

Where U_2: wind speed at 2 meter above the surface

U_{10}: wind speed measured at 10 meter above the surface.

To take into account the effect of changing crop characteristics, the growing season is divided into three crop growth stages as initial, mid-season, and end growth stages and for each a different crop coefficient is used. Where Initial stage runs from planting to ten- percent groundcover, water is lost mainly due to evaporation from the bare 50 % surface. It is influenced by the evapora-transpiration power of the atmospheric (reference-evapo-transpiration) and by the frequency and magnitude of the wetting event, both rainfall and irrigation.

To compute fodder water requirements there are many essential factors:

1. Crop Kc. 2. Sowing time. 3. Length stage, time from sowing to harvest, as shown in Table 6.

2.2.1 Growth stage

There are four growth stage related to crop water requirements according to the FAO classification, these are:

1. Initial stage which starts from the planting time and continue to the time of covers 10 percent.

2. Crop development starts from the end of the initial period and continues to the time effective full cover at which the crop covers 100% of land.

3. Late stage which starts at the end of the mid stage and ends at the time of full maturity and harvest.

Crop factor K_C for the initial stage, the mid stage and at harvest stage is used in CROPWAT software. K_C values for the development stage are interpolated. By using software for FAO CROPWAT the crop water requirement is computing according to FAO software (ARIJ).

Table 6. KC value for all crops growth stage in West Bank.

Fodder	**Initial stage**		**Growth stage**		**Last stage**	
	KC	**Stage length /d**	**KC**	**Stage length /d**	**KC**	**Stage length / d**
Wheat	0.7	115	1.15	40	0.4	30
Barley	0.3	105	1.15	30	0.25	30
Clover	0.4	105	0.9	30	0.85	-
Vetch	0.4	105	0.9	30	0.85	-
Sern	0.4	105	1.1	30	0.3	20
Broom (sorghum)	0.3	55	1	45	0.55	35

(FAO, 1998)

However, it was important to consider sowing date (season) and harvesting, as shown in the Table 7.

Table 7. Sowing times and time length.

Crop	**Sowing date**	**Harvesting date**	**Season length**
Wheat	1/12	1/6	180
Barley	1/12	15/5	165
Clover	1/12	15/4	135
Vetch	1/12	15/4	135
Sern	1/12	15/5	135
Broom (sorghum)	1/4	15/8	135

To achieve dry matter requirements for animals' two sources of information were used.

1. Nutrition tables.
2. Milking cows equation.

*DMI kg/ day = (0.025 * W) + (Y * 0.1) (McDONALD et al, 1989)*

DMI: Dry matter intake kg/ day.

W: *Live* body weight in kg.

Y: Milk yields kg per head per day.

0.025 and 0.1 are constant.

This equation fits mid and late lactation stage for mix diets. At first ten weeks of lactation the ration DM was reduced 2-3-kg/ day.

To estimate DMI kg per head per day, the prior equation was used for lactation (milking) cows, and nutrition tables were used for dry cows.

Estimation of DM requirements for classes of cattle were based on the following:

1. Adult cow
    a. Lactating (milking) cow with 476 kg in average body weight needs 3.4% of live body weight.

b. Dry cow (pregnant and non-pregnant) with 476 kg in average body weight needs 2.1% of body weight.

2. Heifers

   a. Pregnant heifer with 374 kg in average body weight needs 2.5% of live body weight.

   b. Non pregnant heifer with 272 kg in average body weight needs 2% of live body weight.

3. Calves: with 136 kg in average needs 2.5 % of live body weight.

4. Active bulls with 680 kg in average needs 2% of live body weight.

2.2.2 Estimation of DMI for sheep and goat

To estimate daily and annual DMI, nutrition tables were used.

1. Ewe: with 60 kg average body weight consume DMI 2.7 % from average body weight (daily consumption) (Harb & Taba´, 2000).

2. Lamb: average body weight 40 kg need daily DMI 3.8% from average body weight (Harb & taba´, 2000).

3. Replacements ewe: average body weight 50 kg need daily DMI 3% from average body weight (Harb & Taba´, 2000).

4. Ram: average body weight 80 kg need daily DMI 3.5% from average body weight (Harb & Taba´, 2000).

5. Doe: average body weight 50 kg need daily DMI 3% from average body weight (Harb & Taba´, 2000).

6. Kid: average body weight 30 kg need daily DMI 4.3% from average body weight (Harb & Taba´, 2000).

7. Replacement doe: average body weight 40 kg need daily DMI 3.5% from average body weight (Harb & Taba´, 2000).

8. Buck: with 60 kg average body weight need daily DMI 4% from body weight (Harb & Taba´, 2000).

2. 3 Estimation of water requirements for slaughterhouse

To estimate water used in processing of livestock carcasses several field visits were made by the researcher. Interviews with technicians and administrators were performed.

CHAPTER THREE
RESULTS AND DISCUSSION

CHAPTER THREE

Results and Discussion

3.1 Estimation of direct water intake by cattle, sheep and goats classes

3.1.1 Estimation of DWI by cattle classes

The numbers of cattle is shown in table 8. Numbers include all types of cattle used in the estimations: lactating cows, dry cows, heifers, calves and bulls.

The large quantity of DWI by lactation cows, lactation cows were the large number and need more DWI to producing there milk value. The DWI for cattle classes were estimating according to daily DWI, these value related to ration components, weather, and physiological status. The cattle herds in West Bank need their water requirements depend on farm volume, and breeding purposes.

Table 8. Population of cattle in the West Bank according to district

D. No.	Milking Cows Calving 85%	DryCows 15% of cows	Total cows	Calves	Heifers 50% non pregnant / 272kg	Pregnant Heifers 50% / 374kg	Total Heifers	Bulls	Total
1	250	44	294	179	29	29	58	33	564
2	3406	600	406	539	235	235	470	128	5143
3	2855	503	3358	211	148	147	295	76	3940
4	1337	235	1572	1207	157	157	314	45	3138
5	369	65	434	210	43	43	86	14	744
6	2618	461	3079	3890	262	262	524	114	7607
7	292	51	343	201	27	27	54	4	602
T	11127	1959	13086	6437	901	900	1801	414	21738

Numbers of cattle were concentrated in the Hebron district, which came in the first place, followed by the Nablus district in the second place and Jenin and Tulkarm in the third and fourth places. Table 8 shows the DWI by classes of cattle per year. However, DWI according to ecological zone is shown in Table 9. The DWI is highest in the northern hill zone compared to other zones as this ecological zone includes the largest number of cattle.

Table 9. Total DWI by all classes of cattle according to district (cubic meter)

	TWI for cows valvining 85 %of cow	TWI fodry cows 15 % of cow	TWI for total cows	TWI forcalves	TWI for 50 % pregnant heifers & 50 % of non preg heifers		TWI for total heifers	TWI for bulls	TWI for all herd in all districts
					non preg	preg			
1	6815.00	293.00	7108.00	1041.00	221.00	287.00	508.00	470.00	9127.00
2	94585.00	4085.00	98670.00	3523.00	2575.00	3665.00	6240.00	2036.00	110469.00
3	82435.00	3770.00	86205.00	1327.00	1371.00	1853.00	3224.00	1192.00	91948.00
4	37782.00	1641.00	39423.00	7532.00	1214.00	1548.00	2762.00	676.00	50393.00
5	10882.00	533.00	11415.00	1520.00	375.00	499.00	874.00	237.00	14046.00
6	70372.00	2937.00	73309.00	20579.00	2250.00	2903.00	5153.00	1569.00	100610.00
7	8028.00	358.00	8386.00	1178.00	247.00	347.00	594.00	60.00	10218.00
ll	310899.00	13617.00	324516.00	36700.00	8253.00	11102.00	19355.00	6240.00	386811.00

Table 10. TWI by cattle classes in West Bank according to district and Ecological zone

Regions according to climatic condition	District	Cattle no.	TWI/year(m3)	AVERAGE TWI m/head/ year
Jordan valley	**Jericho,**	**744**	**14046**	**18.9**
Southern hills	**Bethlehem, Hebron, rammallah Jerusalem**	**8773**	**100097**	**11.5**
Northern hills	**Nablus, Silfit, Tubas, and Jenin**	**9083**	**202417**	**22.3**
Coastal regions	**Tulkarm, qalqilia).**	**3138**	**50392**	**16.1**
Total		**21738**	**366949**	**16.9**

The above table, table 10, which contains the cattle census, the numbers of each cattle branch according to ecological zone distribution. Average DWI intake for all cattle were 46.2 L/day and 16900 L/year under West Bank condition by using Morris regression, and West Bank climatic data. The average DWI by classes of cattle per year is shown in table 10, the average DWI value for all cattle classes in ecological zone were 18.9, 11.5, 22.3 and16.1 for Jordan valley zone, southern hills, northern hills and coastal region respectively.

Table 11. Annual DWI by classes of cattle

D. No.	COWS 1. Number of cows. 2. Annual WI/head. Annual water intake/herd.			CALVES 1.Number of calves. 2. Annual water intake/head. 3. Annual water intake/ herd.			Heifers 1. Numbers of heifer. 2. Annual WI /head. 3. Annual WI/ herd.			BUULS 1. Number of bulls 2. Annual intake head. 3. Annual intake/ herd.		
	1	2	3	1	2	3	1	2	3	1	2	3
	no	m^3	m^3	No	M^3	m^3	No	m^3	m^3	no	m^3	m^3
1	294	25	7350	179	5.5	985	58	8.8	510	33	14.3	472
2	4006	26	104156	539	6.5	3504	526	11	5786	128	15	1920
3	3358	26	87308	211	6.6	1393	295	12	3540	76	16	1216
4	1572	25	39300	1207	6	7242	314	10.7	3360	45	15	675
5	434	27	11718	210	7	1470	86	12	1032	14	17	238
6	3079	24	73896	3890	5.3	20617	524	10	5240	114	14	1596
7	343	26	8918	201	5.9	1186	54	10.6	572	4	15	60
T	13086	26	340236	6347	5.7	36178	1875	10.7	20063	414	14.8	6127

The DWI by average local cattle was 46 liters. This value for lactating cow was 72 liters while it was 16, 30 and 41 for calves, heifers and bulls, respectively. These values are nearly similar to those reported by Heck (1995) and http://agnews (2002). However, the values for DWI reported by MoA (2002) was underestimated compared to study values (AmoP, 2002) showed that DWI by dairy cattle to be 55 liters.

3.1.2 Estimation of DWI by sheep

Based on the equations (see materials and methods) for estimation of direct water intake, the following values were estimated according to

different sheep classes (Table 12). The annual DWI of lactating ewes was 1.1 Mm^3 while DWI by replacement ewes, rams and lambs were 101.4, 70.8 and 163.7 thousand m^3, respectively.

Table 12. Annual DWI by classes of sheep.

D. No.	EWES 1. Number of ewes 2. Annual WI / head 3. Annual WI / herd			REPLACEMENTS 1. Number of replacements. 2. Annual water intake /head. 3. Annual water intake/herd.			RAMS 1. Number of rams. 2. Annual water intake/head. 3. Annual water intake/herd.			LAMBS 1. Number of lambs. 2. Annual water intake/ head. 3. Annual water intake/herd.		
	1	2	3	1	2	3	1	2	3	1	2	3
	No	m^3	m^3	No	m^3	m^3	no	M^3	M^3	No	m^3	m^3
1	42244	3.1	130956	8449	1.23	10392	2838	2.5	7095	14525	1.5	21788
2	47223	3.3	146391	9445	1.23	11617	7698	2.5	19245	20407	1.5	30611
3	69678	3.7	257809	13963	1.5	20904	4534	3	13602	24538	1.8	44168
4	19502	3.3	64357	3900	1.23	4797	1411	2.5	3528	12647	1.5	18971
5	21126	3.7	78166	4225	1.5	6338	1618	3	4854	7499	1.8	13498
6	105494	3.1	327031	21099	1.23	25952	5854	2.5	14635	15193	1.5	22709
7	32168	3.3	106154	6573	1.23	8085	2276	2.5	5690	7517	1.5	11276
T	338135	3.32	1122608	67627	1.5	101441	26229	2.7	70818	102326	1.6	163722

The daily sheep and goats DWI were 9 liters, which is similar to Heck (1995) and AMoP (2002) values.

3.1.3. Estimation of DWI by goats

The estimation of DWI by goats is shown in table 13. Table showed the water estimations by classes of goats which were by does, replacement does, kids and bucks 611.1, 53.2, 129.4 and 23.5 thousand cubic meter per year, respectively.

The DWI of all classes of animals concerned by the study according to the ecological zones is shown in the Tables 14, 15 and 16. As shown by tables, the lowest number of animals as witnessed in Jordan valley zone had the highest DWI. However, the highest population is located in the northern hills zone with highest DWI in general followed by the southern hills zone.

Table 13. Annual DWI by classes of goats.

D. No.	GOATS 1. Number of goats. 2. Annual water intake/head. 3. Annual water intake/herd.			REPLACEMENT 1. Number of replacements. 2. Annual water intake/head. 3. Annual water intake/herd.			BUCKS 1. Number of bucks. 2. Annual water intake/head. 3. Annual water intake/herd			KIDS 1. Number of kids. 2. Annual W I /head. 3. Annual W I /herd.		
	1	2	3	1	2	3	1	2	3	1	2	3
	No	.m³	.m³	No	m³	m³	No	m³	m³	No	m³	m³
1	38410	2.92	112157	7682	1.28	9833	1896	2.20	4171	19431	1.28	24872
2	21616	2.96	64416	4323	1.28	5533	1333	2.20	2933	12971	1.28	16603
3	30771	3.45	106160	6154	1.53	9416	1555	2.63	4090	15587	1.53	23848
4	5541	3.11	17233	1108	1.28	1418	393	2.20	865	4632	1.28	5929
5	22977	3.60	82717	4595	1.53	7030	1081	2.63	2843	13518	1.53	20603
6	48471	2.75	133295	9694	1.28	12408	2439	2.20	5366	16031	1.28	20520
7	29371	3.03	88994	5874	1.28	7519	1506	2.20	3313	13015	1.28	16659
Total	197157	3.1	611187	39430	1.35	53230	10203	2.31	23569	95185	1.36	129452

Table 14. Total DWI by cattle according to ecological zones

Ecological zone	Districts name	COWS: 1. Numbers 2. Annual WI/head 3. Annual WI/herd			Calves: 1. Numbers 2. Annual WI/ head 3. Annual WI/herd			HEIFERS: 1. Numbers 2. Annual WI /head 3. Annual WI/herd			BULLS: 1. Numbers 2. Annual WI/head 3. Annual WI /herd		
		1	2	3	1	2	3	1	2	3	1	2	3
		NO	M^3	M^3	No	m^3	m^3	No	m^3	m^3	no	m^3	m^3
Jordan valley	Jerecho	434	27	11718	210	7	1470	86	12	1032	14	17	238
Southern hills	Jerusalem Ramalla Bethlehem Hebron	3716	24	89184	4270	5.3	22631	636	9.8	6233	151	13.9	2099
Northern hills	Nablus Salfit Jinin Tubas	7364	26	191464	750	6.4	4800	821	11.4	9359	204	15.3	3121
Coastal region	Tulkarm Qalqilya	1572	25	39300	1207	6	7242	314	10.7	3360	45	15	675
Total		13086	25.2	329767	6437	5.6	36047	1875	10.73	20119	414	14.8	6127

Table 15. Total DWI by sheep according to ecological zone.

Ecological Zones	Districts name	EWES: 1. Numbers 2. Annual WI /head 3. Annual WI/herd			REPLACEMENT 1. Numbers 2. Annul WI/head 3. Annul WI /herd			RAMS: 1. Numbers 2. Annul WI/head 3. Annual WI/ herd			LAMBS: 1. Numbers 2. Annual WI/head 3. Annual WI/ herd		
		1	2	3	1	2	3	1	2	3	1	2	3
		No	m^3	m^3	no	m^3	m^3	No	m^3	m^3	no	m^3	m^3
Jordan Valley	Jerecho	21126	3.7	78166	4225	1.5	6338	1618	3	4854	7499	1.8	14398
Southern Hills	Jerusalem Ramalla Bethlehem Hebron	180606	3.2	577939	36121	1.23	44429	10968	2.5	27420	37235	1.5	55853
Northern Hills	Nablus Salfit Jinin Tubas	116901	3.51	410323	23381	1.38	32266	12232	2.7	33026	44945	1.7	76407
Coastal Regions	Tulkarm Qalqilya	19502	3.3	64357	3900	1.23	4797	1411	2.5	3522	12647	1.5	18971
Total		338135	3.32	1122608	67627	1.3	87915	26229	2.26	59278	102326	1.6	163722

Table 16. Total DWI by goats according to the ecological zones.

Ecological zone	District	DOES 1. Numbers 2. Annual WI/head 3. Annual WI/herd			REPLACEMENTS 1. Numbers 2. Annul WI/head 3. Annul WI/herd			BUCKS 1. Numbers 2. Annual WI/head 3. Annual WI/herd			KIDS 1. Numbers 2. Annual WI/head 3. Annul WI/herd		
		1	2	3	1	2	3	1	2	3	1	2	3
		No	m^3	m^3	No	m^3	m^3	No	m^3	m^3	No	m^3	m^3
Jordan valley	Jerecho	22977	3.6	82717	4595	1.53	7031	1081	2.63	2843	13518	1.53	20683
Southern hills	Jeruslem Ramalla Bethlehem Hebron	116252	2.9	337131	23250	1.28	29760	5814	2.2	12791	48477	1.28	62047
Northern hills	Nablus Salfit Jinin Tubas	52387	3.3	172877	10477	1.43	14982	2888	2.43	7018	28558	1.42	40552
Costl region	Tulkarm Qalqilya	5541	3	16623	1108	1.28	1418	393	2.20	865	4632	1.28	5929
Total		197157	3.1	611187	39430	1.35	53231	10176	2.31	23507	95185	1.36	129452

3.2 The indirect water intake IWI

3.2.1. The indirect water intake by cattle classes

The estimation of this type of water was made through estimation of feed dry matter and total dry matter intake by animals according to the physiological stage of animals. Table 17, showed the daily and annual dry matter intake by cattle classes. Values for daily DMI were 16.2, 9.6, 9.4, 5.5, 3.4 and 13.6 kg by cows, heifers, calves and bulls, respectively.

Table 17. DMI by cattle classes

Number	Cattle branch	Average body weight Unit: kg	DMI kg/day %from body weight	DMI kg/head/day	DMI Kg/ head /year	Annual ration = DMI /.87 (*)
1: Adult cows	**Lactation**	476	3.4%	16.2	5917	6802
	Dry	476	2%	9.6	3507	4032
2: Heifers	**Pregnant**	374	2.5	9.4	3434	3947
	Non pregnant	272	2	5.5	2009	2310
3: Calves	**Male and Female**	136	2.5	3.4	1242	1428
4: Bulls	**Active bull**	680	2	13.6	4968	5710

(*) .87 mean percentage of DM in ration.(Mcdonald *et al*., 1987)

Table 18. DMI by classes of cattle according to district

District No.	No. of lactation cow	Annual DMI ton/herd	No of dry cow	Annual DMI ton/ herd	No of pregnant heifers	Annual DMI ton/herd	No. of non pregnant heifer	Annual DMI ton/herd	No. of calves	Annual DMI ton/herd	No. of bull	Annual DMI ton /herd
1	250	1480	44	154	25	86	25	50	187	233	33	164
2	3406	20154	600	2104	287	985	287	577	539	670	128	636
3	2855	16893	503	1764	147	505	148	297	211	262	76	378
4	1572	9302	235	824	131	450	131	263	1259	1564	45	224
5	369	2184	65	228	37	127	37	255	222	276	14	70
6	2618	15491	461	1616	262	900	262	526	3890	4832	114	566
7	292	1728	51	179	29	100	29	58	201	250	4	20
T	11362	67229	1969	6905	918	3153	919	1846	6509	8084	414	2057

Table 19. DMI by cattle classes according to ecological zone

Zone No.	No of lactation cow	Annual DMI ton/ herd	No of dry cow	Annual DMI ton/ herd	No of pregn ant heifer	Annual DMI ton/her d	No of non pregn ant heifer	Annual DMI ton/her d	No. of calves	Annual DMI ton/herd	No of bulls	Annual DMI ton/her d
1	369	218	65	228	37	127	37	74	222	276	14	70
2	3160	1898	556	1950	316	1085	316	635	4278	5313	151	750
3	6261	37046	1113	3903	434	1490	435	874	750	932	204	1014
4	1572	9302	235	824	131	450	131	263	1259	1564	45	224
T	11362	67229	1969	6905	918	3153	919	1846	6509	8084	414	2057

The daily and annual average DMI for sheep and goat branch considered average DMI of the six physiological stages as the following:

a. DMI for ewes equal 1.6 kg per day.

b. DMI for fattening lamb 1.5 kg per day.

c. DMI for replacement 1.5 kg per day.

d. DMI for rams 1.5 kg per day.

Table 20. DMI by sheep classes.

No	Sheep branch	Average body weight	DMI kg/ day. % from body weight	Daily DMI kg per head	Annual DMI	Ration equal annual DMI /0.87
1	**Ewe**	60	2.7	1.6	585	673
2	**Lamb**	40	3.8	1.5	548	630
3	**Replacement**	50	3	1.5	548	630
4	**ram**	80	3.5	2.8	1023	1176

Table 21. DMI by sheep according to district.

D. No.	Ewes	Annual DMI ton/herd	Lambs	Annual DMI ton/herd	Replacement	Annual DMI ton/herd	Rams	Annual DMI ton/herd
1	42244	24712	14525	7960	8449	4630	2365	2419
2	47223	27626	20407	11183	9445	5176	6415	6563
3	69678	40762	24538	13447	13936	7637	3778	3865
4	19502	11409	12647	6931	3900	2137	1176	1203
5	21126	12359	7499	4110	4225	2315	1348	1379
6	105494	61714	15193	8326	21099	11562	4878	4990
7	32868	19228	7515	4118	6573	3602	1897	1940
T	338135	197809	102332	56078	67627	37059	21857	22359

Table 22. DMI by sheep according to ecological zone

D. No.	No of ewes	Annual DMI ton/ herd	No of lambs	Annual DMI ton/herd	No replace-ment	Annual DMI ton /herd	No of rams	Annual of DMI ton/herd
1	21126	12359	7499	4110	4225	2315	1348	1379
2	180606	105655	37235	20405	36121	19794	9140	9349
3	116901	68388	44945	24630	23381	12813	10193	10428
4	19502	11409	12667	6942	3900	2137	1176	1203
T	338135	197809	102332	56078	67627	37060	21857	22359

3.2.2 The indirect WI for sheep and goats

Table 23. Daily and annual DMI by goats classes.

No.	Branch	DMI % of body weight	Average body weight	Daily DMI kg per head	Annual DMI kg	Annual ration = DMI/0.87
1	**Doe**	3	50	1.5	548	630
2	**Kid**	4.3	30	0.9	329	378
3	**Replace-ment**	3.5	40	1.4	511	587
4	**Buck**	4	60	2.4	876	1007

Table 24. DMI by goats according to district.

D. No.	Doe	Annual DMI ton/ herd	Kids	Annual DMI ton/ herd	Replac-ement	Annual DMI ton/ herd	Buck	Annual DMI ton/ herd
1	38410	21049	19431	6393	7682	3925	1896	1661
2	21616	11845	12971	4267	4323	2209	1333	1168
3	30771	16863	15587	5128	6154	3140	1555	1362
4	5541	3036	4632	1524	1108	566	393	344
5	22977	12591	13518	4447	4595	2348	1081	947
6	48471	26562	16031	5274	9694	4954	2439	2184
7	29371	16095	13015	4282	5874	3002	1506	1319
T	197157	108042	95185	31316	39430	20149	10203	8938

Table 25. DMI by goats according to ecological zone.

Zone no	No of doe	Annual DMI ton/ herd	No of replac-ement	Annual DMI ton/ herd	No of buck	Annual DMI ton/herd	No of kids	Annual DMI ton/herd
1	22977	12591	4595	2348	1081	947	13518	4447
2	11625	6370	23250	11881	5841	5093	48477	15949
3	52387	28708	10477	5354	2888	2530	28558	9396
4	5544	3038	1108	566	393	344	4632	1524
T	197157	108025	39430	20149	10203	8914	95185	31316

The estimated actual dry matter intake was computed through dividing total DM by .87 (feed DM). The composition of rations was based on 60% concentrate and 40% roughage as shown in Table 26.

3.3. DMI and actual DMI by cattle, sheep and goats

Table 26. Total and actual DM intake by animals concerned in the study

Animal group	**Annual DMI ton/year**	**Actual DMI = DMI/0.87**	**Percentages of feeds**	
			60% concentrated	**40% roughage**
Cattle	89274	102614	61568	41046
Sheep	317848	365342	219205	146137
Goat	168404	193568	116141	77427
Total	258843	661524	396914	264610

The actual feed DMI was 662.0 thousand tons of feed composed of about 397.0 tons of concentrates and 265 thousand tons of roughage's. The per animal consumption was consistent to other values reported (AMoP, 2002, Abu Omar, 1998).

3.4. Crop water requirement values

Table 27, showed a proposed ration for classes of cattle, this ration was a model in which estimations of water needs by crops were made. The total water required to produce this ration was estimated. The estimation was based on the crop use of water as described in the materials and methods section.

The amounts of water required by the concerned crops are shown in Table 27. The lowest requirement recorded was in the semi coastal zone followed by northern hills. However, the highest requirements were recorded in Jordan valley zone. Clover and vetch had the lowest water requirements as harvested in many cuttings per year.

Table 27. Crop water requirements, cubic meter per dunum per season according to district.

Crop / District	Wheat	Barley	Clover	Vetch	Sern	Broom
Jerusalem	476	265	216	216	276	554
Nablus	398	225	180	180	230	436
Jinin	431	241	193	193	247	517
Tulkarm	353	190	175	175	221	365
Jericho	577	329	260	260	333	692
Hebron	383	211	173	173	220	421
Ramallah	476	265	216	216	276	554

The detailed areas and requirement for each crop is shown in Tables 28, 29 and 30. The largest area was for wheat followed by barley, vetch and sern then sorghum.

Table 28. Wheat and barley data.

D. No.	Wheat			Barley		
	Area	**Water requir-ements cubic meter/d**	**Total requir-ement**	**Area**	**Water requir-ement cubic meter/d**	**Total requi-ement**
1	7428	476	3535728	7357	265	1949605
2	23318	398	9280564	2703	225	608175
3	73820	430	31742600	5285	245	1294825
4	6308	353	2226742	1793	190	340670
5	4605	577	2657085	200	329	65800
6	41195	375	15448125	73500	211	154350000
7	19120	476	9101120	8585	265	1480027
T	175794		73991964	99423		160089102

(AMoP, 2000)

Table 29. Clover and vetch data.

D. No.	Clover			Vetch		
	Area	Water requirements cubic meter/d	Total water requirements	Area	Water requirements cubic meter/d	Total water requirements
1	-	-	-	202	216	43632
2	1560	180	280800	2498	230	574540
3	16665	194	3233010	13690	194	2655860
4	-	-	-	818	221	180778
5	960	260	249600	60	260	15600
6	710	173	122830	3195	173	552735
7	-	-	-	1340	267	35778
T	19895		3886240	21803		4058923

(AmoP, 2000)

Table 30. Sern and Broom (sorghum) data.

D. No.	SERN			BROOM (SORGHUM)		
	Area	Water requirements cubic meter/d	Total water requirements	Area	Water requirements cubic meter/d	Total water requirements
1	709	276	195684	15	544	8310
2	1782	230	409860	723	436	315228
3	1425	247	351975	695	517	359315
4	673	221	148733	126	365	45990
5	-	-	-	-	-	-
6	14125	220	3107500	1993	421	839035
7	-	-	-	-	-	-
T	18714		4213752	3552		1567878

(AmoP, 2000)

The per kg requirement of water for each crop is shown in Table 31. It was found that the water use efficiency for all of the crops was the most efficient in Tulkarm district, while the lowest efficiency was observed in Jericho. However, the water use efficiency for vetch and clover was the best in Jenin district.

3.5 Water use efficiency (WUE) for feed crops in West Bank conditions

Table 31. Water requirement per kg crop according to district.

District	All values are cubic meter per one kg DM of fodder					
	Wheat	**Barley**	**Clover**	**Vetch**	**Sern**	**Broom**
1	1.2	0.72	-	1.16	1.2	3.69
2	1.3	0.71	0.86	1.05	1.24	8.70
3	1.3	0.60	0.29	0.42	1.3	3.5
4	0.94	0.57	-	1.05	1	3.65
5	1.36	0.72	0.31	0.87	-	-
6	1.04	0.56	0.58	0.51	0.96	-
7	1.11	0.70	-	1.25	-	-

Water use efficiency varies from district to district according to several factors:

1. Rainfall variances.
2. Climatic data.
3. Sowing old land races seeds.
4. Agricultural process.

3.6 Average WUE for feed crops in West Bank

To continue study purposes average water use efficiency (WUE) would be seen, next table 32, contains WUE as average resulted value in West Bank district:

Table 32, average WUE for six feed crops in West Bank.

Feed crop no.	Feed crop	WUI m^3/ kg yield (grain + straw)
1	Wheat	1.18
2	Barley	0.65
3	Clover	0.51
4	Vetch	0.9
5	Sern	1.14
6	Broom (sorghum corn)	4.95

Each kg ration needs 0.903-m^3 water to produce it in Palestinian conditions, it is large value related to fodder production, water shortage and profit obtained.

Less soil moisture in rain fed agriculture occurs in the most sensitive stage fodder growth, the shortage occur generally in spring, but some times in other growth stage, the shortage results are more stress, poor growth and low yields. (ICARDA-033/5000/Aug.1997)

Comments: water use efficiency (WUE) in Palestine is very bad, poor products, week agricultural institutions, low quantity of crops yield, rotation. A rain fed agriculture has unknown risk volume, and several types of old agriculture's without any developments.

3.7 Proposed ration for cattle branch

Table 33. Proposed ration for all cattle branch.

Formatives	Formative quantity per ton
Mashed barley	**678 kg**
Soya bean meal (45% protein)	**154 kg**
Wheat bran	**150 kg**
DCP	**5**
Soft powder stone	**10**
Salt	**3**
Trace elements and vitamins	**Manufacturer recommendation**
Protein percentage	**16%**
Energy Mj /kg	**11-11.5**

(Harb, 2002)

After that the proposed formatives must be converted to real quantity for all cattle branch according to computed DMI for cattle. The same steps must be used to determine ration formatives for sheep's and goats. To interpret precious cattle ration into crude materials quantity some calculations must be takes place. Formative values for cattle feeds appear in next table finally, some quantities are from West Bank farms and the most formatives imported out side country. Feed importers like Israel

traders were exploiting Palestinian breeders to elevate there profit and embedded Palestinian farmers aspirations. However, Palestinian peoples under Israel occupation. See estimated feeds quantity for cattle herds in next table.

The total dry matter intake by classes of cattle was determined based on type of ration (concentrate and roughage) Table 34. Since water requirements for each feed ingredient was known, then total water requirements were calculated as shown in Table 34.

3.8 Actual DMI by cattle classes

Table 34. Cattle feed materials table.

No	Ration	Ton per year	WUI m^3/kg	WUI * formative weight $m^3/year$
1	80% barley +20% wheat or 50% barley + 40% Mays + 10 wheat	41734	0.65	27124500
2	Soya peen meal (48% CP)	9481	1.85*	17539850
3	DCP(D calcume phosphate	308		
4	Soft stone powder	615		
5	Salt	185		
6	Wheat bran	9235	1.18	10897300
Total		61568		55561650

Table 35. Water requirements for ration for cattle.

Cattle	Ration kg/day	Water produced ration m^3/day	Total water m^3/year	Rough-age kg/day	Water produced roughage m^3/day	Total roughage water m^3/year	Total water for ration and roughage m^3/year
Diary cow	11.7	10.6	3872	6.92	6.53	2385	6275
Dry cow	6.62	5.98	2184	4.14	3.87	1414	3598
Pregnant heifer	6.48	5.85	2137	4.32	4.03	1474	3611
Non pregnant heifers	3.79	3.42	1249	2.35	2.20	802	2051
Calves	2.35	2.12	774	1.56	1.46	532	1306
Bull	9.38	8.47	3094	6.25	5.84	2132	6226
Total			13310			8739	22049

Sure that roughage convert from physiological stage to another, its likely to interpret the importance of fibers. Fibers are very important for digestive system and more than that for milk lipid production (Harb, 2002). Other formatives may be change from ration to ration, but additives (vitamins, minerals, DCP, trace elements and concentrated) variable according to requirements need. Animal breeders thought about benefit cost to increased their finance profits, because 70% from breeding cost consumed by nutrition, all natural alternatives fodder come from echo bio diversity.

In this study the credit ration for both sheep's and goats contain all essential formatives according to the nutrition requirements for sheep and

goats. The proposed ration has 15-16% CP and energy 11-11.5 MJ/kg ration, vitamins are manufacturer recommendation, and some formatives may be changed according to availability of crude material and nutrition method use.

Similar procedure was performed to reach water requirement by sheep and goats feeds. Steps were shown in the following tables.

Table 36. Proposed ration for sheep's and goats.

Formatives	**Kg formative per ton of ration**
Mashed barley 69.8%	698
Soya meal (48% CP) 13%	130
Wheat bran 15%	150
Soft stone powder 1%	10
DCP 0.5%	5
Salt 0.5%	5
Trace menials 0.02%	2
Total	1000

(Harb & Taba',2000)

Table 37. Rations and its water requirements for sheep and goat.

Formative no	Component and %	Quantity/year	WUI m^3	Total water requirements m^3
1	Barley or corn and 20% wheat	234072	.76	177894720
2	Soy peen (48% CP)	43595	1.85*	80650750
3	Wheat bran	50302	1.18	59356360
4	Stone powder	3352		
5	DCP	1677		
6	Salt	1677		
7	Trace minerals	671		
Total		335346		317901830

Table 38. Comprehensive table of water use for sheep and goat ration.

Animal	Conc. kg/day	Water req./ conc. m^3	Water req. ration m^3/year	Roughage kg /day	Water req. roughage m^3/day	Water req. roughage m^3/year	Total water req. both conc. +roughage
Ewe	1.1	1.05	384	0.74	0.69	351	699
Replace-ment	1.03	0.98	358	0.69	0.64	234	592
Lambs	1.03	0.98	358	0.69	0.64	234	592
Ram	1.9	1.81	661	1.3	1.21	442	1103
Doe	1.03	0.98	358	0.69	0.64	234	592
Replace-ment	0.96	0.91	332	0.65	0.61	223	555
Kid	0.62	0.59	216	0.41	0.38	139	355
Buck	1.6	1.52	555	1.16	1.08	395	950

Comprehensive table of water requirements for livestock production in West Bank is shown in table 39. Data included in table are based on previous computations.

Table 39. Comprehensive table for live stock production water requirements.

Animal type	Annual WI m/ head	Annual WI m / herd	Annual water produce fodder m/head	Annual water produce fodder m/herd	Total water for WI + water produce fodder m/head	Total water for WI +water fodder production m/ herd
Diary cows	26	34236	6275	69821925	6301	69856161
Dry cows	26		3598	7048482	3624	7082718
Pregnant heifers	10.7	20063	3611	3249900	3622	3269963
Non pregnant heifers	10.7		2051	1847951	2062	1878014
Calf's	5.7	36178	1306	8406722	1312	8442900
Bull	14.8	6127	6226	2577564	6241	2583691
Ewes	3.32	1122608	699	236356365	703	237478973
Replacement ewes	1.5	101441	592	40061824	594	40163265
Lambs	1.6	163722	592	60576992	594	60740714
Rams	2.7	70818	1103	28930587	1106	29001405
Does	3.1	611187	592	116716944	395	117328131
Replacement does	1.35	53230	555	21883650	557	21936880
Kids	1.36	129452	355	33790675	357	33920127
Bucks	2.31	23569	950	9692850	953	9716419
Total		2372631		640962431		643399361

As shown in Table 31, the annual water requirements of all classes of animals were-643 Mm^3. However, the daily requirements were 1.76 Mm^3.

3.9 Estimation of processing water in slaughterhouse

Total water used at slaughterhouse depend on carcass type, and number of animals processed. Each beef carcass need 1.1 m/carcass and sheep or goat carcass need 0.27m/carcass. These values were extremely lower than those reported by Bucket and Oltjen (1994). The following table (32) shows number of carcasses and water requirements each West Bank districts:

Table 40. Comprehensive table of water processing for beef, sheep and goats carcasses

D. No.	No of Sheep & goats carcasses	Carcasses water needs m^3/carcass	Total water requirements m^3/year	No of beef carcasses	Carcasses water needs m^3/carcass	Total water for beef carcass m^3
1	25939	0.27	7004	5085	1.1	5594
2	28033		7569	9066		9973
3	5035		1360	2765		3042
4	11853		3200	2315		2547
5	3729		1007	434		477
6	14086		3803	2829		3112
7	27928		7541	4869		5356
T	116603		31483	27363		30099
Total no for beef, sheep and goat = 61581 m^3						

3.10 Recommendations

The following recommendations can be addressed:

1. A relatively huge amount of water is consumed by livestock sector in Palestine.
2. The water requirements for livestock should be considered and calculated when water shares being distributed.
3. It is recommended to find the proper percent of increase in livestock population at which no negative effects on other sectors.
4. It is highly recommended to utilize agricultural and industrial by-products in feeding livestock. This will decrease the demand on the limited water resources.

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Table (1): Contain DWI by cattle classes L/head/day and TWI cubic meter /head/year.

Cattle class	Average body weight/head	DWI L/day	TWI L/year
Maintenance	476	21.04	77685
Lactation cow	476	79.79	29143
Pregnant cow	476	33.86	12367
Wintering pregnant heifer	476	32.30	11798
Calf's	136	17.48	6385
Active bull	680	43.78	15992
Non pregnant heifer	272	26.30	9606
Pregnant heifers	374	35.16	12843

Table (2) TWI for lactation cow has 476kg body weight in West Bank district.

District No.	Average body weight	Average annual temperature	Average DWI l/head/day without milk need	DWI with water milk needs	WI L/ year
1	476	17.14	57.83	75	27394
2	476	17.783	58.62	76	27759
3	476	20.26	61.68	80	29220
4	476	18.91	60.00	78	28490
5	476	22.41	63.33	81	29586
6	476	15.89	56.18	74	27029
7	476	17.50	58.27	76	27759

Table (3). calve WI L/day and l/year

District no	Average body weight	Average annual temperature	WI L/day	WI L/year
1	136	17.14	15.10	5516
2	136	20.69	17.36	6341
3	136	20.26	17.10	6246
4	136	18.91	16.15	5899
5	136	22.41	18.36	6706
6	136	15.89	14.41	5264
7	136	18.55	15.92	5815

Table (4). WI L/day and L/year for pregnant heifers.

District no	Average body weight kg	Average annual temperature	WI L/day	WI L/year
1	374	17.14	31.42	11477
2	374	17.78	32.10	11725
3	374	20.26	34.50	12602
4	374	18.91	33.10	12090
5	374	22.41	36.92	13485
6	374	19.98	30.33	11078
7	374	18.55	32.72	11951

Table (5): WI L/day and L/year for non-pregnant heifer.

District No.	Average body weight kg	Average annual temperature	WI L/day	WI L/year
1	272	17.142	24.18	8831
2	272	17.783	24.56	8971
3	272	20.260	25.37	9264
4	272	18.910	25.27	9229
5	272	22.410	27.74	10131
6	272	19.900	23.52	8590
7	272	17.500	25.04	9145

Table (6). WI L/day and L/year for dry cow.

District no	Average body weight kg	Average annual temperature c°	WI L/day	WI L/year
1	476	17.142	18.21	6650
2	476	17.783	18.64	6806
3	476	20.260	20.53	7496
4	476	19.910	19.45	7103
5	476	22.410	22.46	8202
6	476	15.890	17.44	6370
7	476	18.550	17.18	7004

Table (7). WI L/day and L/year for active bull.

District no	Average body weight kg	Average annual temperature c°	WI L/day	WI L/year
1	680	17.142	38.97	14.231
2	680	17.783	39.70	14498
3	680	20.265	42.92	15675
4	680	18.910	41.08	15003
5	680	22.410	46.22	16880
6	680	15.890	37.66	13757
7	680	18.550	40.62	14836

Table (8). WI L/day and L/year for pregnant cow last 65 days

District No.	Average body weight kg	Average annual temperature c°	WI L/day	WI L/year
1	476	17.142	30.24	11043
2	476	17.783	30.81	11253
3	476	20.260	33.23	12137
4	476	19.910	31.87	11640
5	476	22.410	35.58	12996
6	476	15.900	29.18	10656
7	476	17.500	31.52	11513

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Table (9). distribution of cattle populations in West Bank district.

District No.	Lactation cows	Calf's	Heifers	Bulls	Dry cows
1	250	131	106	33	44
2	3406	539	470	128	600
3	2855	211	295	76	503
4	1572	1012	1527	45	235
5	369	210	369	14	65
6	2618	3361	2618	114	461
7	292	201	292	4	51
Total	11362	5665	5677	414	1959

Table (10). WI L/head/day, WI L/herd/day, WI m/head/year and WI m/herd/year for lactation cows.

District No.	Number of lactation cows	WI L/head/day	WI L/herd/day	WI m/head/year	WI m/ herd/year
1	250	75	18656	27.26	6815
2	3406	76	258886	27.77	94585
3	2855	80	225743	28.88	82453
4	1336	78	103410	28.28	37782
5	369	81	29786	29.49	10882
6	2618	74	192618	26.88	70372
7	292	75	21979	27.50	8028
Total	11360				310917

Table (11): WI for dry cow.

District No.	No. of dry cows	WI L/head/day	WI L/ herd/day	WI m/head/year	WI m/ herd/year
1	44	18.20	801	0.8	293
2	600	18.64	11184	11.18	4085
3	503	20.52	10322	10.32	3770
4	231	19.44	4491	4.49	1640
5	65	22.45	1460	1.46	533
6	461	17.44	8040	8.04	2937
7	51	19.17	978	0.98	357
Total	1955		37274	37	13615

Table (12) Calves, non-pregnant heifers and pregnant heifers.

District No.	Calf's	Non-pregnant heifers	Pregnant heifers	Total
1	187	25	25	237
2	539	287	287	1113
3	211	148	147	506
4	1259	131	131	1521
5	222	37	37	269
6	3890	262	262	4414
7	201	29	29	259
Total	6509	919	918	8346

Table (13): DWI calves.

District No.	No. of calves	WI L/head/day	WI L/herd/day	WI m/head/year	WI m/herd/day
1	187	15.10	2849	2.85	1041
2	539	17.36	9644	9.64	3523
3	211	17.10	3633	3.63	1327
4	1259	16.15	20620	20.62	7531
5	222	18.63	4161	4.16	1520
6	3890	14.41	56342	56.34	20579
7	201	19.92	3225	3.22	1178
Total	6509				36699

Table (14). DWI for non-pregnant heifers.

District No.	No. of non pregnant heifers	WI L/head/ day	WI L/herd/ day	WI m/head/year	WI m/herd/year
1	25	24.17	604	0.60	221
2	287	24.56	7049	7.05	2575
3	148	25.36	3753	3.75	1371
4	131	27.36	3322	3.32	1213
5	37	27.73	1026	1.03	375
6	262	23.51	6160	6.16	2250
7	27	25.03	676	0.68	247
Total	917				8252

Table (15). DWI for pregnant heifers.

District No.	No. of pregnant heifers	WI L/head/day	WI L/herd/day	WI m/head/year	WI m/herd/year
1	25	31.42	786	0.79	287
2	287	34.96	10034	10.03	3665
3	147	34.50	5072	5.07	1853
4	131	33.10	4336	4.34	1584
5	37	36.92	1366	1.37	499
6	262	30.33	7947	7.95	2903
7	29	32.72	949	0.95	347
Total	918			30.49	11138

Table (16). WI for active bulls.

District No.	No. of bulls	WI L/head/day	WI L/herd/day	WI m/head/year	WI m/herd/year
1	33	38.69	1286	1.29	470
2	128	43.53	5572	5.57	2035
3	76	42.91	3261	3.26	1191
4	45	41.07	1848	1.85	675
5	14	46.21	647	0.65	236
6	114	37.66	4293	4.29	1568
7	4	40.61	162	0.16	59
Total	414		17070	17.07	6235

Table (17): water requirements for pregnant and fattening sheep in several temperature degrees.

Temperature C^o		WI L/kg DM for ewe single bearing Pregnant month				
	Fattening sheep	1	2	3	4	5
15	2	2	2.8	3	3.6	4.4
15-20	2.2	2.5	3.5	3.75	4.5	5.5
>20	3	3	4.2	4.4	5.4	6.6

(Harb & Tabaa, 2000)

Table (18): DMI kg/day in all physiological status for sheep in growth stage.

Nature of eaten feed	Metabolic energy value/total energy ().	Live body weight				
		20	30	40	50	60
		DM g/kg metabolic weight	DM g/kg metabolic weight	DM g/kg metabolic weight	DM g/kg metabolic weight	DM g/kg metabolic weight
Roughage	0.4	33	36.1	39.2	42.2	45.3
	0.5	43.5	46.6	49.6	52.7	55.8
	0.6	54	57	60.1	63.2	66.2
	0.7	64.6	67	70.6	73.6	76.2
Soft ration	0.5	103.1	99.1	95	90.9	86
	0.6	95.3	91.3	87.2	83.1	79
	0.7	87.5	83.5	76.3	75.3	71

(Harb & Tabaa, 2000)

Table (19): DMI kg/day eaten by for pregnant ewe g/kg metabolic weight.

Prenatal weeks	Fetus No.	Ewes with 40 kg live weight	Ewes with 75 kg live weight
12	1	50.3	50
8	1	56.5	55.7
4	1	63.6	64
0	1	72	74
12	2	56.9	57.2
8	2	65.9	67.3
4	2	77.7	79.9
0	2	93	96.2

(Harb & Tabaa, 2000)

Table (20): DMI g/kg metabolic weight for ewes during lactation.

ration	Fetus No.		Kios ewe n ration (67% concentrated)
	1	2	
Hay + concentrated ration	80	85	120 - 150
	100	100	
	135	135	

(Harb & Tabaa, 2000)

Table 22: DMI (kg /day) in all physiological status in sheep's and goats for all Palestinian herds. **

Physiological status	Live wt/kg	DMI	Digestion p	TDN	Ca g	P g	NaCl g	Carotene mg	Vit A
Maintenance	45	1.08	54	0.59	0.3.2	2.5	9	1.7	935
	54	1.26	59	0.68	3.3	2.6	10	2	1100
	64	1.35	68	0.77	3.4	2.7	11	2.4	1320
	73	1.53	73	0.86	3.5	2.8	12	2.7	1485
Bearing 6week prenatal	45	1.53	82	0.91	4.2	3.1	10	5.8	2320
	54	1.71	86	1	4.4	3.3	11	6.8	2720
	64	1.89	91	1.09	4.6	3.5	12	7.9	3160
	73	1.98	91	1.13	4.8	3.7	13	9.1	3640
Lactation 10-14 week postnatal	45	1.89	100	1.24	6.2	4.6	11	5.8	2320
	54	2.07	104	1.33	6.5	4.8	12	6.8	2720
	64	2.25	109	1.40	6.8	5	13	7.9	3160
	73	2.34	113	1.43	7.1	5.2	14	9.1	3640
Flushing derive	45	1.3	60	0.68	3.84	3	10.8	2.04	1122
	54	1.51	73	0.86	3.96	3.12	12	2.4	1320
	64	1.62	86	0.91	4.08	3.24	13.2	2.88	1548
	73	1.84	91	0.91	4.2	3.36	14.4	3.24	1782
Replaced female lambs	27	1.08	73	0.68	2.9	2.6	8	1.7	765
	36	1.26	68	073	3	2.7	9	2.3	1065
	45	1.35	64	0.77	3.1	2.8	10	2.8	1260
	54	1.33	59	0.77	3.2	2.9	11	3.4	1530
Growth lambs and	36	1.26	82	0.91	3	2.7	9	2.3	1035

Rams	45	1.53	82	0.95	3.1	2.8	10	2.8	1260
	54	1.71	82	0.95	3.2	2.9	11	3.4	1530
	64	1.89	82	1.04	3.3	3	11	4	1800
	73	1.98	82	1.09	3.4	3.1	12	4.5	2029
Lambs Fattening	27	1.08	82	0.68	2.9	2.6	8	1	500
	32	1.26	86	0.82	2.9	2.6	8	1.2	660
	36	1.35	91	0.95	3	2.7	9	1.4	770
	41	1.53	91	1.04	3	2.7	9	1.5	825
	45	1.62	91	1.09	3.1	2.8	10	1.7	935

(Abu Hasan, *et al*., 1983)

Table (23): ref (3)*: DMI {g /kg metabolic weight} for sheep in growth stage.

Nature of eaten feeds	Metabolic energy value/ total energy metabolizability	Live body wt/kg				
		20	30	40	50	60
Roughage	4.	33	36.1	39.2	42.2	45.3
	5.	43.5	46.6	49.6	52.7	55.8
	6.	54	57	60.1	63.2	66.2
	7.	64.4	67	70.6	73.6	76.2
Soft rations	5.	103.1	99.1	95	90.9	86
	6.	95.3	91.3	87.2	83.1	79
	7.	87.5	83.5	76.3	75.3	71

(Harb & Tabaa, 2000)

*****Must be increased 3.7 g / 10% increment of concentrated diets {ARC. 1980}.

Table (24) DMI /day eaten by bearing ewes g/kg for metabolic weight. vol.1:322-322.

Prenatal weeks	Fetus No.	Ewes with 40K Body wt	Ewes 75 kg Body wt
12	1	50.3	50
8	1	56.5	55.7
4	1	63.6	64
0	1	72	74
12	2	56.9	57.2
8	2	65.9	67.3
4	2	77.7	79.9
0	2	93	96.2

(Harb & Tabaa, 2000)

Last table shows DMI for ewes during lactation period (12-10 weeks postnatal).

Table 25. DMI [k/g metabolic weight for ewes during lactation].

Ration	No. of lambs		Keio's ewes wt concentrated ration [67% concentrated]
	1	2	
Hay + concentrated rang grass granulated ration	80	85	150-120
	100	110	
	135	155	

*(*Harb & Tabaa, 2002*)*

In beginning DWI/ head were computed, each districts reach to anew comprehensive number clearing TWI/head /year, each physiological status in each districts, the first step is to compute DWI for maintenance [dry ewes] by using DMI requirements from table [29].

And equation used to compute DWI for dry ewes equation is. TWI/ day [dry ewes] = 13.86+-[.75] * DMI/day – 0.99 (Harb & Tabaa, 2000).

And ewes have 60 kg in average in 60 days. And their calculations for ewes assume these use equal 15% /year of total sheep .in addition to DWI from table and 85/60 days.

Table (26).

D. No.	DMI kg/ Day	Equation from ref 3 [DWI[	DWI 60/ days L	No of ewes/ district	TWI / 60DAY]m3[	DWI from ref[12[	TWI 60 days. Temp value	* TWI/ Herd/ year
1	1.35	5.23	314	35977	11275	4.05	223	8007
2	1.35	5.23	314	40140	12604	4.05	223	8951
3	1.35	5.23	314	59226	18597	4.05	223	13208
4	1.35	5.23	314	16577	5205	4.05	223	3697
5	1.35	5.23	314	17957	5639	4.05	223	4004
6	1.35	5.23	314	89670	28156	4.05	223	19997
7	1.35	5.23	314	27953	8777	4.05	223	6234
total				287500	90253			64098

** Reference. McDonald, Edwards, Greenhalg. Translators, Naji, Saad and Talal Butros .1985. Animal nutrition, vol. 1: 575-575 .

Table 27. Computing TWI for 5% dry ewes with use same steps in table [30] and average body weight 60 kg in.

D. No.	DMI/ daily	Equation from ref 3 [DWI[	TWI In one year L/head	No. of dry sheep	TWI m3 / district	DWI ref[12[	TWI One year	TWI/ District
1	1.35	5.23	1910	6337	12104	3.4	1.25	7921
2	1.35	5.23	1910	7083	13529	3.4	1.25	8845
3	1.35	5.23	1910	10452	19963	4.05	1.50	15638
4	1.35	5.23	1910	2925	5587	3.4	1.25	3656
5	1.35	5.23	1910	3664	6998	4.05	1.50	5496
6	1.35	5.23	1910	15824	30224	3.4	1.25	19780
7	1.35	5.23	1910	4915	9456	3.4	1.25	6144
Total				51200	97861			67480

Table (28). DWI for flushing stage.

District no	DMI kg daily	DWI Equation from ref 3	TWI L/head 42 day	No of flushed ewes	TWI/ year]m3[	DWI ref[12[	TWI One/ head	* TWI/ district
1	1.62	6.5	273	42244	11533	4.86	204.12	8623
2	1.62	6.5	273	47223	12892	4.86	204.12	9639
3	1.62	6.5	273	69678	19022	4.86	204.12	14223
4	1.62	6.5	273	19502	5324	4.86	204.12	3981
5	1.62	6.5	273	21126	5768	4.86	204.12	4312
6	1.62	6.5	273	105494	28800	4.86	204.12	21534
7	1.62	6.5	273	32868	8973	4.86	204.12	6709
Total				338135	92312			69021

Stage [3]: pregnant stage:

Pregnant stage bearing reach to 6 weeks prenatal with using data from table [24] data researcher will be compute the DWI and TWI according to table [24] especially for pregnant ewes, but this stage has time length 15 weeks or 108 days, in this paragraph some issues must be known, and these issues are:

.

- 1pregnant ewes twin bearing need increasing DWI 20% in the third month 25% in fourth month and 75% in fifth month respectively , now see table [32] and DM=1.89 kg /day.

Table (29). DWI L/day and TWI m/year at first 108 days in bearing, ewes 60 kg average body weight for single and twin bearing.

District No	DWl single ewes	DWI 108	No of sheep %80	TWI /108 twin days bearing	DWI L/108 twin days bearing	No of 20%sheep twin bear First 108	TWI /108 day for twin bearing
1	8.1	875	33795	29571	1225	8449	10350
2	8.1	875	37778	33056	1225	9445	11570
3	8.1	875	55742	48774	1225	13936	17072
4	8.1	875	15602	13652	1225	3900	4778
5	8.1	875	16900	14788	1225	4226	5177
6	8.1	875	84395	73846	1225	21099	25846
`	8.1	875	26294	23007	1225	6574	8053
total			270506	236694		67629	82846

Table (30). TWI for last 45 from bearing for single bearing and twin bearing depend on same body wt 60kg DMI quantity

District no	DWI sing bearing	TWI L/42 days	No sheep 80%of sheep mothers	TWI/42 days m3/42 day	DWI L/head/42 day	%20 of sheep twin bearing	TWI/42 day twin bearing
1	9.45	397	33795	13417	655	8449	5534
2	9.45	397	37778	14998	655	9445	6187
3	11.34	476.3	55742	26550	786	13936	10954
4	9.45	397	15602	6194	655	3900	2555
5	11.34	476.3	16900	8050	7865	4226	3322
6	9.45	397	84395	33505	655	21099	13820
7	9.45	397	26294	10439	655	6574	4306
Total							

Stage [4]: lactation stage:

Table [31]. DWI and TWI m3/135 days for 85% of lactation of sheep are at 135 milking days.

District No.	DMI	Average temp	Water L/kg DMI	DWI L/head	TWI 135/days L	No of sheep 85% for all	TWI m3/135
1	2.25	17.142	3.9	8.8	1188	35907	42658
2	2.25	17.183	4	9	1215	40140	48770
3	2.25	20.26	4.52	10.2	1377	59226	81554
4	2.25	18.91	4.24	9.54	1288	16577	21351
5	2.25	22.41	5	11.3	1526	17457	26639
6	2.25	15.9	3.6	8.1	1094	89670	98099
7	2.25	17.5	4	9	1215	27953	33963
Total							

Table (32): DWI and TWI for replacement females with same method.
DMI/ day 1.35 kg, average body wt 40 kg.

District No.	Avery Temp	Water L/kg DM	DWI head/	TWI/ head /years in L	No of replaced lamb female	TWI m3/year
1	17.142	2.5	3.375	1233	8449	10418
2	17.783	2.5	3.375	1233	9445	11646
3	20.26	3	4.05	1479.3	13936	25616
4	18.91	2.5	3.375	1233	3900	4809
5	22.41	3	4.05	1479.3	4225	6250
6	15.9	2.5	3.375	1233	21099	26015
7	17.5	2.5	3.375	1233	6573	8105

Table (33). Show how to compute DWI and TWI for rams.

District No.	Average temp range	WI L/kg DM	DWI L/head	/TWI /head year L	No of Rams	TWI /M3 year
1	20-15	2.5	7	2557	2365	6047
2	20-15	2.5	7	2557	6415	16403
3	20<	3	8.4	3086.1	3778	11659
4	20-15	2.5	7	2557	11764	3007
5	20<	3	8.4	3068.1	1348	4136
6	20-15	2.5	7	2557	4878	12473
7	20-15	2.5	7	2557	1897	4851
Total						

Table (34). growth replaced rams with 60 body weight and eat DMI = 2.4kg/day.

District No.	Average temp range	WI /L kgDM	/DWI head	/TWI /head year L	No of rams	TWI M3/ year
1	20-15	2.5	6	2192	473	1037
2	20-15	2.5	6	2192	1283	2812
3	20<	3	7.2	2630	756	1989
4	20-15	2.5	6	2192	235	515
5	20<	3	7.2	2630	270	710
6	20-15	2.5	6	2192	976	2139
7	20-15	2.5	6	2192	379	831

Table (35): DWI L/day and TWI m/year for all district herds .

District No.	Temperature range	WI L/kg DM	DWI L/head/day	TWI L/ Head/ year	Number of fattening Lambs	TWI m/ Herd /year
1	20-15	2.5	4	1461	14525	21221
2	20-15	2.5	4	1461	20407	29815
3	20<	3	4.8	1753	24538	43015
4	20-15	2.5	4	1461	12647	18477
5	20<	3	4.8	1753	7499	13146
6	20-15	2.5	4	1461	15193	22197
7	20-15	2.5	4	1461	7517	10982
Total					102326	158853

Part (3)*: estimation of WI for goats*:

To start computing of DWI and TWI number of factors were assumed:

1- Body weight average is 50 kg in dry and lactation stages.
2- Body weight average is 60 kg in pregnant.
3- Kids percent about 150 kids per 100 does.
4- %90 of adult does had 50% twin bearing.
5- About 240 milking day.
6- About 300-400 liter milk per year

First stage: dry doe

Dry doe has 50 kg body weight in average, eat 1.1 kg DM/day, like dry ewes and use same steps with same calculations.

Equation of dry doe:

DWI [L/day]= 3.86 (+-0.75)* DMI-0.99.

But data can show in table (40).

Table [36]: DWI and TWI for maintenance doe in all west's bank districts: ---

District No.	DWI Ref 3	TWI/year L	No. of dry does	TWI m/year	DWI Ref 18	DWI/year	TWI m3
1	4.081	1498	3841	5754	2.8	1023	3929
2	4.081	1498	2162	3239	2.8	1023	2212
3	4.081	1498	3077	4609	2.8	1023	3148
4	4.081	1498	554	830	2.8	1023	567
5	4.081	1498	2298	3442	2.8	1023	2351
6	4.081	1498	4847	7261	2.8	1023	4959
7	4.081	1498	2937	4000	2.8	1023	3041
Total			19716	29135			20207

Table (37). DWI and TWI / year for single bearing and twin bearing in first 2 month bearing.

District No.	Average temp	WI L/kg DM	DWI/ head L	No. of sheep single	TWI in 60 days	TWI/60 day/ head
1	20-15	3	4.8	34569	288	9956
2	20-15	3	4.8	19454	288	5603
2	20<	3.6	5.8	27694	348	10635
4	20-15	3	4.8	4987	288	1436
5	20<	3.6	5.8	20679	348	7196
6	20-15	3	4.8	43624	288	12564
7	203-15	3	4.8	26434	288	7613
Total				177441		55003

Table [38]. DWI and TWI for single bearing and twin bearing in 30 days.

District numbur	Average temperature	TWI/ head Bearing		WI L/ kg dm	No of 50%of doe single bearing	No of 50%of do twin bearing	TWI/30 day single bearing	TWI/30 day twin bearing	TWI for 50% single bearing	TWI for 50% twin Bearing
		Single	twin							
1	-15 20	6	7.2	3.75	17285	17824	180	216	3111	3733
2	-15 20	6	7.2	3.75	9727	9727	180	216	1751	2101
3	20<	7.2	8.6	4.5	13847	13847	216	259	2991	3589
4	-15 20	6	7.2	3.75	2494	2493	180	216	481	539
5	20<	7.2	8.6	4.5	10340	10339	216	259.2	2233	2834
6	-15 20	6	7.2	3.75	21812	21812	180	216	3926	4711
7	-15 20	6	7.2	3.75	13217	13217	180	216	2379	2855
Total					89262	89259			16872	20362

Table [39]: DWI and TWI in fourth-month bearing single and twin bearing doe.

District No.	Average temp	TWI/ head /day		WI L/ kg dm	TWI/30 day doe pregnant single bearing	TWI/30 day doe pregnant twin bearing	No. of pregnant goats %50 single	No. of pregnant goats %50 Twin	TWI /herd/ 30day M^3 for single	TWI /herd/ 30day M^3 For twin
		Single	twin							
1	20-15	7.2	9	4.5	216	270	17285	17284	3734	4667
2	20-15	7.2	9	4.5	216	270	9727	9727	2101	2626
3	20<	8.6	10	5.4	259.5	324	13847	13847	3589	4486
4	20-15	7.2	9	4.5	216	270	2494	2493	539	973
5	20<	8.6	10	5.4	259.5	324	10340	10339	2680	3350
6	20-15	7.2	9	4.5	216	270	21812	21812	4711	5889
7	20-15	7.2	9	4.5	216	270	13217	13217	2855	3569
T							89262	89259	20209	25560

So, table [44]: interpret DWI L/day, and TWI m3/year for doe has average body weight 60 kg, and DMI /day1.6 kg all in fifth month in pregnant, bearing doe are single and twin bearing and used average annual

Table (40): DWI and TWI for doe has 60 kg body weight, eat 1.6 kg DM, and does have single and twin bearing at fifth month.

District No.	Average temp	TWI/ head Bearing		WI L/ kg dm	TWI/ 30 day DO pregnant		No of pregnant Goats		TWI m^3/ head /30 day	
		Single	twin		Single 50%	Twin 50%	Single 50%	Twin 50%	Single	twin
1	20-15	8.8	15	5.5	264	450	17285	17284	4563	7778
2	20-15	8.8	15	5.5	264	450	9727	9727	2568	4377
3	20<	10.6	18	6.6	318	540	13847	13847	4403	7477
4	20-15	8.8	15	5.5	264	450	2494	2493	658	1122
5	20<	10.6	18	6.6	318	540	10340	10339	3288	5583
6	20-15	8.8	15	5.5	264	450	21812	21812	5758	9815
7	20-15	8.8	15	5.5	264	450	13217	13217	3489	8948
T							89262	89259	24727	45100

Stag2 [3] delivery:

Table (41): DWI and TWI in milking stage.

District No.	Annual average temp c^o	DWI/ kg DM	DWI/ head L	TWI 210 / day	No. of deliver doe	TWI /head m^3
1	20.1	4.5	9.45	1985	34569	68620
2	20.7	4.6	9.66	2029	19454	39472
3	25.1	5.5	11.55	2426	27694	67186
4	21.6	4.8	10.1	2121	4987	10577
5	26	5.7	11.97	2514	20679	51987
6	18.8	4.2	8.82	1852	43624	80792
7	21.9	4.9	10.3	2163	26434	27168
Total					177441	345802

Section 2: estimation of DWI and TWI for replacement does.

Table (42): DWI and TWI for replacements in west bank districts**.**

D. No.	Temperature range C^o	WI L/ kg DM	DWI L/ head	TWI L/head /year	Number of replacements	TWI M/ herd /year
1	20-15	2.5	3.5	1279	7682	9826
2	20-15	2.5	3.5	1279	4323	5529
3	20<	3	4.2	1535	6154	9446
4	20-15	2.5	3.5	1279	1108	1417
5	20<	3	4.2	1535	4595	7053
6	20-15	2.5	3.5	1279	9694	12893
7	20-15	2.5	3.5	1279	5874	7512
Total					39430	53676

Section (3): estimation of water intake for bucks:

DWI liter per head per day, and TWI cubic meter per herd per year, in west bank conditions; assume that average body weight 60

Table (43): DWI and TWI for bucks in West Bank districts.

District number	Temperature range	WI L/ kg DM	DWI L/ head	TWI L/ Head/ year	Number of bucks	TWI m/ Herd/ year
1	20-15	2.5	6	2192	1896	4156
2	20-15	2.5	6	2192	1333	2922
3	20<	3	7.2	2630	1555	4090
4	20-15	2.5	6	2192	393	862
5	20<	3	7.2	2630	1081	2843
6	20-15	2.5	6	2192	2439	5346
7	20-15	2.5	6	2192	1506	3301
Total					10203	23520

Section (4): estimation of DWI and TWI for fattening kids :

Table (44). DWI and TWI for fattening kids in West Bank districts.

District number	Temperature Range C^o	WI L/ Kg DM	DWI L/ head	TWI L/ Head/ year	Number of fattening kids	TWI m/ Herd/ year
1	20-15	2.5	3.5	1278	19431	24841
2	20-15	2.5	3.5	1278	12971	16581
3	20<	3	4.2	1534	15587	23912
4	20-15	2.5	3.5	1278	4632	5922
5	20<	3	4.2	1534	13518	20738
6	20-15	2.5	3.5	1278	16031	20494
7	20-15	2.5	4.2	1278	13015	16638
total					95185	129126

Table (45): chemical combination of vegetarian troublemakers, based on complete dry matter weight.

Kind	DM%	CP%	CF%	TDN
Barley hay	91	4.3	41	46
Wheat hay	89	3.6	42	40
Soybean hay	90	9.2	38	46
Citrus trouble maker	90	6.7	12.2	83
Dry tomato baste	92	23.5	26.9	68
Dry olive cake	90	12.5	48	40
Fresh potato residue	12	5.6	40	52
Mays leafs	25	4.3	6.7	58
Cabbage & Cauliflower leafs	19	3.9	12.1	-
Banana dry leaf	94	9.9	24	-
Grape troublemaker	91	13.4	33.3	26
Acacia leaf	90	15	47	-
Manufactured municipality residue	18	15.5	11	45
Dehydrated blood	90.5	79.9	0.8	60

Table (46). Sheep and goats census (MoA, 2000)

D No.	Sheep				Goat				total
	Ewes	lambs	Replacement	rams	Does	Kids	replacement	Bucks	
1	42244	14525	8449	2365	38410	19431	7682	1896	135002
2	47223	20407	9445	6415	21616	12971	4323	1333	123733
3	69678	24538	13936	3778	30771	15587	6154	1555	165997
4	19502	12647	3900	1176	5541	4632	1108	393	48899
5	21126	7499	4225	1348	22977	13518	4595	1081	76369
6	105494	15193	21099	4878	48471	16031	9694	2439	223299
7	32868	7517	6573	1897	29371	13015	5874	1506	98621
Total	338135	102332	67627	21857	197157	95185	39430	10203	871920

(MoA,2000)

Calculation of ET in West Bank districts

Crop Wat. 4 Windows Ver 4.2 2003/12/4

****

Climate and ETo (grass) Data

****
Data Source: D:\WALEED2\ARROUB.PEM

Country : Palestine (West Bank) Station : AL ARROUB
.Altitude: 960 meter(s) above M.S.L
(Latitude: 31.36 Deg. (North) Longitude: 35.07 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	12.3	4.4	77.0	207.0	6.2	11.3	1.54
February	13.0	4.8	78.0	242.0	6.2	13.3	1.92
March	16.5	6.3	71.0	259.0	7.5	17.6	2.97
April	20.9	8.1	65.0	233.0	8.5	21.3	4.14
May	25.7	12.3	57.0	156.0	10.1	24.9	5.10
June	28.5	14.7	54.0	121.0	11.8	27.7	5.67
July	29.6	15.9	59.0	121.0	11.6	27.2	5.65
August	30.0	16.2	64.0	130.0	11.0	25.3	5.29
September	28.4	14.4	70.0	121.0	9.9	21.6	4.25
October	25.7	12.1	64.0	138.0	8.6	17.0	3.33
November	20.4	9.6	72.0	138.0	7.6	13.2	2.12
December	14.7	6.4	75.0	190.0	6.3	10.7	1.58
Average	22.1	10.4	67.2	171.3	8.8	19.3	3.63

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5
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CropWat 4 Windows Ver 4.2 2003/12/4
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Climate and ETo (grass) Data

****
Data Source: D:\WALEED2\BEITQAD.PEM

'Country : Palestine (West BanK) Station : BEIT QAD 'JENIN
.Altitude:-190 meter(s) above M.S.L
(Latitude: 32.28 Deg. (North) Longitude: 35.21 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	17.4	6.8	80.0	181.0	5.4	10.2	1.68
February	18.2	7.1	84.0	190.0	5.6	12.4	2.00
March	21.6	8.6	76.0	190.0	6.8	16.5	3.08

April	28.3	11.2	67.0	190.0	7.8	20.2	4.75
May	31.0	14.0	39.0	216.0	9.7	24.2	6.74
June	32.9	17.3	63.0	225.0	11.3	26.9	6.74
July	33.6	19.6	63.0	233.0	11.1	26.4	6.81
August	34.2	21.1	65.0	207.0	10.0	23.7	6.16
September	33.2	19.8	64.0	173.0	9.1	20.4	5.12
October	30.6	16.1	65.0	130.0	8.1	16.2	3.63
November	25.0	11.8	66.0	147.0	6.8	12.1	2.56
December	18.8	8.7	74.0	181.0	5.4	9.6	1.80
Average	27.1	13.5	67.2	188.6	8.1	18.2	4.26

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

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CropWat 4 Windows Ver 4.2 2003/12/4

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Climate and ETo (grass) Data

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Data Source: D:\WALEED2\FARAA.PEM

Country : Palestine (West Bank) Station : Al-Far'a
.Altitude:-198 meter(s) above M.S.L
(Latitude: 32.08 Deg. (North) Longitude: 35.30 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	19.5	9.3	73.0	110.4	5.7	10.6	1.69
February	20.2	9.2	73.0	156.0	6.0	12.9	2.34
March	24.3	12.1	63.0	146.4	7.5	17.4	3.53
April	29.1	14.4	63.0	86.4	8.7	21.5	4.28
May	34.6	19.0	52.0	79.2	10.3	25.1	5.53
June	37.1	21.1	51.0	86.4	11.6	27.4	6.30
July	39.4	22.7	51.0	163.2	11.7	27.3	7.55
August	38.5	24.2	52.0	156.0	11.0	25.2	6.89
September	36.6	22.9	43.0	120.0	9.9	21.5	5.50
October	33.5	20.2	54.0	60.0	8.5	16.7	3.32
November	27.9	16.8	55.0	60.0	7.3	12.7	2.16
December	21.5	11.9	67.0	50.4	6.2	10.4	1.37
Average	30.2	17.0	58.1	106.2	8.7	19.1	4.20

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

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Climate and ETo (grass) Data

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Data Country : Palestine (West Bank) Station : Hebron
.Altitude: 1005 meter(s) above M.S.L
(Latitude: 31.53 Deg. (North) Longitude: 35.10 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	10.2	4.0	74.0	223.2	4.7	9.7	1.45
February	11.5	4.7	72.0	230.4	4.8	11.7	1.86
March	14.6	6.5	66.0	228.0	6.4	16.1	2.75
April	19.6	9.9	55.0	206.4	8.1	20.7	4.10
May	23.6	13.2	48.0	168.0	9.0	23.3	4.97
June	25.9	15.8	51.0	168.0	8.3	22.5	5.17
July	27.2	17.0	57.0	165.6	9.6	24.2	5.36
August	27.2	17.0	60.0	156.0	10.9	25.1	5.21
September	26.0	15.9	62.0	146.4	10.3	22.1	4.36
October	23.2	14.0	59.0	144.0	9.8	18.4	3.36
November	17.5	9.9	64.0	158.4	7.0	12.5	2.12
December	12.1	5.6	73.0	182.4	4.7	9.1	1.41
Average	19.9	11.1	61.8	181.4	7.8	18.0	3.51

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

CropWat 4 Windows Ver 4.2 2003/12/

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Climate and ETo (grass) Data

Data Source: D:\WALEED2\JAIRPORT.PEM

Country : Palestine (West BanK) Station : JERICHO AIRPORT
.Altitude:-276 meter(s) above M.S.L
(Latitude: 31.52 Deg. (North) Longitude: 35.30 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	19.0	9.3	71.0	121.0	6.3	11.3	1.80
February	20.6	10.0	64.0	138.0	7.1	14.3	2.57
March	24.4	12.0	59.0	164.0	7.3	17.3	3.75
April	29.5	15.9	53.0	164.0	9.0	22.0	5.24
May	34.4	20.0	43.0	181.0	11.1	26.4	7.06
June	37.0	22.4	39.0	173.0	12.5	28.7	7.83
July	38.6	24.0	41.0	156.0	12.6	28.6	7.76
August	37.9	24.8	46.0	138.0	12.1	26.8	6.95
September	35.8	23.6	49.0	130.0	10.1	21.9	5.57
October	32.7	20.2	51.0	121.0	8.7	17.1	4.11
November	28.1	15.0	55.0	130.0	8.2	13.7	3.00
December	21.4	11.2	66.0	121.0	6.3	10.6	1.90
Average	29.9	17.4	53.1	144.8	9.3	19.9	4.80

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

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CropWat 4 Windows Ver 4.2 2003/12/4

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Climate and ETo (grass) Data

Data Source: D:\WALEED2\JERICHO.PEM

Country : West Bank Station : Jericho
.Altitude:-250 meter(s) above M.S.L
(Latitude: 31.85 Deg. (North) Longitude: 35.45 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	19.1	7.4	70.0	160.8	5.5	10.5	2.00
February	20.9	8.3	65.0	187.2	5.9	12.9	2.77
March	24.3	10.5	57.0	235.2	7.7	17.7	4.29
April	29.3	14.2	45.0	292.8	9.3	22.4	6.63
May	33.7	17.6	38.0	285.6	9.4	23.8	8.01
June	36.7	20.4	38.0	276.0	11.8	27.7	8.98
July	37.8	22.1	40.0	288.0	11.7	27.3	9.20
August	37.6	22.4	44.0	266.4	11.6	26.1	8.42
September	36.1	21.2	47.0	225.6	10.5	22.3	6.83
October	32.3	17.9	51.0	170.4	10.5	19.1	4.78
November	26.4	12.9	60.0	141.6	6.5	11.9	2.77
December	20.5	9.0	70.0	136.8	5.6	9.9	1.84
Average	29.6	15.3	52.1	222.2	8.8	19.3	5.54

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

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CropWat 4 Windows Ver 4.2 2003/12/4

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Climate and ETo (grass) Data
Country : West Bank Station : Jericho
.Altitude:-250 meter(s) above M.S.L
(Latitude: 31.85 Deg. (North) Longitude: 35.45 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	19.1	7.4	70.0	160.8	5.5	10.5	2.00
February	20.9	8.3	65.0	187.2	5.9	12.9	2.77
March	24.3	10.5	57.0	235.2	7.7	17.7	4.29
April	29.3	14.2	45.0	292.8	9.3	22.4	6.63
May	33.7	17.6	38.0	285.6	9.4	23.8	8.01
June	36.7	20.4	38.0	276.0	11.8	27.7	8.98
July	37.8	22.1	40.0	288.0	11.7	27.3	9.20
August	37.6	22.4	44.0	266.4	11.6	26.1	8.42
September	36.1	21.2	47.0	225.6	10.5	22.3	6.83
October	32.3	17.9	51.0	170.4	10.5	19.1	4.78
November	26.4	12.9	60.0	141.6	6.5	11.9	2.77
December	20.5	9.0	70.0	136.8	5.6	9.9	1.84
Average	29.6	15.3	52.1	222.2	8.8	19.3	5.54

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

CropWat 4 Windows Ver 4.2 2003/12/4
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Climate and ETo (grass) Data

Country : Palestine (West Bank) Station : Jerusalem
.Altitude: 800 meter(s) above M.S.L
(Latitude: 31.78 Deg. (North) Longitude: 35.22 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	11.4	6.1	67.0	292.8	5.4	10.4	1.89
February	12.9	6.9	66.0	324.0	7.1	14.3	2.45
March	16.0	8.7	59.0	331.2	7.4	17.3	3.48
April	20.9	10.3	50.0	333.6	9.4	22.6	5.14
May	24.8	15.3	45.0	324.0	11.4	26.8	6.56
June	27.3	17.7	48.0	350.4	12.4	28.6	7.30
July	28.4	18.9	53.0	367.2	12.1	27.9	7.25
August	28.6	19.0	57.0	336.0	11.8	26.4	6.62
September	27.5	18.1	58.0	307.2	10.1	21.8	5.52
October	24.5	16.4	56.0	235.2	7.3	15.4	3.90
November	18.7	12.3	59.0	254.4	6.5	11.9	2.77
December	13.3	8.0	66.0	288.0	5.9	10.2	1.98
Average	21.2	13.1	57.0	312.0	8.9	19.5	4.57

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
* a = 0.25 b = 0.5

CropWat 4 Windows Ver 4.2 2003/12/4
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Climate and ETo (grass) Data
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Data Source: D:\WALEED2\NABLUS.PEM

Country : Palestine (West Bank) Station : Nablus
.Altitude: 680 meter(s) above M.S.L
(Latitude: 32.22 Deg. (North) Longitude: 35.25 Deg. (East

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)	ETo (mm/d)
January	13.1	6.2	67.0	156.0	4.7	9.6	1.58
February	14.4	6.7	67.0	170.4	4.8	11.5	2.02
March	17.2	8.8	62.0	180.0	6.4	16.0	2.93
April	22.2	12.1	53.0	184.8	8.2	20.8	4.36
May	25.7	14.9	51.0	192.0	8.9	23.1	5.30
June	27.9	17.4	55.0	216.0	8.4	22.7	5.65
July	29.1	19.3	61.0	223.2	9.6	24.2	5.83
August	29.4	19.5	65.0	211.2	10.9	25.0	5.65
September	28.4	18.5	64.0	184.8	10.2	21.8	4.77
October	25.8	16.2	57.0	139.2	9.8	18.2	3.57
November	20.2	12.1	57.0	141.6	7.0	12.3	2.32
December	14.6	7.8	67.0	139.2	4.5	8.8	1.49

Average 22.3 13.3 60.5 178.2 7.8 17.8 3.79

Pen-Mon equation was used in ETo calculations with the following values
:for Angstrom's Coefficients
a = 0.25 b = 0.5

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Climate and Eto (grass) Data

Data Source : D:\WALEED2\ Tulkarm.PEM

Country: Palestine (WestBank) Station: TULKARM.
Altitude: 65 meter(s) above M.S.L
(Latitude: 32.31 Deg. (North) Longitude: 35.03 Deg. (East

Month	MaxTemp (deg. C)	MiniTemp (deg.C)	Humidity %	WindSpd. (Km/d)	Sunshine (Hours)	Solar Rad (Mj/m2/d)	Eto (mm/d)
January	13.3	8.6	72.0	103.2	5.2	10.0	1.34
February	13.8	8.7	76.0	98.4	5.5	12.3	1.64
March	16.7	10.8	75.0	91.2	6.5	16.1	2.37
April	21.5	13.8	65.0	81.6	7.7	20.1	3.47
May	24.6	15.9	62.0	79.2	9.0	23.2	4.30
June	27.2	19.4	69.0	69.6	10.3	25.5	4.87
July	29.0	22.1	68.0	69.6	9.7	24.3	4.93
August	29.6	22.7	74.0	64.8	8.9	22.2	4.48
September	28.2	21.2	70.0	62.4	8.3	19.3	3.70
October	26.8	19.2	67.0	69.6	7.6	15.6	2.83
November	20.8	14.3	64.0	91.2	6.7	12.0	1.93
Desember	15.9	10.6	71.0	96.0	5.3	9.5	1.33
Average	22.3	15.6	69.4	81.4	7.6	17.5	3.10

Pen-Mon equation was used in ETo calculations with the following values for Angstrom's Coefficients:

a = 0.25 b = 0.5

جامعة النجاح الوطنية
كلية الدراسات العليا

تقدير الاحتياجات المائية لانتاج الابقار والاغنام والماعز في فلسطين

اعداد الطالب
وليد عرسان راغب صالح

اشراف
الدكتور جمال محمد ابو عمر

قدمت هذه الاطروحة استكمالا لمتطلبات درجة الماجستير في العلوم البيئية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين

تموز 2003

ملخص الدراسة

تم دراسة الاحتياجات المائية للأبقار والأغنام والماعز في الضفة الغربية على أساس حساب الاستهلاك اليومي المباشر وكذلك كمية المياه اللازمة من اجل زراعة وإنتاج العلائق اليومية لهـذه الحيوانات.حيث تم حساب الاحتياج المائي في الضفة الغربية لمحاصيل القمح، والشعير، البرسـيم، البيقيا ،الكر سنة والذرة الرفيعة. وبعد إجراء الحسابات اللازمة لهذه الاحتياجات تبـين أن الأبقـار بجميع فروعها تحتاج كمية مياه للاستهلاك المباشر كما يلي 71، 29، 16 و 41 لتر ماء لكل مـن الابقار الحلابة ، البكيرات، العجول والثيران على التوالي. وكانت كميات المياه اللازمة للاسـتهلاك المباشر لكافة فروع الأغنام والماعز تباعا 9.1 ، 4.4، 4.1، 7.4، 8.5، 3.7، 3.72 و6.32 لتر ماء في اليوم للنعاج الحلابة، البدائل، الحملان، الكباش، المعزات الحلابة ، بدائل الماعز، الجـديان والتيوس على التوالي. أما كميات المياه اللازمة لإنتاج واحد كيلو غرام من أعلاف الأبقار فكـان للعليقة المركزة حوالي 0.903 كوب ماء وللعليقة المالئة 0.934 كوب ماء أمـا علائـق الأغنـام والماعز فيلزم لإنتاج كيلو غرام علف بشقيه المالئ والمركز 0.920 كوب لكل كيلو غـرام ، أمـا احتياج علائق الأبقار اليومية من المياه لجميع أفرع الأبقار تباعا 17.18، 9.89، 3.85 و17 كوب ماء لكل من الأبقار الحلوبة، البكيرات، العجول والثيران على التوالي، بينما تحتاج الأغنام والماعز لنفس الهدف 1.9، 1.62، 1.62، 3.02، 1.62، 1.52، 0.98 و2.6 كوب ماء لكل مـن التعـاج الحلابة، البدائل، الحملان، الكباش، المعزات الحلابة، بدائل المـاعز، والجـديان والتيـوس علـى التوالي.أما مجموع ما تحتاجه الأبقار للاستهلاك المباشر وإنتاج الأعلاف فكانت الكميـات 17.25، 9.92، 3.59 و17.1 كوب ماء لكل راس يوميا على التوالي، أما مجموع مـا تسـتهلكه الأغنـام

والماعز لكل راس فكانت الكميات 1.93، 1.63، 1.63، 3.03، 1.63، 1.53، 0.98 و2.61 لكل من النعاج الحلابة، بدائل الأغنام، الحملان، الكباش، المعزات الحلابة، بدائل المعـزات، الجـديان والتيوس على التوالي. أما بالنسبة لكميات المياه المستهلكة في السالخ لجميـع محافظـات الضـفة الغربية فكانت 30099 كوب لذبائح الأبقار وبمعدل 1.1 كوب لكل ذبيحة، و31483 كوب لجميـع ذبائح الأغنام والماعز وبمعدل 0.27 كوب لكل ذبيحة، أما كمية المياه المسـتهلكة بشـكل مباشـر للأبقار والأغنام والماعز خلال عام فكانت 2.4 مليون متر مكعب، بينمـا كانـت كميـات الميـاه المحسوبة للأعلاف المستهلكة لهذه الحيوانات فكانت 641 مليون متر مكعب مـاء ومجمـوع مـا تستهلكه السالخ المرخصة من المياه في الضفة الغربية فكان 61581 كوب. وتدل هذه النتائج علـى دور القطاع الحيواني واهميته في استهلاك المياه. وهنا يجب الاخذ بعين الاعتبار هذه الكميات عند التقدير واعتماد الاحتياجات المائية المحلية.