EVALUATION OF AGRICULTURAL WATER PRODUCTIVITY IN SOMALIA

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Department of Biosystem Engineering

Master's Thesis

Supervisor: Prof. Dr. A. Halim ORTA

2022

T.C.

TEKIRDAG NAMIK KEMAL UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE

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JULY-2022

ABSTRACT

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This study was conducted to evaluate agricultural water productivity in Somalia. For this purpose, the irrigation area located in Afgoi district of the Lowershabelle region, which is located between 2°8'17.16" N latitude and 45°7'16.32" E - longitude, where irrigation practices are common, has been taken into consideration. Firstly, necessary information was collected from 47 randomly selected field plots between August and December in 2021. The yield values in (kg/ha) and the amount of irrigation water applied (mm) were determined from farmers via interview. In addition, the crop water consumption and irrigation water requirement of the crops in the area were calculated by Cropwat software. The average yield values of maize, sorghum, sesame, tomato and banana crops widely grown in the area were determined as 823.00, 663.00, 471.30, 1500.28, 17573.00 kg/ha, respectively. By Cropwat, the average seasonal cropwater consumption values of maize, sorghum, sesame, tomato and banana were estimated as 329.80, 466.11, 30.48, 433.25 and 893.47 mm, respectively. The amount of net irrigation water needed is calculated as 180.48 mm for maize, 270.80 mm for sorghum, 225.38 mm for sesame, 381.97 2 mm for tomatoes and 624.50 mm for bananas, while the amount of irrigation water applied by the farmers was 408.89 mm for maize, 187.08 mm for sorghum, 415.05 mm for sesame, 616.82 mm for tomato and 1314.00 mm for banana. According to these data the water use efficiency and irrigation water use efficiency values were calculated as 0.25, 0.21, 0.14, 0.31, 1.91 and 0.23, 0.90, 0.12, 0.25 and 1.45 kg/m^3 for maize, sorghum, sesame, tomato and banana, respectively. At the end of study, the low water use and irrigation water use efficiency were observed due to low yield and excessive irrigation water applied by farmers.

Keywords: Crop Water Consumption, Irrigation Water Requirement, Water Use Efficiency, Irrigation Water Use Efficiency, Yield.

ÖZET

SOMALİ'DE TARIMSAL SU VERİMLİLİĞİNİN İNCELENMESİ

Mohamed Hassan OSMAN

Biyosistem Mühendisliği Anabilim Dalı

Yüksek LisansTezi

Danışman: Prof. Dr. A. Halim ORTA

Bu çalışma, Somali'de tarımsal su verimliliğini değerlendirmek için yürütülmüştür. Çalışmada, sulama uygulamalarının yaygın olarak yapıldığı 2°8'17.16" Kuzey enlemi ile 45°7'16.32" Doğu boylamı arasında kalan Lowershabelle bölgesinin Afgoi ilçesinde yer alan sulama sahası dikkate alınmıştır. Bu amaçla, tesadüfen seçilen 47 adet tarla parselinden Ağustos – Aralık 2021 tarihleri arasında gerekli bilgiler toplanmıştır. İşletme sahipleri ile yapılan görüşmelerde yetiştirdikleri ürünlerin verim (kg/ha) değerleri ile uyguladıkları sulama suyu miktarları (mm) saptanmıştır. Alanda yaygın olarak yetiştirilen mısır, sorgum, susam, domates ve muz bitkilerinin ortalama verim değerleri sırasıyla 823.00, 663.00, 471.30, 1500.28, 17573.00 kg/ha olarak belirlenmiştir. Cropwat paket programı ile mısır, sorgum, susam, domates ve muzun ortalama mevsimlik bitki su tüketimi değerleri sırasıyla 329.80, 466.11, 330.48, 433.25 ve 893.47 mm olarak hesaplanmıştır. İhtiyaç duyulan net sulama suyu miktarları ise mısır için 180.48 mm, sorgum için 270.80 mm, susam için 225.38 mm, domates için 381.972 mm ve muz için 624.50 mm olarak hesaplanırken, çiftçilerin uyguladıkları sulama suyu miktarları mısır için 408.89 mm, sorgum için 187.08 mm, susam için 415.05 mm, domates için 616.82 mm ve muz için1314.00 mm olmuştur. Bu verilere göre, hesaplanan su kullanım randımanı değerleri mısır, sorgum, susam, domates ve muz için sırasıyla 0.25, 0.21, 0.14, 0.31, 1.91, sulama suyu kullanım randımanı değerleri 0.23, 0.90, 0.12, 0.25 ve 1.45 kg/m^3 olmuştur. Verim değerlerinin düşük olması bunun yanında, üreticilerin gereğinden çok fazla sulama suyu uygulamaları, su kullanım ve sulama suyu kullanım randımanlarının çok düşük düzeyde kalmasına neden olmuştur.

Anahtar Kelimeler: Bitki Su Tüketimi, Sulama Suyu İhtiyacı, Su Kullanım Randımanı, Sulama Suyu Kullanım Randımanı, Verim.

TABLE of CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ICONS

$	US Dollar
%	Percentage
cm	Centimeter
Ha	Hectare
kg	Kilogram
kg/ha	Kilogram Per Hectare
kg/m^3	Kilogram Per Cubic Meter
kg/mm	Kilogram Per Millimeter
kpa	Kilopascal
L/s	Litre Per Second
m	Meter
m^2	Square Meter
m^3	Cubic Meter
Mjm^2/day	Modified Solar Radiation
mm	Millimeter
mm/day	Millimeter Per Day
^oC	Degree Celsius
Ton/ha	Ton Per Hectare

LIST OF ACRONYMS

CWR	Crop Water Requirement
dn	Net Irrigation Water Requirement
e_s	Saturation Vapour Pressure
e_a	Actual Vapour Pressure
Δ	Slope Vapour Pressure Curve
ET	Evapotranspiration
ETc	Evapotranspiration of the Crop
ETo	Reference Evapotranspiration
FAOSTAT	Food and Agriculure Organisation Statitics
FIT	Full Irrigation Treatment
G	Soil Heat Flux Density
T	Mean Daily Air Temperature
Ha	Hectare
I	Amount of Irrigation Applied
IWUE	Irrigation Water Use Efficiency
kc	Crop Coeffient
R	Rainfall
R_{eff}	Effective Rainfall
Rn	Net Radiation at the Crop
SWALIM	Somalia Land and Water Information Management
U_2	Wind Speed at 2 m Height
USDA	United States Department of Agriculture
WP	Water Productivivty
WUE	Water Use Efficiency
Y	Yield

ACKNOWLEDGEMENT

I am highly indepted to my supervisor Prof. Dr. A.Halim ORTA for giving the oppurtunity to be as his student by all aspects not only science; previous advice, suggestions and guidance for accomplishing for our work, also guides me with his experiences during my Master's study at Tekirdag Namık Kemal University, Institute of Natural and Applied Science Department of Biosystem Engineering, produces solutions to the problems that I encountered, ensures that my work continues as healthy as possible, keeps me motivated when I have the most difficulty in working, and is sincerely interested in all my problems. I would like to extand my sincere thanks to Prof. Dr. Yesim AHI, for her patience helping through out my work and also supported statical data analysis of the research. I am grateful to my father Hassan OSMAN and my brother Abdullahi HASSAN who supported me with all kinds of material and moral through out my education life. I would like to thank to my friend Khaalid Mohamed ALI who supported collecting data from farmers in the area.

July, 2022

Mohamed Hassan OSMAN

Biosystem Engineering

1. INTRODUCTION

Water is a natural resource and most vital factor for living things. In parallel with the increase in population of the world, the need for agricultural water is also increasing with the increasing need for food. It is a known reality that usable water resources are limited. In addition to the increase in agricultural and domestic water demand, the increase in water demand in the developing industrial sector causes inter-sectoral competition in water use. Nowadays, limited water resources must be used effectively in all sectors compatible with the environment (Çakmak & Avcı, 2017).

The strategic importance of water is the quantity and quality of which are decreasing day by day depends on the rate of use. Water is mostly used in agriculture in Turkey and in the world. One of the most important factors that will affect the use and quality of water resources in the future will be efficient operation and management of water in agriculture. In addition to the rapid population growth, urbanization, industrialization, and expansion of irrigation areas experienced globally, there is an increasing pressure on water resources due to climate change and drought that have been experienced frequently in recent years. Although the water usage rates vary according to the development level of the countries, 70% of total water consumption in the world is for agriculture, 19% for industry and 11% for domestic use (Aydoğdu, 2020).

The main objective in the agricultural use of water is; to increase yield with less water, to obtain the maximum benefit from the unit of water and thus to increase the per capita income and thus the contribution to the national income. The first option towards this goal is to increase the efficiency of the water used in agriculture and to make the water resource superior quantitatively and qualitatively. In determining of the water productivity of water in agriculture; crop pattern in the basin, irrigation schedule, irrigation method and selection of the water source directly affect the accuracy of the decisions. Many research activities are carried out in the world to increase water efficiency in agriculture and to produce universal solutions. In this context; in Turkey the institutional structure of irrigation planning and management needs to be changed rapidly and reorganized in a way that will ensure a more rational, planned and efficient use of water. There is a need for an innovative, participatory, environmentally sensitive water management with stronger solution reflexes (Kodal & Ahi, 2018).

The decrease in the quantitative and qualitative properties of water resources day by day results in increased cost of irrigationwater, and this necessitates more precise irrigation management (Orta, 2017).

The gradual decrease in usable water resources in the face of increasing water demand in the world necessitates the prevention of excessive water use. Although more water is used in agriculture, high yields cannot be obtained due to high water losses. Measures such as the application of pressurized irrigation methods, the establishment of closed water conveyance and distribution networks, the use of treated wastewater, the harvesting of rain water, the training of farmers, can be taken to save water in agriculture. Pricing of irrigation water is the most important tool, especially in preventing excessive water use (Çakmak & Avcı, 2017).

Many studies carried out in Somalia have shown that the performance of irrigation practices and equipments are still very poor, especially in term of homogeneous distribution of water due to lack of farmer's knowledge on how to manage irrigation systems. This case not only reduces yields but also wastes water resources.

Water conveyance efficiency and water distribution uniformity are very low in Somalia because surface irrigation methods are widely used. For this reason, pressurized irrigation methods should be used to increase irrigation efficiences mentioned above. In order to overcome this problem, it is necessary for the farmers in the country to use technological irrigation methods, to increase the agricultural water efficiency, so that both the welfare of the farmers and the effective use of water resources increase, to ensure food security (Mbara, 2007).

Water shortage is one of the main limiting factors in agricultural production, especially corn production in Somalia. Improving the water productivity of crops is becoming more and more important today due to the reduction of irrigation resources (Kapila, 2014).

1.1. Literature Review

In Somalia there is no any literature studied on water productivity. Our research will be the first literature and guide for farmers how to increase water use efficiency and irrigation water use efficiency by decreasing water losses in the irrigation schemes in Somalia.

Irrigation efficiency can be defined as the ratio of irrigation water requirement to water diverted from the source for irrigation. In traditional irrigation systems, small size of the irrigation plots and inappropriate choosing to the furrow or pan sizes make water management difficult, reduce irrigation efficiency and result high water losses in the field. The water application efficiency of surface irrigation methods is around 60% under ideal conditions. Besides the leakage and evaporation, the efficiency is approximately 50%. If sprinkler and drip irrigation methods are used instead of traditional irrigation methods, the efficiency increases from 60% to 80% and 90%, respectively. This means that it saves water between 20% and 30% (Çakmak, Yıldırım & Aküzüm, 2006).

Despite the high costs of installation, pressured irrigation methods offer the ability to prevent water losses and regulate the harmful impacts of excess water on the land. Additionally, increased irrigation efficiency and more uniform water distribution are realized. The water that is delivered as irrigation water is more than the plant's water requirement due to the losses that occur during water conveyance. To meet a 1 m^3 crop water requirement, 2 m^3 of water is used (Çakmak, Yıldırım & Aküzüm, 2006).

The ratio of irrigation water reaching the field to water diverted from the source is commonly referred to as water conveyance efficiency. Channel leaks, evaporation losses from channels, and pipeline leaks are all examples of water losses in the conveyance system. Conveyance losses are often much lower in closed channels or pipelines than in open channels. Due to material deterioration or poor maintenance, the conveyance efficiency of open channels might decline over time. Water conveyance efficiency in gravity irrigation systems is 0.70 percent in earth channels and 0.85 percent in concrete channels (Howell, 2003).

In irrigation network systems, the conveyance and distribution of water consists of earthen channels, concrete covered channels and closed pipe systems. In Turkey, 46.6% of the irrigation channels are close concrete, 42.4% are open concrete canals, 5.8% are soils and 5.2% are pipe systems. Although an average of 10% conveyance loss is specified in irrigation networks, these losses reach much higher values in practice. A large amount of water will be saved with the use of closed pipe systems in newly developed irrigation projects (Çakmak & Gökalp, 2017).

Nowadays the use of drip irrigation systems is important in order to save water as a result to reduce the quantity of water used in agriculture. In the drip irrigation method, evaporation

from the soil surface and the crop water consumption is generally lower than other irrigation methods in which the entire area is getting wet. This is because there is a dry area between the plant rows, and the wet section is often shaded by the plant. In addition to, with a good design and operation, homogeneous water distribution throughout the irrigated area and high water application efficiency is ensured. In the drip method, partially water is dilevered directly to the root zone of the plant in small amounts and frequent application. Due to these features, significant savings are achieved in irrigation water compared to other classical methods. Compared to flood irrigation, a drip irrigation system can incease a farmer's water efficiency up to 70% and reduce energy costs by 50% (Duraktekin et al; 2017).

The low irrigation efficiency is an indicator of excess water losses. Those losses occur during the conveyance, distributions and field applications (Toprak & Acar, 2010).

Irrigation water is normally conveyed from a water source to the farm or field through natural drainage ways, constructed earthen or lined canals, or pipelines. Many conveyance systems have transmission losses, meaning that water delivered to the farm or field is usually less than the water diverted from the source. Water losses in the conveyance system include canal seepage, canal spills (operational or accidental), evaporation losses from canals, and leaks in pipelines. The water conveyance efficiency is typically defined as the ratio between the irrigation water that reaches a farm or field to that diverted from the water source (Irmak, Odhiamb, Kranz & Eisenhauer, 2011).

Water-use efficiency is often overemphasized in efforts to manage demand in agriculture, with efforts aimed at reducing water losses in irrigation distribution systems.Two factors limit the scope for and impact of water loss reduction. First, part of the water ‘‘lost” in withdrawals can be recovered. Second, some of the water lost between the source and the end use returns to the hydrological system via aquifers or river systems and can be re-used downstream (Unver, Bhaduri & Hoogeveen, 2017).

In most cases, the single most important means for managing water demand in agriculture is increasing agricultural production per unit volume of water. Increases in crop yield (i.e. production per unit of land) can be achieved through better water control combined with improvements in, for example, genetic materials and soil fertility. The best approach from a farming perspective, therefore, is to manage overall water demand by focusing on water

productivity rather than the technical or management efficiency of water use (Unver et al; 2017).

Water productivity in agriculture constitutes the whole measures to be taken in order to manage and effectively use fromaunit water in a unit of area. Many words (productivity, efficiency, performance index, etc.) are used in the expression of water productivity. The word water productivity conceptually indicates the utilization rate of water efficiency. The water use productivity as a commonly used term to describe the relationship between water (input) and agricultural produce (output), and water use efficiency is also used to express irrigation water use efficiency and water distribution (Kodal & Ahi, 2018).

Due to increasing water shortage, the concept of water efficiency in agriculture gained traction, with a focus on water to soil as a production factor in agriculture (Kapila, 2013).

Plant water productivity refers to the amount of grain that can be produced per unit of water consumed. Crop productivity and plant water consumption efficiency can both benefit from proper irrigation water management (Xiao et al; 2018).

Water productivity refers to the amount of water used to grow a crop in irrigation engineering. The crop yield per unit of water consumed, as defined by WUE. When water is a limited element in arid and semi-arid regions of the world, the goal of enhancing IWUE in agricultural production is to produce more economic yield with less water. Water productivity, also known as water use efficiency, is a strategy that has been adopted to mitigate the effects of drought. A crop with a high WUE should yield more than one with a low WUE (Boutraa, 2010).

Akcay and Dağdelen (2016) observed the effects of different irrigation treatments on yield and yield components of second crop sunflower (*Helianthus annuus*L.) grown in western Turkey and applied six different water levels cumulatively (125, 100, 75, 50 and 25% by using Class-A pan evaporation. Seasonal evapotranspiration varied between193.7 mm – 667mm.The net water for irrigation was varied between from 72.3 – 488.2 mm and result of seed yields were varied between 2328.2 kg/ha – 4720.8 kg/ha. Water use efficiency and irrigation water use efficiency values were varied from 1.21 kg/m^3 to 0.70 kg/m^3 and 0.97 – 3.47 kg/m^3.

Bahramloo and Nasseri (2019) carried out the study of maize on yield measured on the fields were compared with those simulated by the agro-ecological zone method under cold

semi-arid environment. The average yield of maize was 6404 kg/ha with net irrigation water to produce maize was of 10567 m^3/ha. The average water use efficiency (WUE) was 0.61 kg/m^3 and water application efficiency was 51.2% in maize fields.

Xiao et al; (2018) investigated the yield formation capacity, soil water consumption property, and the plant water use efficiency (WUE) of wheat under various irrigation treatments. The seasonal water consumption varied between 355.17 mm – 485.70 mm and they were indicated wheat grain yield varied between 9045.00 kg/ha – 10584.00 kg/ha. The water productivity or water use efficiency was varied between 2.55 kg/m^3 – 2.18 kg/m^3.

A study was carried out on the economical water productivityon watermelon using yield from field data. The seasonal actual evapotranspiration was 2930 to 5050 m^3/ha. The seasonal irrigation water was 1130 m^3/ha to 4,490 m^3/ha and the net income value of yield ranged from 5,309 tl/ha to 9,855 tl/ha. The WUE and IWUE varied between 1.81 to 1.96 tl/m^3 and 2.19 to 4.70 tl/m^3 (Kuşçu et al; 2017).

Xiao et al; (2018) studied the yield generation capacity, properties of soil water consumption and plant water use efficiency (WUE) of wheat under various irrigation applications. The seasonal water consumption used was 355.17 mm - 485.70 mm and the yield of wheat crop was 9,045.00 kg/ha to 10,584.00 kg/ha. The water use efficiency ranged between 2.55 kg/m^3 to 2.18 kg/m^3.

An experiment was carried out on the water productivity of tomato and onion under drip irrigation. The seasonal irrigation water applied to both onion and tomato was 346.1mm to 461.5 mm and 337.35 mm to 449.79 mm, respectively. The resulted marketable yield was ranged to 10.2 to 18.26 ton/ha and 17.55 to 19.39 ton/ha, respectively. The water productivity ranged between 4.2 to 5.80 kg/m^3 and 1.601 to3.47 kg/m^3, respectively (Wondatir & Belay, 2020).

Field experiment was conducted to determine the possible amount of water consumption and to achieve the most possible yield of potato crop. The amount of net irrigation water was measured 1770.23 to 3542.13 m^3/ha and crop yield was found 16.95 ton/ha to 29.65 ton/ha. The measured IWUE ranged to 8.37- 9.98 kg/m^3 (Afshar, Afsharmanesh, Adeli & Malekian, 2014).

Nasseri (2021) Studied water productivity on corn yield under moderate semi-arid environment. It was confirmed that water productivity of maize was from 1.22 to 1.52 kg/m^3 with an average of 1.38 kg/m^3 under 68% of water application efficiency. The yield obtained ranged from 3800 to 6971 kg/ha with an average of 5345 kg/ha and water applied was from 312.5 to 458.4 and averaged 383.6 mm.

A field experiment was conducted to evaluate the response of cotton plants to deficit irrigation water under drip irrigation conditions. Water use efficiency (WUE), seed cotton yield and fiber quality parameters were evaluated at various irrigation levels. The total amounts of irrigation water applied were 408 and 773 mm and the average seed cotton yields were 2,909 and 5,090 kg/ha. Values of IWUE were 0.65 and 0.70 kg/m^3 (Janat & Yakoub, 2011).

Duraktekin et al, (2017) determined the effects of different irrigation strategies of yield and water use efficiency of subsurface drip irrigated on table grape. The net irrigation water applied was 110 mm -0 220 mm and the seasonal crop water consumption was 310 mm to 472 mm. The crop yield ranged between 11.70 to 30.90 ton/ha. The WUE and IWUE were 3.76 – 6.54 kg/m^3 and 14.04 – 21.10 kg/m^3.

Yenigün and Erdem (2019) investigated the effects of different irrigation treatments with drip irrigation method on eggplant water use, yield and vegetative parameterswere carried out in Tekirdag conditions. The seasonal evapotranspiration of the crop was 411.7 and 797.1 mm with total irrigation application of 293.0 and 693.0 mm. The yield varied between 21.80 to 31.90 ton/ha. The WUE and IWUE ranged between 4.49 to 7.44 kg/m^3 and 3.83 to 5.30 kg/$m^{3.}$

Uygan (2017) carried out research on water consumption and water use efficiency of drip-irrigated sugar beet under Eskisehir conditions. Crop water consumption was 463 – 891 mm and total application of irrigation water was 332.92–782.76 mm. They found sugar beet yield of 680.57–12,33.33 kg/ha. Water use efficiency (WUE) and irrigation water use efficiency (IWUE) were found to be between 1.38–1.87 kg/m^3 and 1.58–2.21 kg/m^3, respectively.

Djaman et al, (2018) estimated maize water use and water productivity under semi-arid climatic conditions. The average seasonal irrigation water applied was 837.7 mm and actual seasonal maize water use was 665.3 mm. Maize water use efficiency varied from 1.3 to 1.9 kg/m^3 and averaged 1.53 kg/m^3 and maize irrigation water use efficiency was an average of 1.74 kg/m^3.

The effects of water applications at different levels on the growth, yield and water use efficiency of okra were estimated under the drip irrigation system in the dry season under four different irrigation management i.e, namely 100 FIT (full irrigation treatment), 80 FIT, 60 FIT, 40 FIT measured. Yield varies between 2050 and 3600 kg/ha. Irrigation water use efficiency (IWUE) varies between 2.4 – 4.1 kg/m^3 and crop water use efficiency (CWUE) varies between 8.8 – 13.9 kg/m^3. The crop irrigated with drip irrigation at 60 FIT recorded the highest IWUE, CWUE and approximately 73% higher yields than 40 FIT with 4.1 kg/m^3, 13.9 kg/m^3 and 3560 ton/ha, respectively. It was concluded that okra crop irrigated at 60 FIT should be adopted to irrigate additional land to save 40% water. Drip irrigation is encouraged during the dry season for farmers (Sedara & Sedara, 2020).

The evaluation of irrigation schedules for watermelon under drip irrigation was the subject of a study. The total irrigation water used was 248 mm, with 412 mm of seasonal crop evapotranspiration. The maximal WUE and IWUE respectively were calculated to be 22.1 and 33.3 kg/m^3 (Orta, Ahi, Erdem & Okursoy, 2005).

An experimental design was carried out the affect of the amount of drip irrigation application on watermelon in three years. The total irrigation water was applied 116.2 mm and 293.81mm during growing season each year. The seasonal crop evapotranspiration and total yield in each year were determined as 362.13 mm, 400.02 mm, 408.03 mm and 10369 kg/ha, 89840 kg/ha, 75420 kg/ha, respectively. The WUE and IWUE were varied from 19.89 – 24.31 kg/m3 and 17.17 to 30.30 kg/m3 respectively (Orta, Erdem & Yüksel, 2001).

Crop yield to water response were studied on different genotype varieties of wheat in the western Turkey. The water use efficiency of different varieties were determined 1.21 kg/m^3, 1.21kg/m^3, 1.69 kg/m^3 and 1.39 kg/m^3 (Orta et al, 2002).

Maize is an efficient user of water in terms of total dry matter output, and among cereals, it has the potential to be the highest yielding grain crop, according to data collected from various nations throughout the world. A medium maturity grain crop requires between 500 and 800 mm of water for maximum productivity, depending on climate. The number of potential irrigation applications may range between 2 and 5 in conditions of marginal rainfall and inadequate irrigation water availability. Grain yields range from 6 to 9 ton/ha when irrigated. Grain water consumption efficiency ranges between 0.8 and 1.6 kg/m^3 estimated by Food and Agriculture Organisation (FA0, 2020).

Crop water requirements (ETc) for high yielding 110 to 130 day sorghum ranged between 450 – 650 mm, depending on the region. Depending on climate onditions and soil texture, the number of irrigations ranges one to four. Under irrigation, a yield is 3.5 – 5 ton/ha. The harvested yield for grain has a water use efficiency of 0.6 to 1.0 kg/m^3 (FA0, 2020).

After transplanting, total water requirements (ETm) for a tomato crop cultivated in the field for 90 to 120 days range from 400 to 600 mm, depending on the climate. When water is scarce, salad crop irrigation can be concentrated during the transplanting, blossoming, and yield development stages. Furrow irrigation is a common method of surface irrigation. The emergence of fungal infections and even bacterial canker under sprinkler irrigation could become a big issue. Furthermore, under the spray, fruit set may be inhibited, and fruit rotting may increase. Sprinkler irrigation will cause leaf burn if the water is of low quality; this can be reduced by sprinkling at night and changing sprinkler lines in the direction of the prevailing wind. Drip irrigation has been used successfully due to the crop's unique requirements for high soil moisture content without leaf wetting. A decent commercial output under irrigation is 45 to 65 tons of fresh fruit per hectare, with a water use efficiency of 10 to 12 kg/m^3 for tomatoes (FA0, 2020).

Sesame crops require 430 – 470 mm of water per crop, depending on climatic onditions. It is ideally provided throughout the reproductive phase in single irrigation. When irrigation water becomes available following the thinning procedure, the crop can be irrigated to field capacity in 15 – 20 days. Under irrigation, crop yields range from 1.2 to 1.5 ton/ha. The crop's water use efficiency ranges from 0.28 to 0.32 kg/m^3 (FA0, 2020).

Banana, in humid places, 1200 mm of water is required, whereas in dry areas, 2200 mm is required. Because total accessible soil moisture deficiency of more than 35% during the entire growing season is detrimental to growth and fruit yield, frequent irrigation is essential. Irrigation intervals can range from three days in high evaporative conditions and light soils to fifteen days in low evaporative conditions and high water retaining soils. When rainfall and irrigation water are limited it is preferable to reduce the depth of each water application rather than increase the irrigation interval. In commercial banana plantations, overhead sprinkler systems with modest applications at frequent intervals are prevalent. Basin, furrow, and trench irrigation systems are examples of surface irrigation technologies. Drip irrigation is also used.

Banana yields range from 40 to 60 ton/ha. Water use efficiency ranges from 2.5 to 4 kg/m^3 (https://www.fao.org/land-water/databases).

1.2. Objective and Scope of Study

With population growth and increasing prosperity in the world, the need for food and agricultural water increases, and in parallel, the supply of water in sufficient quantity and quality decreases. With the increase in the need for water, solutions are sought for the development of water resources, the creation of alternative water resources, the availability of water at the des ired place and time, in the desired quantity and quality, its allocation between sectors, control of losses and leaks, treatment and reuse of waste water (Kodal & Ahi, 2018).

The use of inappropriate surface irrigation methods in Somalia reduces irrigation and water use efficiency and increases water losses in the fields. According to 2010 data, the irrigation efficiency was determined to be 40% by the United Nations Food and Agriculture Organization (FAO, 2010).

The aim of this study is to monitor and evaluate the irrigation system and to determine the physical agricultural water productivity in irrigation area located in Afgoi district of Somalia. For this purpose, some data were collected via farmer interview, others from global statistics center of Food and Agriculture Organisation Statitics (FAOSTAT, 2020). At the end of the study, inadequacies and their reasons in water use in agriculture has been determined and solutions for improvement of irrigation applications has been suggested. The results will help the farmers and co-operatives to apply correct amount of irrigation water required, and to increase water productivity in basin scale. Besides results will be confidential source for scientists, technicians and students in agricultural sector of Somalia.

2. MATERIAL and METHODS

This chapter discusses about the material and methods of data analysis used in study.

2.1. Material

2.1.1. Experimental Area

Study was carried out in the LowerShabelle region of Afgoi district, in the Southwest of Somalia which is approximately 30 km from the capital of Mogadishu. The latitude and longitude of the study is 2°8'17.16''N and 45°7'16.32''E, respectively. The elevation from sea level is 83 m (Venema & Vargas, 2007) (Figure 2.1).

The total population of the Afgoi district is 79400 and 33000 of them are farmers. The total cultivated area of the district is 235242 ha. The rainfed agricultural area is 121590 ha while the irrigated agricultural area is 113652 ha (Oduori et al; 2012).

Figure 2.1. Location of the study area

2.1.2. Climatic Conditions

Somalia generally has a traditional zone between arid and semi-arid climate. Rainfall is the defining characteristic of the climate and has a great spatial and temporal variability. Some climatic factors of experimental area during long term period (1990-2020) are given in table 2.1. According the values in table 2.1, the annual temperatures in South west Somalia between 22.1 - 31.1°C. The annual rainfall in southwest is 582 mm. Generally, rainfalls fall in the form of showers or localized torrential rains is extremely variable. Average wind speed is 3.1 m/s, the strongest winds occur between June and August, while the windless duration generally occurs from April to May in southern Somalia. Relative humidity usually remains about 68% even during dry seasons.

The main climate features are the existence of distinct wet and dry seasons and the absence of any large seasonal temperature changes. Rainfall is the most important meteorological element affecting life in Somalia. It is the defining characteristic of the climate and has great spatial and temporal variability. The dramatic variation from season to season and variations within the seasons determines the successes or the failure of agricultural activities (Venema & Vargas, 2007).

Somalia has four seasons: (a) Jilaal, a warm, sunny and a dry season from December to mid-March; (b) Gu, the main rainy season starting from mid-March to June; (c) Haggai, a cool, dry and a rather cloudy season starting from July upuntil mid-September; some weather stations along the southern coast and the northwestern regions receive significant amounts of rainfall; (4) Deyr, the secondary rain season, from mid-September to November (Venema & Vargas, 2007).

Table 2.1. Long-term climate data (FAO, 1990-2020)

Month	Min Temp (°C)	Max Temp (°C)	Humidity (%)	Wind Speed (m/s)	Sunshine (hours)	Radiation (Mj/m^2/day)	Total Rainfall (mm)	Effective Rainfall (mm)
January	21.6	33.5	65.0	4.0	7.9	20.6	2.0	2.0
February	21.8	34.1	70.0	4.2	9.2	23.5	2.0	2.0
March	23.0	35.0	69.0	3.8	9.0	23.6	10.0	9.8
April	23.5	34.3	71.0	2.5	7.5	20.8	91.0	77.8
May	23.1	32.8	76.0	2.5	6.4	18.3	94.0	79.9
June	22.6	31.2	79.0	3.0	6.2	17.3	64.0	57.4
July	21.5	30.5	75.0	3.0	7.9	20.1	58.0	52.6
August	21.5	31.1	75.0	3.1	8.1	21.2	24.0	24.9
September	21.7	32.0	71.0	3.1	8.5	22.5	15.0	14.6
October	22.0	32.2	72.0	2.8	7.5	20.8	62.0	55.8
November	21.8	32.3	67.0	2.1	6.8	19.0	121.0	97.6
December	21.6	33.0	66.0	3.2	6.6	18.4	39.0	36.6
Average	22.1	31.1	68.0	3.1	7.6	20.5	582.0	511.1

2.1.3. Soil Properties and Topography

Southern west Somalia is composed of low alluvial plains connected by the Shabelle River. These plains often have clay and dark fertile soils, some with poor drainage, high water-holding capacity and high salt content. Some of the river areas are also in danger of flooding and the slope value of the area is between 0 – 4% (Hadden, 2007).

2.1.4. Crop Pattern and Irrigation System

Sorghum, maize, cowpea, sesame, mung bean, and numerous vegetables are all pre-sown in rainfed agriculture. The most important crop in this area is maize. Due to the region's two rainfall seasons, sowing times occur two and three times throughout the year. In general,

the yield is poor. In regions with relatively high rainfall (500 – 600 mm), the average yield is 700 – 800 kg/ha for maize, 400 – 500 kg/ha for sorghum and 300 – 400 kg/ha for sesame.

The main crops on the irrigated areas are maize, sorgum, sesame, beans, cowpea and vegetables and large-scale plantationsof fruit trees such as banana, citrus, grapefruit, mango and papaya. The entire irrigated area is 776 ha, of which 116 ha is grown with maize, 133 ha with sorghum crops, and 256 ha with sesame as oil crop. The entire irrigated area of the banana plantation is 126 ha, and the tomatoes crop is grown on 145 ha. Bananas constitute the nation's major commercial crops. The sowing and harvesting date of maize, sorghum, sesame and bananas is between April – August, March – July, October – January and March – January, respectively. The average yield in irrigatedareasis 17.055 ton/ha for banana, 0.750 ton/ha for maize, 0.4450 ton/ha for sesame and 0.400 ton/ha for sorghum (FAO, 2020).

The Shabelle River flooding in Afgoi occurs along the riverbank and supports important irrigation schemes in the region, with an average discharge of 80-90 m^3/s when the river reaches Afgoi (Hassan, 2015).

Irrigation systems of the area comprise the following:

- **Controlled irrigation system:** It has wide principal channels (more than 2.5 m) and is controlled by rivers via a weir or a dam. If the area is sloped down hill, these systems supply irrigation throughout the year or during the Gu and Deyr rainfall seasons. The maintenance of such canals necessitates the use of heavy machinery. There are also a few smaller canals (less then about 2.5 m). These canals can be manually maintained without the use of large machinery.
- **Uncontrolled irigation system:** Irrigation water can only be used in rivers during high flow periods, as it is gravity fed directly from the river. Water is usually more abundant in Gu season than in Deyr season. The most of these canals are short and simple to maintain manually.
- **Pumping irrigation system:** Water is applied by large pumps and Shabele River has schemes in which water is supplied by large pumps and then distributed by the canal networks. Elsewhere individual farmers and co-operative of farmers use small pumps to access water directly from rivers, dams or canals (Hassan, 2015).

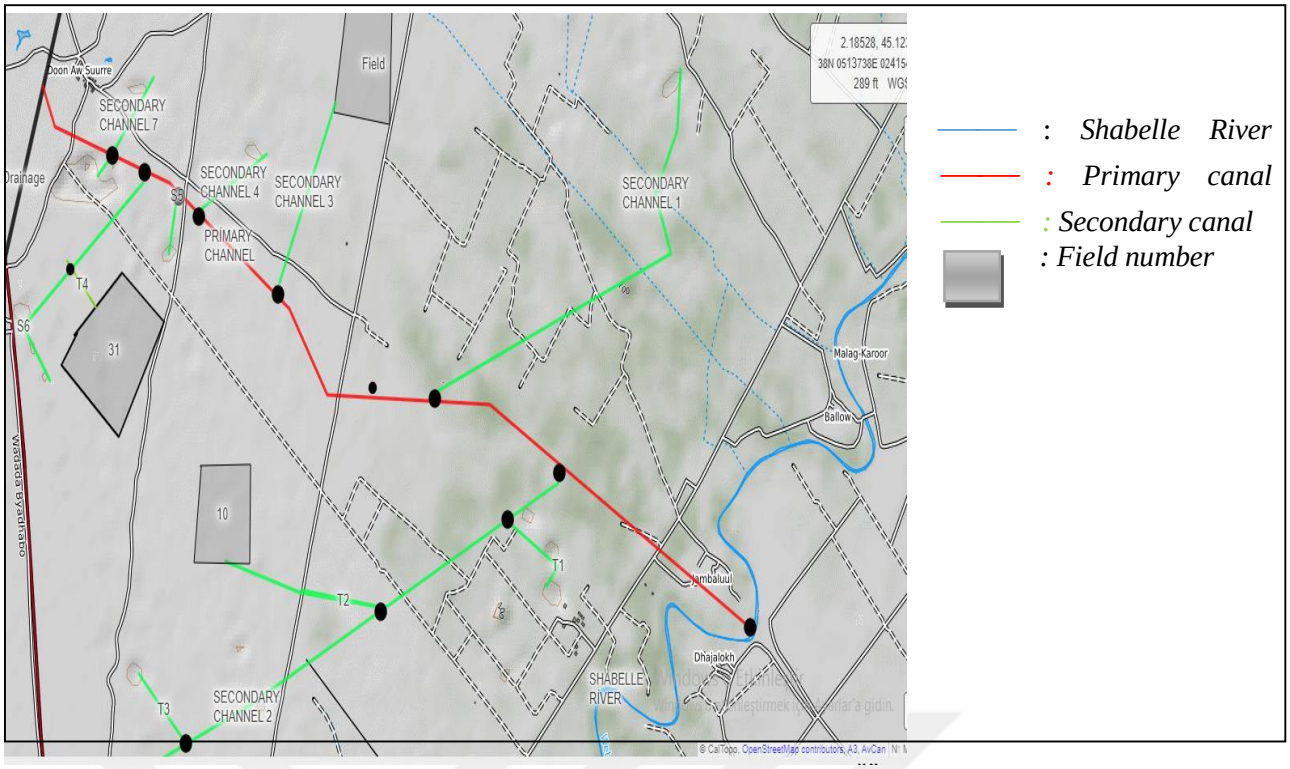

Figure 2.2. Irrigation layout in the experimental area

2.1.5. Socio Economic Conditions

In river side households, agriculture is the most important source of income. Unemployment affects about half of the population. They are mostly full-time housewives or students in their early twenties. Women are employed more than men, and employment begins early in life and often continues until one reach age of retirement. Women account for more than 40% of the population in livestock herding and agriculture. Agricultural work is also a significant food source and revenue in the region. Land preparation, sowing seeds or transplanting trees, weeding, irrigation, and crop protection, harvesting as well as threshing are some of the agricultural activities and it has become an income source for under privileged households. Poor households harvest roughly 900 to 1000 kg of maize per year on average, 50 to 55% of which they consume by food security and nutrition analysis unit (Fsnau, 2013).

2.1.6. Questionnaire Form

A questionnaire was prepared in order to collect the confidential information about the agricultural enterprises selected in the research area. As an example, the questionnare form of field 5 is given in table 2.2. Farmer's interview was realized during the August – December of 2021 in the field.

Table 2.2. An example of questionnaire form

1. INFORMATION ABOUT FARMER	
1) Field Number	: 5
2) Name of the farmer	: Abdullah TUUGAREY
3) Adress	: Hawotako, Afgoi, Somali
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FİELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 25 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, Tomato, Sesame.
3) Plant spacing between rows	: 70 cm
4) Plant spacing on the row:	: 25 cm
5) Sowing (planting) – Date of harversting	:10 April-15 Augost
6) Yield (ton/ha):	: 1010 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 90 cm
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primarychannel	: 30 L/s
7. OPERATION ofTHE SYSTEM	
1) Irrigation water applied by a farmer	: 90 mm x 5 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

2.2. Methods

This section includes yields obtained from farmer's interview, estimation of ET_C, WUE and IWUE calculation to determine the water productivity for different crops in the research area.

2.2.1. Yield

The average crop yield of maize, sorghum, sesame, tomato and banana were collected from farmers in the research area. For this purpose, 47 enterprises were selected randomly. Besides, average production values in the country were taken from statical data of FAOSTAT (http://www.fao.org/faostat/en/#data/QC).

2.2.2. Crop Evapotranspiration

The sum of evaporation from the soil surface and transpiration on leaf through stomata is termed as the crop water consumption (evapotranspiration). It's commonly represented in mm. It is difficult to monitor evaporation and transpiration independently in practice. There are numerous examples of equations which can be used to estimate the value for crop water consumption based on climate data. Although some of these equations are simple and only include a limited number of climate elements. In order to estimate ETc, the reference crop evapotranspiration is determined and then this value is multiplied by a crop coefficient that is developed according to the crop planting date, rooting depth, and environmental conditions in the growing environment (Yıldırım & Kadayıfcı, 1998).

For this purpose the equation is given below are used (Doorenbos & Pruitt, 1977).

$$ETc = ETo \times kc \quad (2.1)$$

Where;

ETc : Crop evapotranspiration (mm/day),

ETo : Reference evapotranspiration (mm/day),

Kc : Crop coeffient.

In the fields, the FAO-Penman Monteith method is used to estimate reference evapotranspiration, and the equations of this method are approved as standard by all organizations. While some scholars have directly employed the FAO-Penman Monteith

equation, many have already modified the equations of this method. This method corrects the inadequacies in the earlier FAO Penman method by producing numbers that are more in line with actual crop water use data from around the world (Smith, 1992).

$$ETo = \frac{0.408\Delta(Rn - G) + ɤ\frac{900}{T+273}u_2(e_s - e_a)}{\Delta + ɤ\,(1 + 0.34u_2)} \qquad (2.2)$$

Where;

ETo : Reference evapotranspiration (mm/day),
Rn : Net radiation at the crop surface (Mj m^2/ day),
G : Soil heat flux density (Mjm^2/day),
T : Mean daily air temperature at 2 m height (°C),
U_2 : Wind speed at 2 m height (m/s)
e_s :Saturation vapour pressure (kPa),
e_a : Actual vapour pressure (kPa),
e_s - e_a :Saturation vapour pressure deficit (kPa),
D :Slope vapour pressure curve (kPa/°C),
γ :psychometric constant (kPa/°C).

Crop Water Management (Cropwat), has been originally delivered by FAO in 1992 and use Agricultural engineers, agronomists, and students of irrigation and water management. The FAO's Climwat database includes average monthly climate data from 146 countries, and also a database which enables Cropwat to be used in the planning studies on both rain - fed and irrigated crop production (DehghaniSanij, Yamamoto & Rasiah, 2004). Latest versions of Cropwat and Climwat were downloaded from the FAO website (https://www.fao.org/land-water/databases-and-software).

Cropwat uses the seasonal crop water requirement for each crop. For each month, the FAO Penman-Monteith reference evapotranspiration and effective rainfall are computed using Cropwat. For effective rainfall, the USDA Soil Conservation Service method is chosen in this situation (input: daily temperature, relative humidity, windspeed, sunshine hours, total rainfall). Cropwat was used to calculate the crop coeffient for each crop based on planting date, growth stages, and length of growth stages, rooting depth, crop height, and critical depletion. Because the majority of periods are hot, the banana crop grows from March to February, and the resting or forest period is 20 days (FA0, 2020).

2.2.3. Crop Water Requirement and Irrigation Water Requirement

Crop water requirements (CWR) cover the total amount of water used in evapotranspiration. It is defined as depth of water needed to meet the water loss through evapotranspiration of a crop, being disease-free, growing in large fields under non restricting soil conditions, including soil water and fertility, and achieving full production potential growing under suitable environmentalconditions (Savva & Frenken, 2002).

Irrigation requirements (IR) indicate the water that is supplied through the irrigation system to ensure that the crop receives its full water need. If irrigation is the only source of water for the plant, the irrigation requirement will always be greater than the crop's water requirement to allow for efficiencies in the irrigation system. If the crop gets some of its water from other sources (precipitation, water stored in the soil, underground seepage, etc.), the irrigation need may be much less than the crop's water needs (Savva & Frenken, 2002).

The crop water and irrigation requirements of each crop were estimated with the Cropwat by using the input of crop data, ET_o, ET_C and effective precipitation values calculated. Calculation of crop water requirements is done on monthly.

The empirical equations for irrigation scheduling are rather sophisticated equations that typically involve numerous meteorological elements and produce healthy outcomes for daily, weekly, and maximum of ten-day periods (Orta,1991).

The net irrigation requirement was estimated by subtracting the effective rainfall (mm) from the calculated crop evapotranspiration in a seasonal basis using this equation

$$CWR = ETc - R_{eff} \quad (2.3)$$

Where;

CWR : Crop water requirement (mm),

ETc : Crop evapotranspiration (mm),

R_{eff} : Effective rainfall (mm).

2.2.4. Estimation of Water Productivity

Average yields of each crop and the amount of irrigation water applied obtained farmers interview and evapotranspiration of each crop calculated Cropwat were used to evaluate water

productivity (water use efficiency and irrigation water use efficiency). The following equations were used to estimate water efficiency as well as irrigation water use efficiency for each crop, taking into account yield value from farmers, seasonal crop water consumption, irrigation water applied by farmers (Jomaa & Shaban, 2018).

$$WUE = \frac{Y}{ET} \quad (2.4)$$

$$IWUE = \frac{Y}{I} \quad (2.5)$$

Where;

WUE : Water use efficiency (kg/m^3),

IWUE : Irrigation water use efficiency (kg/m^3),

Y : Crop yield (kg/ha),

ET : Crop water consumption (mm),

I : Irrigation water requirement (mm).

3. RESULTS and DISCUSSIONS

In this section crop yield, evapotranspiration of the crop estimated by Cropwat Software, amount of irrigation water applied by farmers and water productivity are given and discussed.

3.1. Crop Yield

The actual crop yields were obtained by farmer's interview and average yields are 823 kg/ha for maize, 663 kg/ha for sorghum, 417.3 kg/ha for sesame, 1500.28 kg/ha for tomato and 17574.10 kg/ha for banana.

According to mean values in the world related to yields ranges from 6000 – 9000 kg/ha for maize, 3500 – 5000 kg/ha for sorghum, 1200 – 1500 kg/ha for sesame, 45000 – 65000 kg/ha for tomato and 40000 – 60000 kg/ha for banana.

According to FAOSTAT (2020) data of yields in Israil are 19219.6 kg/ha for maize, 21000.0 kg/ha for sorghum, 20417.0 kg/ha for sesame, 68278.0 kg/ha for tomato and 50295.5 kg/ha for banana. In USA, average yields are 10794.5 kg/ha for maize, 4594.6 kg/ha for sorgum, 110716.3 kg/ha for tomato and 8975.5 kg/ha for banana. In Brazil, average yields are 5695.5 kg/ha for maize, 3150.1 kg/ha for sorghum, 72240.1 kg/ha, and 14587.4 kg/ha. In Mexico, average yields are 3832.2 kg/ha for maize, 3235.7 kg/ha for sorghum, 6607 kg/ha for sesame, 4817.0 kg/ha for tomato and 30899.9 kg/ha for banana. In Ethiopia average yields are 4240.4 kg/ha for maize, 2826.2 kg/ha for sorghum, 703.6 kg/ha for sesame, 6519.7 kg/ha for tomato and 9362.4 kg/ha for bananas. In Kenya average yields are 1731.0 kg/ha for maize, 1434.1 kg/ha for sorghum, 417.8 kg/ha for sesame, 29343.4 kg/ha for tomato and 25743.0 kg/ha for banana.

So, our results show that the average yield of all crops in Somalia is about five to ten times less than to the different countries in the world except Ethiopa's banana yield.

3.2. Crop evapotranspiration and Crop Water Requirement

Crop evapotranspiration estimated by Cropwat according to climatic parameters of 2021, effective rainfall in research area and calculated crop water requirements during whole growing periods for each crop are given in table 3.1, table 3.2, table 3.3, table 3.4, table and 3.5. As it can be seen from tables, seasonal crop evapotranspiration and crop water requirement of maize are 349.70 and 184.40 mm, sorgum are 367.26 and 208.68 mm, sesame are 340.22

and 275.97 mm and tomato are 502.77 and 438.57 mm, banana are 910.44 and 641.28 mm respectively. Although, the average amount of irrigation water applied by farmers are 408.89 mm in maize, 187.07 mm in sorghum, 415.05 mm in sesame, 616.82 mm in tomato and 1314.40 mm in banana are shown in table 3.6, table 3.7, table 3.8, table 3.9 and table 3.10. As can be seen, the amount of irrigation water applied by farmers is about two times more than the values calculated via Cropwat for all crops except for sorghum.

Table 3.1. Crop evapotranspiration and crop water requirement of maize

Month	ETo (mm)	kc	ETc (mm)	Effective rainfall (mm)	Crop water requirement (mm)
April	121.80	0.34	41.41	33.20	8.21
May	117.80	0.85	100.13	75.80	24.33
June	102.60	1.07	109.78	17.60	92.18
July	100.44	0.96	96.42	39.90	56.52
August	3.50	0.56	1.96	2.80	0.00
Total	446.14	–	349.70	169.30	184.40

Table 3.2. Crop evapotranspiration and crop water requirement of sorghum

Month	ETo (mm)	kc	ETc (mm)	Effective rainfall (mm)	Crop water requirement (mm)
March	129.27	0.30	38.78	9.00	29.78
April	121.80	0.47	57.25	33.20	24.05
May	117.80	0.93	109.55	75.80	33.75
June	102.60	0.96	98.50	17.60	80.90
July	97.20	0.65	63.18	22.99	40.19
Total	568.67	–	367.26	158.59	208.67

Table 3.3. Crop evapotranspiration and crop water requirement of sesame

Month	ETo (mm)	kc	ETc (mm)	Effective rainfall (mm)	Crop water requirement (mm)
October	116.25	0.64	74.40	22.30	52.10
November	117.30	0.75	87.98	35.70	52.28
December	115.63	0.90	104.07	6.10	97.97
January	110.10	0.67	73.77	0.10	73.67
Total	459.28	–	340.22	64.20	275.97

Table 3.4. Crop evapotranspiration and crop water requirement of tomato

Month	ETo (mm)	kc	ETc (mm)	Effective rainfall (mm)	Crop water requirement (mm)
October	116.25	0.60	69.75	22.30	47.45
November	117.30	0.73	85.63	35.70	49.93
December	115.63	1.02	117.94	6.10	111.84
January	113.70	1.08	122.80	0.10	122.70
February	112.56	0.92	103.56	0.00	103.56
March	4.17	0.74	3.09	0.00	3.09
Total	579.61	–	502.77	64.10	438.57

Table 3.5. Crop evapotranspiration and crop water requirement of banana

Month	ETo (mm)	kc	ETc (mm)	Effective rainfall (mm)	Crop water requirement (mm)
March	129.27	0.50	64.64	0.10	64.54
April	121.80	0.50	60.90	33.20	27.70
May	117.80	0.50	58.90	75.80	0.00
June	102.60	0.55	56.43	17.60	38.83
July	100.44	0.64	64.28	39.90	24.38
August	108.50	0.73	79.21	25.10	54.11
September	114.90	0.81	93.07	27.70	65.37
October	116.25	0.90	104.63	31.30	73.33
November	117.30	0.97	113.78	35.70	78.08
December	115.63	0.97	112.16	6.10	111.60
January	113.67	0.91	103.44	0.10	103.34
Total	126.16	–	910.44	292.60	641.28

3.3. Water Productivity

Water productivity for each field was calculated according to actual yield, evapotranspiration by Cropwat and amount of irrigation water applied by farmers. Water use efficiency and irrigation water use efficiency for each crop are presented in table 3.6, table 3.7, table 3.8, table 3.9 and table 3.10.

Table 3.6. Water productivity of maize

Field number	Size of area (ha)	Yield (kg/ha)	ETC (mm)	CWR (mm)	Irrigation water applied (mm)	WUE (kg/m^3)	IWUE (kg/m^3)
1	10.00	650.00	334.70	164.60	300.00	0.19	0.22
2	20.00	750.00	328.20	180.10	471.00	0.23	0.16
3	18.00	900.00	327.80	212.30	450.00	0.27	0.20
4	25.00	850.00	330.10	176.00	360.00	0.26	0.24
5	25.00	1010.00	330.10	176.00	450.00	0.31	0.22
6	15.00	670.00	332.40	164.80	628.00	0.20	0.11
7	25.00	950.00	326.90	189.90	312.00	0.29	0.30
8	18.00	800.00	328.20	180.10	300.00	0.25	0.27
Average	—	823.00	329.80	180.48	408.89	0.25	0.23

According to table 3.6, the lowest WUE of maize was found to be 0.11 kg/m^3 and the highest WUE 0.31 kg/m^3 and averaged 0.25 kg/m^3. IWUE changed from 0.11 – 0.30 kg/m^3 and averaged 0.23 kg/m^3 in farmer's application.

According to mean values in the world related to maize, yield is 6000 – 9000 kg/ha, crop requires 500 – 800 mm of water, crop water use efficiency ranges between 0.8 and 1.6 kg/m^3 (FAO, 2020).

The effect of planting date and plant density on maize water use efficieny was studied in USA, calculated water use efficiency of maize ranges between 1.76 – 2.71 kg/m^3(Allen et al., 2021). Study of the optimization of drip irrigation and fertilization regimes for high grain yield, crop water productivity of maize in China. The total irrigation water applied was 493 mm and irrigation water use efficiency was found 3.44 kg/m^3 (Zou et al; 2019). Nasseri (2021) Studied water productivity on corn yield under moderate semi-arid environment in South Iran. It was confirmed that water productivity of maize was from 1.22 to 1.52 kg/m^3 with an average

of 1.38 kg/m^3. The yield obtained ranged from 3800 to 6971 kg/ha with an average of 5345 kg/ha and water applied was from 3125 to 458.4 mm and averaged 383.6 mm. Gürbüz, Dağdelen, Yılmaz and Wzorek (2021), investigated the effect of different deficient water levels on yield, water use efficiency and some yield characteristics of maize in Turkey at Aydın province. The total water applied was 132 – 656 mm and seasonal crop water consumption varied between 134 mm to 737 mm. The average yield ranged between 2520 kg/ha 1366 kg/ha and WUE was 1.85 – 2.26 kg/m^3.

Water use efficiency of maize under drip irrigation system was found as 2.03 kg/m^3. The highest WUE value are found when less irrigation is applied as complementary to effective rainfall of the growing season (Djaman, et al., 2018).

Table 3.7. Water productivity of sorghum

Field number	Size of area (ha)	Yield (kg/ha)	ETC (mm)	CWR (mm)	Irrigation water applied (mm)	WUE (kg/m^3)	IWUE (kg/m^3)
9	10.00	650.00	301.60	152.30	360.00	0.22	0.18
10	5.00	500.00	311.60	108.80	425.00	0.16	0.12
11	15.00	550.00	301.60	152.30	352.00	0.18	0.16
12	10.00	750.00	335.10	161.10	328.00	0.22	0.23
13	20.00	850.00	336.10	285.40	360.00	0.25	0.24
14	15.00	550.00	302.50	182.40	300.00	0.18	0.18
15	5.00	500.00	463.30	331.10	450.00	0.11	0.14
16	25.00	650.00	286.00	175.50	350.00	0.23	0.19
17	18.00	880.00	288.30	169.30	380.00	0.31	0.23
18	10.00	750.00	301.60	152.30	425.00	0.25	0.21
Average	—	663.00	466.11	270.80	187.07	0.21	0.9

According to table 3.7, the minimum WUE of sorghum was found 0.11 kg/m^3 and the highest was 0.31 kg/m^{3}and averaged 0.21 kg/m^3, IWUE changed from 0.12 – 0.24 kg/m^3 and averaged 0.90 kg/m^3 in farmer's application.

According to mean values in the world related to sorghum for high yield ranged between 450 – 650 mm, produdes yield between 3500 – 5000 kg/ha. The harvested yield for grain has a water use efficiency of 0.6 to 1.0 kg/m^3.

Sorghum yield in USA was reported 3340.0 – 3770.0 kg/ha when seasonal crop water requirement ranged between 259 – 663 mm and WUE of crop ranges between 1.47 – 1.52 kg/m^3 (Tolk & Howell, 2021).

According to FAOSTAT data, average yield of sorghum in Israil is 21000 kg/ha in 2020 when applied irrigation water 563.8 mm of water, IWUE was calculated 3.91 kg/m^3.

Table 3.8. Water productivity of sesame

Field number	Size of area (ha)	Yield (kg/ha)	ETC (mm)	CWR (mm)	Irrigation water applied (mm)	WUE (kg/m^3)	IWUE (kg/m^3)
19	10.00	524.30	307.90	197.60	255.00	0.17	0.20
20	15.00	515.50	318.30	194.30	360.00	0.16	0.14
21	18.00	533.20	322.10	203.00	390.00	0.17	0.14
22	25.00	542.30	338.00	237.30	440.00	0.16	0.12
23	10.00	365.90	338.00	237.55	450.00	0.10	0.08
24	30.00	450.00	338.90	250.6	475.00	0.13	0.09
25	15.00	341.50	335.70	224.60	400.50	0.10	0.09
26	8.00	450.00	331.50	211.70	440.00	0.14	0.10
27	10.00	440.00	337.50	233.30	420.00	0.13	0.10
28	15.00	550.00	336.90	263.80	520.00	0.16	0.11
Average	–-	471.30	330.48	225.38	415.05	0.14	0.12

According to table 3.8, the minimum WUE of sesame was found 0.10 kg/m^3 and the highest was 0.17 kg/m^3 and averaged 0.14 kg/m^3. IWUE changed from 0.08-0.20 kg/m^3 and averaged 0.12 kg/m^3 in farmer's application.

According to global data estimation sesame crops require 430 – 470 mm of water per crop. Under irrigation crop yields range from 1200 to 1500 kg/ha. The crop's water use efficiency ranges from 0.28 to 0.32 kg/m^3 (FA0, 2020).

Table 3.9. Water productivity of tomato

Field number	Size of area (ha)	Yield (kg/ha)	ETC (mm)	CWR (mm)	Irrigation water applied (mm)	WUE (kg/m^3)	IWUE (kg/m^3)
29	15.00	1550.00	486.10	423.10	600.00	0.32	0.25
30	10.00	1430.00	488.00	430.10	500.00	0.29	0.28
31	10.00	1520.00	483.40	410.30	525.00	0.31	0.29
32	5.00	1440.00	490.10	437.40	600.00	0.29	0.24
33	10.00	1,528.00	484.50	416.40	580.00	0.32	0.26
34	15.00	1565.00	484.30	410.10	750.00	0.32	0.21
35	15.00	1436.00	485.40	422.4	650.00	0.30	0.22
36	20.00	1400.00	475.90	359.60	750.00	0.29	0.19
37	10.00	1530.00	446.50	309.70	650.00	0.34	0.24
38	15.00	1578.00	479.30	382.90	580.00	0.32	0.27
Average	---	1500.82	433.25	391.97	616.82	0.31	0.25

As shown in table 3.9, the lowest WUE of tomato was found 0.29 kg/m^3 and the highest was 0.34 kg/m^3 and averaged 0.31 kg/m^3. IWUE changed from 0.19 – 0.29 kg/m^3 and averaged 0.25 kg/m^3 in farmer's application.

According to global data estimation tomato crop yield under irrigation is 45000 to 65000 kg of fresh fruit per hectare, while crop water requirement range from 400 – 600 mm with water uses efficiency of 10 to 12 kg/m^3.

According to Israil tomato yield and water requirement are 68278.2 kg/ha and 668.6 mm and WUE is 10.2 kg/m^3.

According to China yield of tomato is 58359.90 kg/ha, when 179 mm of irrigation water applied the WUE was calculated 32.60 kg/m^3 (http://www.fao.org/faostat/en/#data/QC).

Table 3.10. Water productivity of banana

Field number	Size of area (ha)	Yield (kg/ha)	ETC (mm)	CWR (mm)	Irrigation water applied (mm)	WUE (kg/m^3)	IWUE (kg/m^3)
39	10.00	17340.00	889.40	614.00	1080.00	1.95	1.61
40	5.00	17399.00	890.60	615.60	1200.00	1.95	1.45
41	10.00	17550.00	893.30	618.00	1260.00	1.96	1.39
42	18.00	17607 .00	897.50	663.60	1100.00	1.96	1.61
43	20.00	17550.00	889.80	614.40	1200.00	1.97	1.46
44	15.00	17622.00	892.20	611.10	1080.00	1.99	1.63
45	25.00	17635.00	899.00	630.90	2160.00	1.96	0.82
46	5.00	17649.00	890.00	610.10	1430.00	1.98	1.23
47	18.00	17815.00	899.40	642.70	960.00	1.98	1.86
Average	---	17574.10	893.47	624.50	1314.00	1.97	1.45

According to table 3.10, the lowest water use efficiency of banana was found to be 1.95 kg/m^3 and the highest water use efficiency was 1.99 kg/m^3 and averaged 1.97 kg/m^3. IWUE changed from 0.82–1.13 kg/$m^3$and averaged 1.45 kg/m^3 in farmer's application.

According to mean values in the world related to banana, yield ranges from 40000 – 60000 kg/ha, WUE varied from 2.5 – 4 kg/m^3.

According to FAO STAT in Israil yield of banana is 15300 kg/ha with irrigation water of 830.8 mm and IWUE is 1.84 kg/m^3(http://www.fao.org/faostat/en/#data/QC).

As we saw the above tables if the irrigation water applied is less leads to increasing the water use efficiency. Thus, increasing irrigation water productivity avoids excess water loss and saves more water during irrigation.

Yields are generallay lower than with full irrigation, but WUE and IWUE may be higher in a limited irrigation (Orta et al; 2001).

4. CONCLUSION and RECOMMENDATIONS

This study was conducted to evaluate water productivity in Somalia. The estimated crop evapotranspiration of maize, sorghum, sesame, tomato and banana are 329.80, 466.11, 330.48, 433.25 and 893.47 mm respectively. The actual yield from farmer's fields are 823.00 kg/ha for maize, 663.00 kg/ha for sorghum, 471.30 kg/ha for sesame, 1500.28 kg/ha for tomato and 17570.0 kg/ha for banana. The irrigation water applied by farmers are 408.89 mm for maize, 187.08 mm for sorghum, 415.05 mm for sesame, 616.82 mm for tomato and 1314 mm for banana. According to these data, WUE and IWUE of maize, sorghum, sesame, tomato and banana values are calculated as 0.25, 0.21, 0.14, 0.31, 1.91 and 0.23, 0.90, 0.12, 0.25 and 1.45 kg/m^3. Average yields through out the world are 6000 – 9000 kg/ha for maize, 3500 – 5000 kg/ha for sorghum, 1200 – 1500 kg/ha for sesame, 45000 – 65000 kg/ha for tomato and 40000 – 60000 kg/ha for banana and, WUE of maize, sorghum, sesame, tomato, banana is 0.8 –1.6, 0.6 – 1.0, 0.28 – 0.32, 10 – 12 and 2.5 – 4 kg/m^3 respectively.

Therefore, at the end of study the low water use and irrigation water use efficiency were observed due to low yield and excessive irrigation water applied by farmers.

Climate change, which includes frequent droughts, flooding, rising temperatures, and high winds across the country, is the primary cause of low yield in the region. Low yields in the region are caused by a variety of factors, including limited using agricultural fertilizers, poor seed quality, poor pest control, inappropriate sowing date, mismanaging in irrigation scheduling (Abdulle, 2020).

Flooding is a result of climate change event that reduces crop yields. During rainy seasons, floods are common due to downpours that overrun existing rivers. Excessively irrigation water is applied to the field, resulting water logging and decreasing crop yield. The use of uncontrolled surface irrigation is a serious issue that reduces water use efficiency and irrigation water use efficiency. On other hand, excessive water is lost during conveyence of irrigation water by using earth canals and this causes increasing salinity of the soil and raises water table of soil profile (Abdulle, 2020).

To be able to solve these problems detailed above some suggestions are listed:

- The government should have build dams in order to store excessive water on the river during rainy period in Gu season.
- The institutions or NGOs should adapt or apply reuse of waste water in order to avoid droughts.
- In order to reduce water loss and increase water use efficiency pressurized irrigation systems are recommended instead of uncontrolled surface irrigation method.
- Extension agents should educate the farmers about the advantages of pressured irrigation methods (sprinkler and drip irrigation methods).
- Farmers training about irrigation management and irrigation scheduling by extension agents from institutes, non-governmental organizations and Ministry of agriculture and irrigation.
- Concrete canals should be used instead of earth canals to prevent excess water loss during water conveyance.
- Farmers should be provided seminars about cultural practices such as, crop spacing, sowing dates of crops, fertilization, etc.
- The government should support subsidise farmers for irrigation investment, agricultural fertilizers usage, chemicals for pest control and high yield seeds supplying.

Otherwise food security can not be managed continous in the country.

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APPENDIX

APPENDIX -TABLE 1. QUESTIONNARE FORM of NUMBER 1

1. INFORMATION ABOUT FARMER	
1) Field Number	: 1
2) Name of the farmer	: Ahmed Sheikh ABDULLAHI
3) Adress	: Ifo iyo Aakiro, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field has to a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 80 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: -----
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, vegetable, alfa-alfa
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	:1 April – 5August
6) Yield (ton/ha):	: 0.65 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: ---
7. OPERATION of THE SYSTEM	
1)Irrigation water applied by a farmer	: 75 mm x 4 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 15 days
4) Irrigation labour and charges	: 5 x $10
5) Unit water price	: $4/hour

APPENDIX -TABLE 2. QUESTIONNARE FORM of NUMBER 2

1. INFORMATION ABOUT FARMER	
1) Field Number	: 2
2) Name of the farmer	: Ali OSMAN
3) Adress	: Dhagaxtuur, Afgoi, Somali
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 20 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	:15 April – 17August
6) Yield (ton/ha):	: 0.750 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 55 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 157 mm x 3times
2) Irrigation duration applied by farmer	: 14 hours
3) Irrigation interval by farmer	: 24 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $2/hour

APPENDIX -TABLE 3. QUESTIONNARE FORM of NUMBER 3

1. INFORMATION ABOUT FARMER	
1) Field Number	: 3
2) Name of the farmer	: Mohamed MAYOW
3) Adress	: Baarismaail, Afgoi, Somalaia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 18 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, sesame, watermelon
3) Plant spacing between rows	: 0.70
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	:5 April-7August
6) Yield (ton/ha):	: 0.900 ton/ha
7) Market price of the crop ($/ton)	: $ 400/ton
5. PROPERTIES OF SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 l/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer	: 150 mm x 3 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 23 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $3/hour

APPENDIX -TABLE 4. QUESTIONNARE FORM of NUMBER 4

1. INFORMATION ABOUT FARMER	
1) Field Number	: 4
2) Name of the farmer	: Selman SIDOW
3) Adress	: Masjid jaamac, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 25
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, sesame, watermelon
3) Plant spacing between rows	: 0.70
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	:10 April – 5August
6) Yield (ton/ha):	: 0.850 ton/ha
7) Market price of the crop ($/ton)	: $ 400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 10 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 90 mm x 4 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX -TABLE 5. QUESTIONNARE FORM of NUMBER 5

1. INFORMATION ABOUT FARMER	
1) Field Number	: 5
2) Name of the farmer	: Abdullah TUUGAREY
3) Adress	: Hawotako, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group	
Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 25 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, tomato, sesame.
3) Plant spacing between rows	: 70 cm
4) Plant spacing on the row:	: 25 cm
5) Sowing (planting) – Date of harversting	:10 April – 15 August
6) Yield (ton/ha):	:0.1010 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 90 cm
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 90 mm x 5 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX -TABLE 6. QUESTIONNARE FORM of NUMBER 6

1. INFORMATION ABOUT FARMER	
1) Field Number	: 6
2) Name of the farmer	: Dahir HİLOWLE
3) Adress	:Bosteejada xamar, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 1.90 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, tomato, sesame.
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.20 m
5) Sowing (planting) – Date of harversting	:5 April – 20 August
6) Yield (ton/ha):	: 0.670 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 90 cm
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 90 mm x 5 times
2) Irrigation duration applied by farmer	: 14 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 4 x 10$
5) Unit water price	: $4/hour

APPENDIX-TABLE 7. QUESTIONNARE FORM of NUMBER 7

1. INFORMATION ABOUT FARMER	
1) Field Number	: 7
2) Name of the farmer	: Yuusuf GUULED
3) Adress	: Embageti, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 25 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	:65 L/s
4) Height of water source (Code to river, height of channel)	: 1.90 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, tomato, sesame.
3) Plant spacing between rows	: 0.70 m
4) Plant spacing on the row:	: 0.20 m
5) Sowing (planting) – Date of harversting	:20 April – 22 August
6) Yield (ton/ha):	: 0.950 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 90 cm
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 104 mm x 3 times
2) Irrigation duration applied by farmer	: 18 hours
3) Irrigation interval by farmer	: 17 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX -TABLE 8. QUESTIONNARE FORM of NUMBER 8

1. INFORMATION ABOUT FARMER	
1) Field Number	: 8
2) Name of the farmer	: Omer BEERE
3) Adress	: Jambalul, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group	
Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 18 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	:50 L/s
4) Height of water source (Code to river, height of channel)	: 1.85 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Maize
2) Crop rotation system	: Maize, Cowpea, Sorghum
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.20 m
5) Sowing (planting) – Date of harversting	: 15 April – 17 August
6) Yield (ton/ha):	: 0.800 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 90 cm
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	:75 mm x 4 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 12 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $2/hour

APPENDIX -TABLE 9. QUESTIONNARE FORM of NUMBER 9

1. INFORMATION ABOUT FARMER	
1) Field Number	: 9
2) Name of the farmer	: Mayow ASHİR
3) Adress	: Hawo taako Marko road-2, Lowershabelle, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	:50 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, maize vegetable
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	: 15 March – 5 July
6) Yield (ton/ha):	: 0.65 ton/ha
7) Market price of the crop ($/ton)	: $300/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 45 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in evey irrigation	: 90 mm x 4 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 20 days
4) Irrigation labour and charges	: 4 x 8$
5) Unit water price	: $4/hour

APPENDIX -TABLE 10. QUESTIONNARE FORM of NUMBER 10

1. INFORMATION ABOUT FARMER	
1) Field Number	: 10
2) Name of the farmer	: Hussein ISAK
3) Adress	: Ifo iyoAakiro, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field has to a farmer group	
Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 5 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: -----
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, mungbea, tomato
3) Plant spacing between rows	: 0.70 m
4) Plant spacing on the row:	: 0.20 m
5) Sowing (planting) – Date of harversting	:1 March – 2 July
6) Yield (ton/ha):	: 0.50 ton/ha
7) Market price of the crop ($/ton)	: $ 300/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: ---
7. OPERATION of THE SYSTEM	
1)Irrigation water applied by a farmer	: 85 mm x 5 times
2) Irrigation duration applied by farmer	: 6 hours
3) Irrigation interval by farmer	: 18 days
4) Irrigation labour and charges	: 4 x $8
5) Unit water price	: $3/hour

APPENDIX -TABLE 11. QUESTIONNARE FORM of NUMBER 11

1. INFORMATION ABOUT FARMER	
1) Field Number	: 11
2) Name of the farmer	: Mohammet SH.ALİ
3) Adress	: Buulodoon, Lowershabelle, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	:40 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, maize vegetable
3) Plant spacing between rows	: 0.65 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	: 15 March – 10 July
6) Yield (ton/ha):	: 0.55 ton/ha
7) Market price of the crop ($/ton)	: $300/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 45 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 88 mm x 4 times
2) Irrigation duration applied by farmer	:10 hours
3) Irrigation interval by farmer	: 20 days
4) Irrigation labour and charges	: 6 x 8$
5) Unit water price	: $3/hour

APPENDIX -TABLE 12. QUESTIONNARE FORM of NUMBER 12

1. INFORMATION ABOUT FARMER	
1) Field Number	: 12
2) Name of the farmer	: Daahir GUULED
3) Adress	: Dhagaxtuur, Afgoye, Somalia.
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	:60 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, maize, vegetable
3) Plant spacing between rows	: 0.70 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	: 10 January – 10 May
6) Yield (ton/ha):	: 0.75 ton/ha
7) Market price of the crop ($/ton)	: $380/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION OF THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	:82 mm x 4 times
2) Irrigation duration applied by farmer	:8 hours
3) Irrigation interval by farmer	: 18 days
4) Irrigation labour and charges	: 4 x 9$
5) Unit water price	: $3/hour

APPENDIX -TABLE 13. QUESTIONNARE FORM of NUMBER 13

1. INFORMATION ABOUT FARMER	
1) Field Number	: 13
2) Name of the farmer	: Osman AALİN
3) Adress	: Embigeeti, Afgoye, Somalia.
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 20 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, maize, vegetable
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	: 5 January – 5 May
6) Yield (ton/ha):	: 0.85 ton/ha
7) Market price of the crop ($/ton)	: $380/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 82 mm x 4 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 20 days
4) Irrigation labour and charges	: 6 x 9$
5) Unit water price	: $2/hour

APPENDIX -TABLE 14. QUESTIONNARE FORM of NUMBER 14

1. INFORMATION ABOUT FARMER	
1) Field Number	: 14
2) Name of the farmer	: Yuusuf MAHDEY
3) Adress	: Embigeeti, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 80 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, mungbea ,maize
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	: 5 July – 5 October
6) Yield (ton/ha):	: 0.55 ton/ha
7) Market price of the crop ($/ton)	: $450/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	:75 mm x 4 times
2) Irrigation duration applied by farmer	:10 hours
3) Irrigation interval by farmer	: 18 days
4) Irrigation labour and charges	: 7 x 10$
5) Unit water price	: $2/hour

APPENDIX-TABLE 15. QUESTIONNARE FORM of NUMBER 15

1. INFORMATION ABOUT FARMER	
1) Field Number	: 15
2) Name of the farmer	: Osman IKIR
3) Adress	: Embigeeti, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	:5 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 70 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, mungbea ,maize
3) Plant spacing between rows	: 0.65 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	: 10 June – 5 September
6) Yield (ton/ha):	: 0.50 ton/ha
7) Market price of the crop ($/ton)	: $460/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 90 mm x 5 times
2) Irrigation duration applied by farmer	: 6 hours
3) Irrigation interval by farmer	: 18 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $2/hour

APPENDIX-TABLE 16. QUESTIONNARE FORM of NUMBER 16

1. INFORMATION ABOUT FARMER	
1) Field Number	:16
2) Name of the farmer	: Amer QASAY
3) Adress	: Hawotako, Afgoye, Somalia.
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group	
Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 25 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, mungbea,tomato
3) Plant spacing between rows	: 0.70 m
4) Plant spacing on the row:	: 0.30 m
5) Sowing (planting) – Date of harversting	: 15 June – 1 September
6) Yield (ton/ha):	: 0.65 ton/ha
7) Market price of the crop ($/ton)	: $460/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 45 L/s
7. OPERATIONof THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 95 mm x 4 times
2) Irrigation duration applied by farmer	: 15 hours
3) Irrigation interval by farmer	: 20 days
4) Irrigation labour and charges	: 10 x 10$
5) Unit water price	: $2/hour

APPENDIX -TABLE 17. QUESTIONNARE FORM of NUMBER 17

1. INFORMATION ABOUT FARMER	
1) Field Number	: 17
2) Name of the farmer	: Abdifatah AMEY
3) Adress	Hawotako, Afgoye, Somalia.
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group	
Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 18 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 1.20 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	:Sorghum,vegetable, mungbea
3) Plant spacing between rows	: 0.75 m
4) Plant spacing on the row:	: 0.30 m
5) Sowing (planting) – Date of harversting	: 15 March – 10 June
6) Yield (ton/ha):	: 0.88 ton/ha
7) Market price of the crop ($/ton)	: $ 400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATIONof THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 85 mm x 5 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 17 days
4) Irrigation labour and charges	: 7 x 10$
5) Unit water price	: $2/hour

APPENDIX -TABLE 18. QUESTIONNARE FORM of NUMBER 18

1. INFORMATION ABOUT FARMER	
1) Field Number	: 18
2) Name of the farmer	: Abdirahman IKOW
3) Adress	:Embigeedo, Afgoye, Somalia.
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 50 L/s
4) Height of water source (Code to river, height of channel)	: 2.00 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sorghum
2) Crop rotation system	: Sorghum, vegetable, maize
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.30 m
5) Sowing (planting) – Date of harversting	: 20 March – 15 June
6) Yield (ton/ha):	: 0.75 ton/ha
7) Market price of the crop ($/ton)	: $400/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 75 mm x 3 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 17 days
4) Irrigation labour and charges	: 8 x 6$
5) Unit water price	: $2/hour

APPENDIX-TABLE 19. QUESTIONNARE FORM of NUMBER 19

1. INFORMATION ABOUT FARMER	
1) Field Number	: 19
2) Name of the farmer	: Nuur ADUUNYO
3) Adress	: Dhagaxtuur, AFgoi, Somali
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 1.50 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, maize, tomato
3) Plant spacing between rows	: 0.30 m
4) Plant spacing on the row:	: 0.25 m
5) Sowing (planting) – Date of harversting	:1 June – 10 September
6) Yield (ton/ha):	:0.5243 ton/ha
7) Market price of the crop ($/ton)	: $1500/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5)Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION OF THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 85 mm x 3 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 20 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $2/hour

APPENDIIX -TABLE 20. QUESTIONNARE FORM of NUMBER 20

1. INFORMATION ABOUT FARMER	
1) Field Number	: 20
2) Name of the farmer	: Hassan ALOW
3) Adress	: Ifo iyo Akhiro, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	:15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	:40 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, vegetable, Tomato
3) Plant spacing between rows	: 0.30 m
4) Plant spacing on the row:	: 0.15 m
5) Sowing (planting) – Date of harversting	:1 July – 5 October
6) Yield (ton/ha):	:0.5155 ton/ha
7) Market price of the crop ($/ton)	: $1480/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 120 mm x 3 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 19 days
4) Irrigation labour and charges	: 6 x 9$
5) Unit water price	: $3/hour

APPENDIX -TABLE 21. QUESTIONNARE FORM of NUMBER 21

1. INFORMATION ABOUT FARMER	
1) Field Number	: 21
2) Name of the farmer	: Osman MACOW
3) Adress	: Hawoabdi, Lowershabelle, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	:18 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	:50 L/s
4) Height of water source (Code to river, height of channel)	:1.75 m
5) Othe	: ---
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, maize,vegetable
3) Plant spacing between rows	: 0.40 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:1 July – 5 October
6) Yield (ton/ha):	:0.5332 ton/ha
7) Market price of the crop ($/ton)	: $1480/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 90 mm x 4 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 22 days
4) Irrigation labour and charges	: 8 x 9$
5) Unit water price	: $3/hour

APPENDIX -TABLE 22. QUESTIONNARE FORM of NUMBER 22

1. INFORMATION ABOUT FARMER	
1) Field Number	: 22
2) Name of the farmer	: Jeylani MAHDEY
3) Adress	:Hawoabdi, Lowershabelle, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field hast o a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	:25 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: ----
3) Discharge	:50 L/s
4) Height of water source (Code to river, height of channel)	:1.75 m
5) Other	: ---
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, maize, vegetable
3) Plant spacing between rows	: 0.35 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:1 September –5 February
6) Yield (ton/ha):	:0.5420 ton/ha
7) Market price of the crop ($/ton)	: $1500/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay
2) Effective soil depth	: 0.90
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 110 mm x 4 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 24 days
4) Irrigation labour and charges	: 10 x 9$
5) Unit water price	: $3/hour

APPENDIX-TABLE 23. QUESTIONNARE FORM of NUMBER 23

1. INFORMATION ABOUT FARMER	
1) Field Number	: 23
2) Name of the farmer	: Mohamed SALAH
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, Tomato, cowpea
3) Plant spacing between rows	: 0.55 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:1 July – 5 Decembert
6) Yield (ton/ha):	: 0. 3659 ton/ha
7) Market price of the crop ($/ton)	: $1500/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 75 mm x 4 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 24. QUESTIONNARE FORM of NUMBER 24

1. INFORMATION ABOUT FARMER	
1) Field Number	: 24
2) Name of the farmer	: Ali OSMAN
3) Adress	: Makoyga, Afgoi. Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 30 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 50 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, tomato, cowpea
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:1 5 July – 25 September
7) Market price of the crop ($/ton)	: $1500/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 95 mm x 5 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 22 days
4) Irrigation labour and charges	: 10 x 9$
5) Unit water price	: $4/hour

APPENDIX-TABLE 25. QUESTIONNARE FORM of NUMBER 25

1. INFORMATION ABOUT FARMER	
1) Field Number	: 25
2) Name of the farmer	: Ibrahim KATAAJOW
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, tomato, cowpea
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:15 Augusto – 12 December
6) Yield (ton/ha):	: 0. 3415 ton/ha
7) Market price of the crop ($/ton)	: $1450/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 33 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigationin	: 80.1mm x 5 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 18 days
4) Irrigation labour and charges	: 8 x 10$
5) Unit water price	: $4/hour

APPENDIX-TABLE 26. QUESTIONNARE FORM of NUMBER 26

1. INFORMATION ABOUT FARMER	
1) Field Number	: 26
2) Name of the farmer	: Abdurahman MAALOW
3) Adress	: km-18, Lowershabelle, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 8 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 45 L/s
4) Height of water source (Code to river, height of channel)	: 1.50 m
5) Other	
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, Tomato, cowpea
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:1 Augost -5 November
6) Yield (ton/ha):	: 0.4500 ton/ha
7) Market price of the crop ($/ton)	: $1450/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 75 mm x 6 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 12 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $4/hour

APPENDIX-TABLE 27. QUESTIONNARE FORM of NUMBER 27

1. INFORMATION ABOUT FARMER	
1) Field Number	: 27
2) Name of the farmer	: Abdurahim UKASH
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 1.50 m
5) Other	
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, tomato, cowpea
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:25 August – 5 December
6) Yield (ton/ha):	: 0. 4500 ton/ha
7) Market price of the crop ($/ton)	: $1450/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 84.5 mm x 5 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 19 days
4) Irrigation labour and charges	: 7 x 10$
5) Unit water price	: $3.5/hour

APPENDIX-TABLE 28. QUESTIONNARE FORM of NUMBER 28

1. INFORMATION ABOUT FARMER	
1) Field Number	: 28
2) Name of the farmer	: Adam SHAFIYE
3) Adress	: Embageda, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field has to a farmer group	
Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 1.5 m
5) Other	: -----
4. CROP	
1) Current crop in the field	: Sesame
2) Crop rotation system	: Sesame, maize, potato,
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.10 m
5) Sowing (planting) – Date of harversting	:1 October – 25 January
6) Yield (ton/ha):	: 0.550 ton/ha
7) Market price of the crop ($/ton)	: $1500/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: ---
7. OPERATION ofTHE SYSTEM	
1)Irrigation water applied by a farmer	: 130 mm x 4 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 17 days
4) Irrigation labour and charges	: 7 x $10
5) Unit water price	: $2/hour

APPENDIX-TABLE 29. QUESTIONNARE FORM of NUMBER 29

1. INFORMATION ABOUT FARMER	
1) Field Number	: 29
2) Name of the farmer	: Abdalla MAHMAHDEY
3) Adress	: Buundada-2, Afgoi, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	Tomato
2) Crop rotation system	: Tomato, maize, cowpea
3) Plant spacing between rows	: 0.80 m
4) Plant spacing on the row:	: 0.60 m
5) Sowing (planting) – Date of harversting	:10 October – 5 February
6) Yield (ton/ha):	: 1550 ton/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Secondary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigationin	: 72.50 mm x 8 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 10 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 30. QUESTIONNARE FORM of NUMBER 30

1. INFORMATION ABOUT FARMER	
1) Field Number	: 30
2) Name of the farmer	: Siidow Alow
3) Adress	:km-12,Calamada, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 20 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, maize, cowpea
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.45 m
5) Sowing (planting) – Date of harversting	:15 October – 5 March
6) Yield (ton/ha):	: 1430 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Basin irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 100 mm x 5 times
2) Irrigation duration applied by farmer	: 15 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 7 x 10$
5) Unit water price	: $2/hour

APPENDIX-TABLE 31. QUESTIONNARE FORM of NUMBER 31

1. INFORMATION ABOUT FARMER	
1) Field Number	: 31
2) Name of the farmer	: Osman ABDIYOW
3) Adress	:km-17, Lower Shabell, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, sesame , cowpea
3) Plant spacing between rows	: 0.65 m
4) Plant spacing on the row:	: 0.40 m
5) Sowing (planting) – Date of harversting	:1 October – 22 February
6) Yield (ton/ha):	: 1520 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 70.12 mm x 7 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 13 days
4) Irrigation labour and charges	: 4 x 10$
5) Unit water price	: $2/hour

APPENDIX-TABLE 32. QUESTIONNARE FORM of NUMBER 32

1. INFORMATION ABOUT FARMER	
1) Field Number	: 32
2) Name of the farmer	: Geni HAAJI
3) Adress	: Benadir, Mogadishu, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 5 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, sesame, maize
3) Plant spacing between rows	: 0.70 m
4) Plant spacing on the row:	: 0.60 m
5) Sowing (planting) – Date of harversting	:5 October – 15 February
6) Yield (ton/ha):	: 1440 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 75 mm x 4 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 15 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 33. QUESTIONNARE FORM of NUMBER 33

1. INFORMATION ABOUT FARMER	
1) Field Number	: 33
2) Name of the farmer	: Abdullahi MAYOW
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	:Tomato
2) Crop rotation system	: Sesame, tomato, cowpea
3) Plant spacing between rows	: 0.80 m
4) Plant spacing on the row:	: 0.40 m
5) Sowing (planting) – Date of harversting	:1 5 October – 5 February
6) Yield (ton/ha):	: 1528 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 85.10 mm x 7 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 34. QUESTIONNARE FORM of NUMBER 34

1. INFORMATION ABOUT FARMER	
1) Field Number	: 34
2) Name of the farmer	: Aweys MIIRE
3) Adress	:km-13, Benadir, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 50 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, Sesame, cowpea
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.50 m
5) Sowing (planting) – Date of harversting	:1 October – 5 February
6) Yield (ton/ha):	: 1565 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 87.10 mm x 9 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 35. QUESTIONNARE FORM of NUMBER 35

1. INFORMATION ABOUT FARMER	
1) Field Number	: 35
2) Name of the farmer	: Abdulweli MAYOW
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, maize, vegetable
3) Plant spacing between rows	: 0.60 m
4) Plant spacing on the row:	: 0.50 m
5) Sowing (planting) – Date of harversting	:1 October – 5 February
6) Yield (ton/ha):	: 1436 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 85.10 mm x 8 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 36. QUESTIONNARE FORM of NUMBER 36

1. INFORMATION ABOUT FARMER	
1) Field Number	: 36
2) Name of the farmer	: Abdukadir SHOWAW
3) Adress	: Km-13, Benadir, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 20 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, Sesame, cowpea
3) Plant spacing between rows	: 0.80 m
4) Plant spacing on the row:	: 0.60 m
5) Sowing (planting) – Date of harversting	:15 October – 5 February
6) Yield (ton/ha):	: 1400 kg/ha
7) Market price of the crop ($/ton)	: $750/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 87.10 mm x 8 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 15 days
4) Irrigation labour and charges	: 8 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 37. QUESTIONNARE FORM of NUMBER 37

1. INFORMATION ABOUT FARMER	
1) Field Number	:37
2) Name of the farmer	: Hawo FALIIR
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, maize, cowpea
3) Plant spacing between rows	: 0.55 m
4) Plant spacing on the row:	: 0.40 m
5) Sowing (planting) – Date of harversting	:1 June – 5 September
6) Yield (ton/ha):	: 1530 kg/ha
7) Market price of the crop ($/ton)	: $700/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION OF THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 75.10 mm x 8 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 38. QUESTIONNARE FORM of NUMBER 38

1. INFORMATION ABOUT FARMER	
1) Field Number	: 38
2) Name of the farmer	: Said Mohamed NOR
3) Adress	: Waberi, Mgadishu, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field has to a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Vegetable
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 1 m
5) Other	: -----
4. CROP	
1) Current crop in the field	: Tomato
2) Crop rotation system	: Tomato, Maize, Sesame
3) Plant spacing between rows	: 0.70 m
4) Plant spacing on the row:	: 0.60 m
5) Sowing (planting) – Date of harversting	: 5 September – 25 February
6) Yield (ton/ha):	: 1578 kg/ha
7) Market price of the crop ($/ton)	: $700 /ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: ---
7. OPERATION of THE SYSTEM	
1)Irrigation water applied by a farmer	: 145 mm x 4 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 15 days
4) Irrigation labour and charges	: 10 x $10
5) Unit water price	: $4/hour

APPENDIX-TABLE 39. QUESTIONNARE FORM of NUMBER 39

1. INFORMATION ABOUT FARMER	
1) Field Number	: 39
2) Name of the farmer	Osman BEGEDI:
3) Adress	:Waberi, Mgadishu, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field has to a farmer group Names other farmer	:---
6) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit crop
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 2 m
5) Other	: -----
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, maize, tomato
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 4 m
5) Sowing (planting) – Date of harversting	: 1 March – 25 January
6) Yield (ton/ha):	: 17340 ton/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Surface irrigation (Furrow irrigation)
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: ---
7. OPERATION of THE SYSTEM	
1)Irrigation water applied by a farmer	: 90 mm x 12 times
2) Irrigation duration applied by farmer	: 10 hours x 4
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 3 x $10
5) Unit water price	: $2/hour

APPENDIX-TABLE 40. QUESTIONNARE FORM of NUMBER 40

1. INFORMATION ABOUT FARMER	
1) Field Number	: 40
2) Name of the farmer	: Ahmet NAAJI
3) Adress	:Km-17,Lowershabelle, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the field has to a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit tree
2) The size of field in (ha)	: 5 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, maize, vegetable
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 4 m
5) Sowing (planting) – Date of harversting	:1 March – 24 January
6) Yield (ton/ha):	: 17,399 kg/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 100 mm x 12 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 5 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 41. QUESTIONNARE FORM of NUMBER 41

1. INFORMATION ABOUT FARMER	
1) Field Number	: 41
2) Name of the farmer	: Hassan OSMAN
3) Adress	: Wadajir, Mogadishu , Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit tree
2) The size of field in (ha)	: 10 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 55 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, maize, vegetable
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 4 m
5) Sowing (planting) – Date of harversting	:1 0 March – 10 February
6) Yield (ton/ha):	: 17,550 ton/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 100 mm x 12 times
2) Irrigation duration applied by farmer	: 7 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 2 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 42. QUESTIONNARE FORM of NUMBER 42

1. INFORMATION ABOUT FARMER	
1) Field Number	: 42
2) Name of the farmer	: Ali ABOW
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit crop
2) The size of field in (ha)	: 18 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 40 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, Tomato, cowpea
3) Plant spacing between rows	: 5.0 m
4) Plant spacing on the row:	: 4.0 m
5) Sowing (planting) – Date of harversting	:15 March – 5 February
6) Yield (ton/ha):	: 17,607 kg/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Secondary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 110 mm x 10 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 43. QUESTIONNARE FORM of NUMBER 43

1. INFORMATION ABOUT FARMER	
1) Field Number	: 43
2) Name of the farmer	: Abuukar HARAASH
3) Adress	: Embagedi, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit tree
2) The size of field in (ha)	: 20 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, maize, cowpea
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 5 m
5) Sowing (planting) – Date of harversting	:5 March – 5 February
6) Yield (ton/ha):	: 17,550 kg/ha
7) Market price of the crop ($/ton)	: $1500/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 35 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 120 mm x 10 times
2) Irrigation duration applied by farmer	: 18 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 44. QUESTIONNARE FORM of NUMBER 44

1. INFORMATION ABOUT FARMER	
1) Field Number	: 44
2) Name of the farmer	: Adukadir SAGAARO
3) Adress	: Excontrol, Mogadishu, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit tree
2) The size of field in (ha)	: 15 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	:Banana
2) Crop rotation system	: Banana, maize, melon
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 4 m
5) Sowing (planting) – Date of harversting	:1 April – 5 March
6) Yield (ton/ha):	: 17,622 kg/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 90 mm x 12 times
2) Irrigation duration applied by farmer	: 10 hours
3) Irrigation interval by farmer	: 10 days
4) Irrigation labour and charges	: 4 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 45. QUESTIONNARE FORM of NUMBER 45

1. INFORMATION ABOUT FARMER	
1) Field Number	: 45
2) Name of the farmer	: Abdurahman UBEYD
3) Adress	: Dhagahtuur, Afgoye, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit tree
2) The size of field in (ha)	: 25 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 50 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	:-----
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, sorghum, tomato,
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 5 m
5) Sowing (planting) – Date of harversting	:10 April – 15 March
6) Yield (ton/ha):	: 17635 kg/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 180 mm x 12 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 18 days
4) Irrigation labour and charges	: 7 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 46. QUESTIONNARE FORM of NUMBER 46

1. INFORMATION ABOUT FARMER	
1) Field Number	: 46
2) Name of the farmer	: Abdirasaq TAAJIR
3) Adress	: Waaberi, Mogadishu, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Fruit tree
2) The size of field in (ha)	: 5 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 2.0 m
5) Other	
4. CROP	
1) Current crop in the field	:Banana
2) Crop rotation system	: Banana, Tomato, maize
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 5 m
5) Sowing (planting) – Date of harversting	:1 March – 5 December
6) Yield (ton/ha):	: 17,649 kg/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 40 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 110 mm x 13 times
2) Irrigation duration applied by farmer	: 8 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour

APPENDIX-TABLE 47. QUESTIONNARE FORM of NUMBER 47

1. INFORMATION ABOUT FARMER	
1) Field Number	: 47
2) Name of the farmer	: Abdulle BUUWE
3) Adress	: Wadajir, Mogadishu, Somalia
4) Location of the field	: Jambalul, Afgoi, Somalia
5) If the fieldhasto a farmer group	:---
6) Names other farmer	:---
7) Others	:---
2. INFORMATION ABOUT THE FIELD	
1) Type of field	: Field crop
2) The size of field in (ha)	: 18 ha
3) Others	: ---
3. IRRIGATION WATER	
1) Source of water	: River (earth canal)
2) Water quality	: -----
3) Discharge	: 60 L/s
4) Height of water source (Code to river, height of channel)	: 1.80 m
5) Other	
4. CROP	
1) Current crop in the field	: Banana
2) Crop rotation system	: Banana, sorghum Tomato,
3) Plant spacing between rows	: 5 m
4) Plant spacing on the row:	: 5 m
5) Sowing (planting) – Date of harversting	: 10 March – 5 December
6) Yield (ton/ha):	: 17815 kg/ha
7) Market price of the crop ($/ton)	: $1000/ton
5. PROPERTIES of SOIL	
1) Soil texture	: Clay loamy
2) Effective soil depth	: 0.90 m
3) Limiting factors in soil:	: ---
4) Other	: ---
5) Sketch	: ---
6. PROPERTIES of IRRIGATION SYSTEM	
1) Irrigation method	: Furrow irrigation
2) Type of channel conveyed water to field	: Primary channel
3) Discharge from water source to Primary channel	: 30 L/s
7. OPERATION of THE SYSTEM	
1)The amount of water applied by a farmer in every irrigation	: 80 mm x 12 times
2) Irrigation duration applied by farmer	: 12 hours
3) Irrigation interval by farmer	: 14 days
4) Irrigation labour and charges	: 6 x 10$
5) Unit water price	: $3/hour