بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Economic Analysis of Resources Use in Milk Production in Kuku Farms- East Nile- Khartoum- Sudan

تحليل اقتصادي للموارد المستخدمة في إنتاج اللبن بمزارع كوكو- شرق النيل- الخرطوم- السودان

A thesis Submitted in Fulfillment for the Requirements of the Degree of Ph.D. in Agricultural Economics

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April, 2019

الآية

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قال تعالي:

(وَإِنَّ لَكُمْ فِي الْأَنْعَامِ لَعِبْرَةً نُسْقِيكُمْ مِمَّا فِي بُطُونِهِ مِنْ بَيْنِ فَرْثٍ وَدَمٍ لَبَنًا خَالِصًا سَائِغًا لِلشَّارِبِينَ)

صدق الله العظيم

سورة النحل الآية (66)

DEDICATION

To my family

To my relatives

To my friends

ACKNOWLEDGEMENTS

First, I am grateful to Allah for providing me with the health, strength, and power to complete this study successfully. I would like to express my sincere appreciation to my main supervisor **Prof. Dr. Hag Hamad Abdelaziz** for his intellectual guidance, keen interest, valuable comments and help which led to successful completion of the study .I am also thankful to myco-supervisor Dr. Abdel Lateif Hassan Ibrahim, for his keen interest, patient guidance that displayed, and the time he devoted. I am thankful to the staff of the Faculty of Economics, University of Bahr El-Ghazal for their encouragement and help throughout my study. I am thankful to staff of the Kuku farms and Kuku dairy farms scheme management.

I would like to express my sincere appreciation to my colleagues, Layla Jalela, Bashier, Ibrahim and Muadafor their encouragement and help throughout the study. I am also thankful to Dr. Khalid Salih from Bahry University and Dr. Elrashid Elkhadier Imam from Khartoum University for their valuable assistance during the stages of analysis.

My gratitude is extended to my family for their support and encouragement throughout the study.

ABSTRACT

The main objective of the study was to analyze the resources use in dairy production inKuku farms and specifically to determine the main factors affecting technical inefficiency, to assess the optimum feeding combination and to identify the socio-economic factors that affect the level of efficiency of Farmers. Both primary and secondary data were used for the study purposes. Primary data were collected from a survey conducted in 2016/2017, through a random sampling technique using a sample of 85 farmers. The secondary data were collected from relevant sources. Descriptive Statistics, Technical Efficiency, linear Programming models, Gross Margins and ARIM Model were employed to analyze the collected data to achieve the study objectives. The descriptive statistics of the selected socio-economic characteristics showed that the average age of the sampled farmers was 36 years and 96.5% of them in the active age 18-65years. Most of the farmers 93% have attained some sort of education. All surveyed farms were managed by males; about 98% of the surveyed farmers were married. For the sampled farmers, the average family members work in farm was found to be 14 persons per household. The majority of the sampled farmers 64.7% have practiced for more than 10 years in the farms work. The sampled farmers69.4% were fully occupied with farms (i.e. had no off-farm activities).The frontier production function analysis revealed thatmost of the estimated B- co-efficients of the stochastic frontier model for all production models have the expected signs and significance.The mean technical efficiency was 60%, and 76% for small and large farms, respectively. This shows that there is scope for increasing small and large farms, dairy production lie by 40% and 24%, respectively, with present technology, herd size, labour number, amount of roughage and amount of concentrate, health expenditure, for dairy production were significant variables for improving technical efficiency. Farmers age, education level, experience years were significant in explaining technical inefficiency in Kuku farms. The result ofLP models revealed that the real feed plan was different from the basic plan; the net farmsfeed costin the optimal models was lessthan the current situation by42.15%.The budget analysis of dairy farms, large farms, had high cost than small farms. Large dairy farms had the higher gross margin than the small farms. For improvement of the technical efficiency of dairy production in the farm, the study recommended the improvement of extension services and supervision, more coordination between Kukudairy scheme manger and Ministry of Animal Resource and Ministry of Agriculture to solve the problems of animal health by improving the environment and cultivate forages to decrease the cost of feed, and adoption of the recommended improved technologies.

الخلاصة

الهدف الاساسي من هذه الدراسة هو تحليل المواردالمستخدمة في انتاج اللبن في مزاع كوكووبتحديد العوامل التي تتسبب في عدم الكفاءة الفنية وتحديد ادني مستوي تكلفة للتغذية في ظل توليفة غذائية (عليقة) مثلي ومعرفة العوامل الاقتصادية الاجتماعية التي تؤثر علي مستوي الكفاءة الفنية للمزارعين. اعتمدت الدراسة علي البيانات الأولية والثانوية، البيانات الأولية جمعت من المسح الميداني في الفترة 2016-2017 من 85 مزارع في مزارع حلة كوكو عن طريق العينة العشوائية البسيطة بواسط استبيان مصمم للدراسة، والبيانات الثانوية جمعت من المصادر ذات الصلة بموضوع البحث كالكتب والدوريات والوزارات. التحليل الوصفي، دالة الإنتاج المجال العشوائي،تحليل البرمجة الخطية،تحليل ميزانية المزرعة،نموذج اريما للتنبوء،استخدمت هذه الطرق المختلفة لتحليل بيانات الدراسة وتحقيق أهدافها. أظهرت نتائج التحليل الإحصائي الوصفي ان متوسط اعمار المزارعين في العينة 36 عام منهم حوالي 96.5% تقع في المدى العمري النشط 18-65، وحوالي 93% تحصلوا علي تعليم ،المزارع تتم اداراتها بواسطة الرجال ومنهم حوالي98% متزوجين،ومتوسط عدد افراد الاسرة الذين يعملون بالمزرعة 14 افراد، حوالي 64.4% من العينة عملوا في تربية الابقار اكثر من 10 اعوام، وتمثل تربية الابقار المهنة الرئيسية لحوالي 69.4% من المزارعين في العينة. أظهرت نتائج دالة الإنتاج المجال العشوائي ان معظم عوامل الانتاج التي تؤثر في الكفاءة الفنية ذات تأثير معنوي ،وان متوسط الكفاءة الفنية للمزارعين60% و76% لكل من المزارع الصغيرة والكبيرة علي التوالين وهذا يعني ان هنالك مجال لزيادة انتاج الالبان بنسبة 40 و24 للمزارع الصغيرة والكبيرة علي التوالي في ظل استخدام عوامل الانتاج المتاحة والمتوفرة . حجم القطيع، العلف المالى والمركز، الخدمات البيطرية والعمالة، تمثل العوامل المعنوية بمستويات مختلفة لتحسين الكفاءة الفنية. الخصائص الاجتماعية للمزارعين مثل المستوي التعليمي ،عمر المزارع وعدد سنوات الخبرة كانت عوامل ذات تاثير معنوي في تفسير عدم الكفاءة الفنية في المزارع بمستويات مختلفة. أظهرت نتائج البرمجة الخطية ان تركيبة العليقة المثلىتختلف من التركيبةالحالية، حيث ان تكاليف العليقة المثلي تقل عن تكاليف التركيبة الحالية بنسبة 42.15. اظهر تحليل الميزانية ان المزارع الكبيرة كان اعلي تكلفة من المزارع الصغيرة، وايضا تمثل المزارع الكبيرة اعلي ربحية من المزارع الصغيرة.

اوصت الدراسة بالاتي:

تحسين الكفاءة الانتاجية بالمزارع، وذلك من خلال الاهتمام بخدمات الارشاد البيطري والاشراف علي المزارعين، وحل المشاكل الصحية والتنسيق بين ادارة مشروعالبان كوكو مع وزارة الثروة الحيوانية ووزارة الزراعة لحل مشاكل صحة الحيوان بتحسين البيئة، وزراعة الأعلاف لتقليل تكلفة التغذية، وتبني التقانات الحديثة والموصي بها التي تؤدي إلى زيادة دخل المزارع.

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ABBREVIATIONS

ACF	Autocorrelation Function
AIC	Akaike Information Criteria
AOAD	Arab Organization for Agricultural Development
AR	Auto-Regressive
ARMA	Autoregressive Moving Average
ARIMA	Autoregressive Integrated Moving Average
Ca	Calcium
CBS	Central Bureau of Statistics
CEPA	Center for Efficiency and Productivity Analysis
CP	Crude Protein
EE	Economic Efficiency
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
gm.	Gram
H AC	High Advisory Committee
KG	Kilo Gram
LP	Linear Programming
Log	Logarithm

MAPE	Mean Absolute Percentage Error
Max	Maximum
ME	Metabolize Energy
MEF	Ministry of Finance and Economic
Min	Minimum
ML	Maximum Likelihood
NaCl	Sodium Chloride
P	Phosphors
PACF	Partial Autocorrelation Function
PPF	Production Possibility Frontier
RMSE	Root Mean Square Error
SDG	Sudanese Pound
SPF	Stochastic Production Function
SPSS	Statistical Package for Social Sciences
TDN	Total Dry Nutrient
TE	Technical Efficiency

CHAPTER ONE

INTRODUCTION

1.1 Introduction:

Sudan is the third largest country in Africa and seconds in the Arab countries occupying an area of about 1,882,000 Km^2. It lies in the Northeast part of Africa between longitude 21° 49 and 38° 34 E, latitude 8° 45 and 22° 8 N. The total population of the country according to 2016 census is 39.60 million head with an annual growth rate of about 2.4% per year (CBS, 2017).

Most of the population lives in the rural areas (67%) (CBS,2016).The climatic conditions are diverse with an average annual rainfall varying from zeroto500 mm in the North part to 500-1000mm in the Center and South west. The main rainy season extends from July to September, with peak in August. The main daily temperature varies from a maximum of more than 38 C◦ in the North to minimum of 6 C° in Jebal Merra, Western Sudan.

Sudan has five distinct agro- ecological zones. Which are differentiated in fairy regular sequence from the North to the central and Southwest of the country (www.en.wikipeido).They are characterized by different climatology (especially rainfall and soil fertility). Within different eco-zones, the farming system and the land use practices are fairly homogenous. In addition, to cotton and sugar cane groundnuts, sorghum and maize are also cultivated. Many of these crops have direct impact on livestock production by providing useful post- harvest residues and/ or agro- industrial products in various parts of the country. The desert represents about 29.1% of the total area. The amount of rainfall received in each zone is variable; it tends to increase as moving from North to

South west. Camels are raised in the desert zone. The common farming system in the arid zone is the traditional pastoral nomadic and semi-nomadic. The annual seasonal rainfall patterns force the pastoralists to migrate from one place to another in search of forages and water ponds. Camels, desert sheep, goats and cattle are the most important species raised in Sudan.

Sudan comes in the front of the Arab countries and ranks second among African countries in terms of animal resources and their products (MFE, 2016). The livestock population numbers were estimated at 108 million heads composed of 4.8, 30.93, 40.8, 31.66 heads of camels, cattle, sheep and goats, respectively (MFE, 2017).

The average annual growth rate of this sector in the country was estimated at 6.1% (MFE, 2014).

Livestock sector contributed 20.7% of Gross Domestic product (GDP) and 40% of agricultural domestic products (MFE, 2017).It also contributes to the country's total foreign earnings by about 121.7 million US $ representing about 23.1% of total foreign earnings (MFE, 2016) and provides job opportunities for more than 40% of the Sudan citizens (MFE, 2016). Livestock are the major component of agriculture in small scale holder systems of the tropical countries. It plays an important role in providing food to people, enriches their land with organic manure as fertilizers and provides direct and indirect cash income. Further, livestock can be used as capital assets and source of power for transportation and cultivation.

Dairy production is one of the most important sectors in Sudan as it plays a big role in achieving food security, it is also considered as one of the main pillars of the country's development. Dairy products are the most important products of livestock sector (FAO, 2013). The total figure of milk produced in Sudan is increasing consistently over time with cattle milk constituting the lion share (Table, 1).

1.2 Sudan Economy

Sudan has one of the highest growth rates amongst sub-Saharan African countries and a rapidly rising per capita income, with per capita GDP of US$1,500. Nonetheless, the country's human development outcomes remain weak. Sudan ranks 171 out of 187 countries in the UNDP's Human Development Report 2013. However, the secession of the south in 2011, had gravelly affected the economy as more than 80% of Sudan's oil fields existed in the southern part of the country. This decline in oil revenues caused a major adjustment to the Sudan's fiscal situation and prompting financial austerity measures. Historically, agriculture remained as the main source of income and employment in Sudan, hiring over 80% of Sudanese. Despite this strong agricultural orientation, oil production drove most of Sudan's post-2000 growth. Real GDP growth was estimated at 4.1% in 2018. As a result of the oil loss, the growth of industrial sector fell into the negative in 2011and 2014but service sector increased about 47% in 2011-2014while only agricultural sector witnessed constant growth in both years. In the agricultural sector, the government has tried to diversify its cash crops; however cotton and gum Arabic remain its major agricultural exports. Grain sorghum (Dura) is the principal food crop, and wheat is grown for domestic consumption, sesame seeds and peanuts are cultivated for domestic consumption and export. Livestock production has vast potential, and many animals, particularly camels and sheep, are exported to Egypt, Saudi Arabia, and other Arab countries. Problems of irrigation and transportation remain the greatest constraints to a more dynamic agricultural economy. Sudan continues to strengthen links with key emerging country partners, especially China, Malaysia and India following the attraction of substantial “resource seeking” since the late 1990s. The government has already decided to make more credit available to agriculture as part of its future development plans. It continues efforts to engage in strategic partnerships with local and foreign private investors, particularly reared towards increasing agricultural exports and diversification of production to absorb the shock of the declining oil revenues. Sudan’s economic growth is dominated by agriculture which estimated on average at 31.4% of gross domestic product (GDP) in 2015 (CBoS, 2016). Agricultural remains the main source of employment and household income in rural areas where 65% of population live. About 80% of the labour force employed in agriculture and related activities such as agro-industries (FAO, 2015). It provides livelihood to about 70% of the population (Ministry of Finance and National Economy, 2017). The agricultural sector provides most of the raw material required by local industries such as sugar, textile and vegetable oil(Bank of Sudan,2016), therefore, provision of food, fiber, foreign exchange earnings, labor employment, and sale of industrial goods in rural areas.

Table 1: Estimate of milk production in Sudan during the year (2011-2017) in 000tons.

Year	Cattle	Sheep	Goats	Camels	Total
2011	2752	390	1072	60	4274
2012	2776	394	1088	60	4318
2013	2795	398	1105	60	4358
2014	2813	402	1116	60	4391
2015	2858	407	1126	60	4451
2016	2899	411	1136	61	4507
2017					4553

Source: Ministry of Animal Resource and Fishery (2018).

The up- grading of milk production during the 2011-2016 was attributed to the increase of cattle numbers, improvement of veterinary cares and increasing percentage of foreign bloods in the local breeds cross, (MARF ,2016).

But it seemed that the dairy producers aren’t commercially oriented as only 50% of the total milk produced in the country is available for human consumption and the rest about (50%) were used for young animals feeding (table 2).On the other hand, milk demand is in a continuous increase, it increased from 3.5 million tons in 2008 to about 5.1 million tons in 2015 (MEF, 2016).

Table 1.2: Total milk production, human consumption and young animals feeding (000 tons) during the period 2011-2017

Year	Production	Young animals feeding	Human consumption
2011	4.27	1.71	2.56
2012	4.31	2.15	2.16
2013	4.35	2.17	2.18
2014	4.36	2.18	2.18
2015	4.42	2.21	2.21
2016	4.51	2.25	2.26
2017	4.55	2.27	2.28
Average	4.40	2.13	2.27

Source: Ministry of Animal Resource and Fishery (2016)

The average per capita consumption of milk and dairy products in the country is (75 Kg), which increased up to (100 Kg) for high- income group and decreased to (50 Kg) for the low- income ones (Ministry of Animal Resource and Fishery, 2017). According with the per capita consumption rates of milk provided by World Health Organization for the people in developing countries (200 kg/ year), the total estimated quantities for Sudanese consumption are around 5.1 million tons. This figure shows a large gap between the estimated per capita consumption rate and the currently available milk for consumption in country (2.9), the deficit is about 2.2million tons. Surely, this deficit has its impact on price by escalating the prices of milk and milk products up as the average price of fresh dairy milk in Khartoum state in 2016 was 11SDG/ liter. To bridge the gap, the country has resorted on imported powder milk which was steadily increasing (MEF, 2017).

Dairy production in Sudan is produced from both traditional and modern sectors; however traditional is the most common source. This sector is usually divided into two types; the first type comprises nomadic cattle producers who are migratory by definition and depend on natural pastures in raising their cattle always move in pursuit of water and however, most of their milk production is not available for marketing due to the remoteness of production area and the weak marketing facilities and services. In addition, they largely depend on milk for food and mainly raise cattle for meat production i.e. milk production is the secondary activity for the majority of them.

The second type comprises traditional producers who settled around cities and agricultural projects. This type of producers mainly relies on crop residues in feeding their animals.

As regards the modern sector is always located around cities and dairy factories. This sector applies modern rearing techniques (Heba et al; 2008).

On the other hand, although Khartoum state has the lowest numbers of cattle compared to other states, yet it represents the major modernized dairy production center specialized in commercial milk production.

1.2 Problem statement

Despite the importance of the dairy sector to Sudanese economy and the huge livestock numbers, the country yet holds its full potential of this sector hasn't been achieved, In fact the country will import milk and milk products to satisfy the ever increasing demand.

Many factors affect against realizing full improvement of this sector and also effect on the productivity of the dairy, among them lack and shortage and high cost of animal feeds poor quality and most producers lack the knowledge of efficient utilization of animal feed resources, inefficient and inadequate milk processing technologies and also poor production hygiene and there are some policies impose, all these factors affect production (AOAD, 2013).

In addition, increasing production costs particularly feeding cost, veterinary cost care and medicines, drinking water and others. Milk prices are in a continuous fluctuation within months and between years, these fluctuations hindered many producers to invest in the business resulting dramatic increase in prices. Likewise, the socio- economic factors played a substantial negative role reflected production.

1.3 Objectives of the study:

1.3.1 Main objective:

The main objective of the study was to analyze the resources use in dairy production in Kuku Farms- Khartoum North.

1.3.2 The specific objectives are to:

1- Study the socio- economic characteristics of producers of dairy in Kuku Farms- Khartoum North.

2- Determine the factors affecting production of milk in Kuku Farms.

3- Analyze the efficiency of resources use in milk production in Kuku Farms.

4- Estimate the costs and returns of dairy production in Kuku Farms.

5- Forecasting milk production in Khartoum state.

1.4 Methodology:

1.4.1 Data collection

Both primary and secondary data were used, although primary data is the main data source. Primary data was collected by means of a well set (questionnaire) from 85 milk producers in Hilat Kuku, Khartoum North, using probability sampling techniques'(simple random sampling).

Relevant Secondary data were collected from various sources. These sources include information from related sources such as books, references, periodicals and Ministry of Animal Resources and Fisheries in Khartoum states, Ministry of Finance and National planning, Central Bureau of Statistics and other related institutions.

1.4.2 Analytical techniques:

-Descriptive statistics were used to identify the socio- economic characteristics.

-Technical efficiency was used to determine the factors affecting dairy production.

-Linear programming was used to determine optimal feeding mix.

-Partial budget analysis was used to estimate cost and profit of dairy production.

- ARIMA Model was used to forecast milk production in Khartoum State.

1.5 Organization of the study:

This study was organized into six chapters; the first chapter includes introduction, problem statement, objectives, and research methodology.

The second chapter contains the literature review related to the study. The third chapter contains conceptual frame work. The fourth chapter includes the research methodology. While the fifth chapter includes results and discussion; the last chapter is the summary, conclusions and recommendations.

CHAPTER TWO

LITRATURE REVIEW

2.1 Dairy cattle (dairy cows)

Dairy cattle are e cows breed (adult females) for the ability to produce large quantities of milk, from which dairy products made. Dairy cows generally are of the species' boss Taurus.

Historically, there was little distinction between dairy cattle and beef cattle. With the same stock often being used for both meat and milk production. Today dairy cows are specialized and mostly raised to produce large volumes of milk with little or no regard for their meat production. The life span of the dairy cow is approximately 25 year, however, they are kept longer than twenty five year prior to slaughter.

2.2 Milk production levels

A cow will produce large amounts of milk over its life time. Certain breeds produce more milk than others; however, different breeds produce within the range of around 4,000 to over 10,000kg of milk per annum.

2.3 Milk and its nutritional value

Milk is defined as the normal secretion excluding colostrum's obtained by normal milking methods from the lactating mammary gland of a healthy cow (Johnson, 1980).Also, Foley et.al; (1974) defined milk as fluid secreted by female mammal to provide food for their offspring from the time of birth until they are able to feed themselves and the mammal blood stream is the immediate source of milk constituent.

African people usually use milk from cows, sheep, goats and camels but cow's milk is the most widely produced and processed (FAO, 1990). The value of milk as food for infants is very clear as it is usually the chief source of complete protein, calcium, vitamins, riboflavin, niacin, essential fatty acids and energy for the rapidly developing child. The essential element necessary for vitality and good health are present in milk; in balanced proportion e.g. proteins, fats and carbohydrates (Gamal, 1999). He also added that milk is an excellent source of important minerals and contains water and fat soluble vitamins and essential trace elements.

Milk is an important agricultural product, which contributes greatly to food security and plays a basic role in the process of nutrition during all the stages of life.

It is a rich source of protein that easy to digest and has comparatively lower price than that of meat and eggs (Shakir, 1993 and M; 1994).

One litter of cow's milk supplies about 10% of calories, 20% of protein and 70% of calcium daily requirement, respectively. It also provides about one third of vitamin A and thiamine daily requirements of children less than five years old (kon, 1972).

Milk and dairy products have become a major part of the human diet in many countries over many years, hence considerable attention has been paid to improve the yield, the composition and hygienic quantity in order to minimize the level of contaminants (Hardig, 1999).

2.4 Milk production in Sudan

MARF (2018) estimated the total quantity of milk produced in Sudan at 4.6 million tons per year. Most of this milk comes from indigenous cattle of the zebu type and up to 90 percent of milking animals are found within the range-based nomadic and transhumance areas. In fact, about 64percent of milk comes from cattle, 25.21 percent from goats, 9.1 percent from sheep and 1.4percent from camel, (MARF, 2018).

2.5 Sudanese dairy local breed and their milk productivity

Sudan cattle belong to species boss indicus which includes humped cattle (zebu) of Asia and Africa. Sudanese cattle are broadly classified into two breeds, Nilotic cattle, and North Sudan zebu cattle. There are six main indigenous Zebu cattle among which Kenana and Butana are known for their high productivity. The milking potential of other breeds, namely Baggara, Nilotic, Umbararo and Nuba is low of milk productivity. The profitability of dairy enterprise is mainly related to obtaining as much milk as possible with in the prevalent nutritional environment, relative to the maintenance cost of animals. Figures for the milk yield of cattle under traditional management were not available. Among the cattle population, Kenana and Butana are promising indigenous milk breeds, which under improved feeding and management research stations yield more than 1500kg milk per lactation relative to international standard(Saeed et al,1987;ElHabeeb1991 and Musa et al, 2005). Through experience, many herds-men have come to understand that the best local cattle (usually Kenana and Butana) with exotic breeds (usually Friesian)(Musa et al;2005), This process of fast upgrading aims at increasing local milk production in response to the rising demand in urban areas.

2.5.1 Cross breeds in Sudan

The first attempt of cross breeding in Sudan was performed in Belgravia Dairy farm (Khartoum North) in 1925 by using short horn bulls imported from England mated with native cattle (Butana).

Frisian cross breeds were found to perform better than other exotic cross breeds, because of the fast adaption to environment and high yield capacity.

Most crossing operation in Sudan used Kenana and/ or Butana as an indigenous breed with exotic ones (Mesani, 1996).

Milk yield from cross breeds (Frisian+Kenana+Butana) having 75% of Frisian blood, (Yousif et.al, 1998) explained that milk yield of cross breed cows was significantly influenced by percentage of foreign blood.

2.6 Major livestock systems of Sudan

The major livestock production systems in Sudan comprise the following:

1. Nomadic

Livestock, mainly camels and sheep, with some goats, are raised entirely on natural rangelands. Households moving with livestock and growing short-maturity subsistence crops. Income is derived from the sale of animals, meat and milk in the form of white cheese.

2. Transhumant

In the transhumant agro pastoral system, households depend mainly on livestock, mostly cattle, with some sheep and goats, although there is some cropping. In western Sudan, households migrate north during the rainy season and return back during the dry season. In the central and eastern states, migration is towards the Nile during the dry season.

3. Sedentary

The sedentary system exists where there is rainfed, arable farming in settled villages. Some livestock, mainly small ruminants, are kept, but the animals are less important than the crops. Sorghum, sesame and cotton are grown on clay soils, and millet and groundnuts on sandy soils.

4. Sedentary irrigated crop-livestock system

Permanently settled farmers in the irrigated areas of central Sudan grow cotton, sorghum, groundnuts and wheat, and also raise livestock, especially small ruminants. Livestock, although less important than crops, are a supplementary source of income. Productivity is low and animals depend heavily on crop residues, industrial by-products and the grazing of limited areas of fallow and the sides of canals. Intensive cow's milk production is becoming more common within the large irrigation schemes, and these areas are seen as promising for future expansion of livestock production.

5. Other systems

Other animal production systems include ranching, feedlot operations and peri-urban backyard livestock production. Ranching is recent trend in Sudan. Animals are raised for meat on natural rangelands in western Sudan (kordofan and Darfur) and in Butana in Kassla state.

2.7 Milk production system in Khartoum state

The dairy production system in Khartoum state is divided into two main systems; the traditional and the modern system and to some extent transitional system according to the herd size operation level and type of production.

2.7.1 The traditional system

It's a non-specialized and is applied generally in rural areas, agricultural and pastoral towns, representing 95% of milk production in the Khartoum and the general practice of this system is production on the following levels:

1. Small household level is prevalent in small towns and marginal areas, limited size of the herd and milk production of local breed and the hybrid calves, milk production within this subsystem is organized into different forms, which include private specialized dairy farms.

2. Travelers level (nomadic), which is characterized by instable and frequent movement search of income sources, water and pasture available during the year, surplus of milk production and household consumption needs of the infants, and calf surplus is sold or processed in traditional methods to their needs.

2.7.2 The modern system

The modern system is a specialized system, which utilizes modern animal husbandry methods, pen construction and management. However, its contribution to milk production is low and production costs are higher than those in the traditional system (Dinar, 1999).

Smith (1979) reported that in modern system livestock are raised to produce cash and not for subsistence. In addition to its management and production objectives, ranching differs from traditional pastoralism in supporting fewer people in the land, which is always being sedentary in land tenure and in the option for intensifying water and feed supplies.

Table 2.1 Estimation of milk production in Khartoum state in (000) tons

Year	Camels	Goats	Sheep	Cattle	Total
2011	-	1024	391	4370	6785
2012	-	1026	415	4560	6001
2013	-	1028	436	4766	6230
2014	37	1197	461	4955	6650
2015	39	1245	462	5133	6879

Source: Ministry of Agriculture and Animal Resources, Khartoum (2015)

2.8 The problems facing milk production sector

1. Production constraints

-Over grazing in some areas, particularly around settlements, while vast areas are under grazed because of lack of water for animals.

- The great distances that animals often have to walk from water points to graze; Fadalla(1987) estimated that walking required 30% of the daily energy intake of lactating sheep during the dry season
- Poor husbandry
- Poor genetic potential, unfavorable conditions and improper nutrition.
- High cost of inputs example concentrates grains, (FAO, 2002).
- In adequate fodder resources and limited varieties (FAO, 2002).
- Poor livestock farm management.

- Lack of processing of feeds and exports of by- products
- Lack of infrastructure such as research, extension, roads, education, and health services and livestock markets.

2- Animal health problems

-Poor veterinary services

3- Problems of milk processing plants

4- The lack of production inputs

The lack of production inputs in the investment and operation fields plays a negative role on dairy activities because it can stop completely or reduce investment in milk production due to their inability to obtain such inputs like fodder, medicines, vaccines and basic prices(Ministry or Animal Resource and Fisheries,2007).

2.9 Milk market

Over 50 per cent of total milk produced is utilized as fluid milk or cream pasteurization, mechanical refrigeration, and the use of the modern methods that based on the knowledge of the sanitary and requirements that facilitate the mentioned process as easy as possible.

2.10 Demand for milk and milk products

One of the important factors affecting the total amount of milk produced and the way in which this milk is utilized is the demand for the various products.

If more milk produced the consumers are willing to buy at prevailing prices. Prices of various products will fall, as prices of milk fall, milk production becomes less profitable and less milk is produced.

Similarly, if milk prices are high enough so that dairying is more profitable than other farm enterprises herds. This will greatly expand the supply of milk and tend to lower the prices from the profitable levels which previously existed.

The demand for milk derived from the demand for all dairy products such as market milk, butter, cheese, and ice cream.

The demand for the various products depends upon many things, but two of the most important are ability to buy and habits of consumption. The ability to buy depends upon income. Low income groups tend to spend a greater share of their incomes for dairy products, but their total expenditures for dairy products per family are less than the comparable expenditures in the higher income families.

Often, the consumption of one or more dairy products may be increasing at the sometime that the per capita sales of another products are being reduced. Prices of the dairy products, also trend to rise and fall with changes in income.

2.11 Milk prices

Devaraja,el al;(2001) have studied the cost and price spreads in milk marketing in India, data were obtained from market intermediaries operating around five milk plants; the prices spreads in six identified marketing channels were obtained, the study concluded that producer can increase their profit margins if they venture into processing. In addition to the fact, that the number of intermediaries involved will have a bearing on both producers and consumers prices. The shorter the channel the more likely that consumer prices will be low and the producer will get high returns.

Heady, et al. (1954) stated that profits and losses in dairy farming depend more on the prices, when they are favorable farming is profitable, even for inefficient farmers and via versa .Aryan, et al.(1990) has stated that the price of milk had the greatest influence on production followed by other factors. The improvement of production practices with provision of incentive in the form of increasing milk price is important if milk production to be increased. The rise in the total cost of inputs will affect the prices of milk negatively, which implies that producers would increase the milk price. Stability of prices of inputs plus limiting the number of intermediate agents would reduce the price of milk to consumers. The price of product is an important factor influencing consumer demand; a dairy product may be competitively priced. This implies that the cost involved in raw materials, processing, storage, marketing and distribution must be kept as low as possible. It is important that all cost elements are included in the calculation of the market value of the product. Overpricing can lead to uncompetitiveness of the product; while underpricing can cause financial loss and eventual collapse of the business.

2.12 The cost of production

Atkar et al (2002) has studied the factors affecting the cost of milk production, such as cost of feeds, labor, and health coverage. Data on 30 cross-bred cows were maintained at farm in Maharashtra, India. Average gross cost of milk production per litter was determined on both herd and season basis. The major expenditure was incurred on the cost of feed followed by the labor and supervision cost.Ragab, et al. (1990) concluded that feeding cost represents about 75% of the total cost of milk production in the developing countries. The same result was found by Mustafa, et al (1989) who studied feed cost in Sudan. He found that the feed cost was estimated at 86% of the total cost of production i.e. by reducing the average cost of inputs included in milk production, it would be possible to gain reasonable profit. Therefore it is most feasible to use cheap feeding sources. Rohr, et al. (1991) have found in their studies that the increase of cow productivity than more the increase in herd size. Sharma, et al. (1987) in their economic study of dairy farms in India found that the cost of milk production per litter was lowest in the farms having source of cheap green fodder. The same result was obtained by Yeshwant, et al.

(1990) in their study of livestock economy in India, as they concluded that production of fodder and feed sub elements need to be encouraged to reduce the cost of milk production.

2.13 Feeding of milking animals

Knowing the systems and management of feeding, the types of feeds and the amount taken by the milk-producing cows, is of major importance and basic for increasing the production of milk and meat.

Feeding milk-producing animals vary from one place to another, in quantity of milk produced, even from the same species of cows in different parts of the world. The difference in milk quantity between the developing and developed countries is 1:10 the reason is the difference in feeding (El Faki, 1991). Moreover, animal feeding in Africa and in Sudan faces a crisis due to the drought, sharp fluctuations of rain fall which affect pasture capacities, overgrazing, the low quantity of pastures and the wide spread of tsetse fly in rich pastures(in west Africa as an example ,Ragab,1990).

In Sudan, in particular, natural pastures constitute major source of fodder. More than 80% of cattle depend upon them for feeding. These pastures are found in the savannah belt in the clay lands in the east and the sandy region in the west. These are the most important region from the economic point of view, since they have all the requirements of the rain fed cultivation and animal breeding (Suliman, 1999). Adam (1983) reported that available fodder is poor in its nutritional value; and they are adversely affected by over-grazing and desertification. This has affected the rates of animals' growth, multiplication and production. Due to poor quality of fodder, the best types like Friesian in large size produced about 10-12 liter per day, whereas for the same in small size they produced about 7-8 liter per day. In Khartoum state producing farms follow this pattern also (Gumuaa, 1978). In Khartoum state, producers feed their animals, with fresh and/or dry forage as the only animal feed, in the irrigated areas. But green fodder and concentrates and industrial and agricultural by-products are considered a luxury, because of its high cost (Gumuaa, 1982). The most important point here is that the source of fodder does not satisfy the feed needs in the state. This is because the feeding needs of animal amounts about 238 to 977 tons of feeding material but; total production of various sources of fodder amount to 190 to 262 tons (MAR ,2017).Thus there is a feeding gap of 48 to715 tons of feeding materials per year.

A further important point is ignorance of the producers of proper feeding to the right age of animals. It is well known that each age has its own requirements of feeding. This means that the level of extension and awareness amongst producers is still far away from being satisfactory. There are also other problems involved in this situation; such as, the rise in the costs of feeding. This results from the deterioration of pastures, the export of the raw materials,(such as, molasses and oil seeds cake from which concentrated forage is made) in addition the charges imposed on the production of feeding(AOAD;2003).The solution of these problems lies in changing the current socio-economic policy towards pastoralism(El-sammani et al;1994). Likewise, it is an important endeavor to achieve agricultural integration between the postural farms and the mechanized farming schemes, through a program for production of fodder and animal production (AOAD, 2003). In Khartoum state, for bridge the gap of animal feed, shown above it’s important to make agro-investment green fodder, maize and clover for supply of more protein for animals .Moreover, the introduction of an intensive agricultural rotation would double the crop area and lead to the development of the use of crops left-outs to improve their nutritional value and increase the rate of the production of concentrated fodder (AOAD; 2003).

2.14 Feeding and the cost of production

Feeding represents 75% of the total cost of milk in the developing countries (Mahesh, 1990). In the Sudan, it is estimated that feeding represents 86% of the total cost of milk production(Mustafa,1994 and Soad,1994).The cost of feeding is a basic part of the current cost in all types of farms. So, the reduction in the cost of feeding animals, reduce the cost of milk production(Kummer and Gupta,1988), yet, by reducing the average cost of the productive unit of animals, it would be possible to gain reasonable profit. This is because the cost of production contributes the greater ratio of total cost in the production. Accordingly, feed is the largest single area where profits can be increased, either by reduced feed costs or by increased efficiency of feed utilization (Bath et al 1985). Reduction of feed cost is the easiest and direct method for increasing profits where traditional or semi traditional husbandry practices are followed.

2.15 Source of animal feed in the state

There are several sources of animal feeds in the state these are the following:

2.15.1Green fodder

Green fodder is an important feed stuff. It supplies the animal with carotene, the main source of vitamin A that cannot be produced in the ruminant animals. It is also sources of vitamin D when dried; and also contains a high percentage of calcium, specially the leguminous fodder (Soad, 1994). The most important green fodders grown in the state are, Abu sabeen (a grass plant), maize, cowpeas, lubia and Lucerne. These fodders cultivated area, at present is 202,296 Fadden's of the total available area for investment of 360,002million Fadden's (Ministry of Agriculture and Animal Resources, 2018)

2.15.2 Concentrates and additives

Concentrates are materials contain a high percentage of protein, energy and have less than 18 percentage of its weight in fibers. This gives them a high nutritive value and high digestibility. These are produced locally, except for some salts mixtures and vitamins that are imported to the state. The contents include oil cake (from cotton seeds, sesame and groundnuts), molasses, bran, grains and agricultural crops left outs. Despite the availability of these elements, the factories in Khartoum state operate at about 1/3rd of their designed capacity (Jabir et al; 1995).

Additives which are usually salt mixtures and vitamins are imported from abroad at very high expenses.

2.15.3 Agricultural left-outs

This range of products is represented by the left-out of sorghum (dura), groundnuts, wheat and the leaf-outs of the processing of some agricultural crops. The use of these materials has increased in view of the rise in the prices of fodders.

2.15.4The natural pastures

Natural ranges are native pastures grow according to weather conditions. They are the cheapest source of feed for livestock, but they fluctuate in quantity and quality throughout the year. If the natural range can be improved, it can be expected to provide more than the basic maintence requirement of animals, because unimproved pasture cannot be expected to provide more than the basic maintenance requirement of animals in commercial dairy production systems (Suaad, 1994).

The state is generally poor in natural pastural resources. The available pastures are confined to valleys and low lands. Thus according to estimates of pastures and fodders section (1994), the average production of fodder is 0.14 tons per fedan (Badria, 1996)

The fodder produced in Khartoum state out of these entire source, is used for feeding other animals coming from the other states whether for local consumption or export. Yet there is a feeding gap; estimated at about 20% (Baadria, 1996).

In the sample surveyed, there were very few farmers who feed their animals in the natural ranges, and were faced with problems of malnutrition. This situation resulted in many drawbacks on the production and the reproduction performances of the animals.

Many studies suggested that great amount of natural ranges may be used to raise the total feed inputs while maintaining concentrates level.

Amella et al. (1982) and ugarte (1991) concluded that farmers in tropical areas must base their animal production on the utilization of natural resources basically grasses and with supplementation of industrial by-products. The natural range resources in the state can play its expected role on providing the cheapest forage.

2.16 Factor limiting fodder production

Factors limiting fodder production (especially in the central, Khartoum and the Northern state) according to a survey carried out by the Arab Organization for Agricultural Development (AOAD, 2003), are:

1- Lack of a well-developed animal production industry, marketing of fodder crops is restricted to the owners of small herds of animal (largely small farmers who raise livestock for both subsistence and small scale commercial purposes). Animal feed plants are lacking. Such plants are needed to supply animal feeds, especially during certain items of the year. The existing crop rotation adopted by the principal farming regions do not include adequate areas for production of fodder crops. This situation resulted in the existing low priority given to the production of fodder crops by the majority of farmers in the Sudan.

2- Lack of adequate transport facilities for linking fodder production areas with fodder utilization centers. When and where available fodder transport involves considerable cost.

3- Lack of adequate fodder storage facilities also restrict the capacity for expanding the areas under the principle fodder produced in the country.

4- Low productivity of some varieties of fodder crops also discourages expansion of the area committed to production of animal feeds in the Sudan.

5- Unavailability of machinery, fuel and spare parts

6- Unavailability of fertilizers

7- Administration problems, e.g. licensing.

CHAPTER THREE

CONCEPTUAL FRAME WORK

This chapter focuses on the conceptual framework, the theoretical background, estimation procedures and the empirical models of the stochastic production frontier (SPF), linear programming (LP), and Budget analysis, used to test the study objectives.

3.1 Definition and measures of Efficiency

3.1.1 Efficiency Concept

Efficiency is very loose term indeed; to an engineer efficiency may mean the ratio of output/ input or output/ theoretical capacity, percent. While the cost account uses the ratio standard cost /actual cost, percent, or it’s inverse to measure the productive efficiency of a firm. The economist, when he refers to the efficiency of a firm generally means one of two ratios, the first concerns the firm’s success in producing as large as possible an output from a given set of inputs; or what amount to the same thing, producing a given output with least inputs; this called productivity, or technical efficiency(Amey;1969).

3.1.2 Production Efficiency

Production efficiency refers to a firm’s costs of production and can be applied both to the short and long run; it is achieved when the output is produced at minimum average total cost. For example, we might consider whether a business is producing close to the low point of its long run average total cost curve. When this happens the firm is exploiting most of the available economies of scale.

Productive efficiency exists when producers minimize the wastage of resources in their production processes (Tutor2u, 2006)

Rahman, 2002 cited that productive efficiency has two components. The purely technical, or physical, component refers to the ability to avoid waste by producing as much output as input usage allows, or by using little input as output production allows.

Rahman, 2002 stated that production efficiency is one of the three conditions necessary for an economy to be economically efficient is that it be on its production -possibilities frontier. If it is not on the production-possibilities frontier, more could be produced with given resources and technology. Because greater production would increase value, any position below the production- possibilities frontier is inefficient. Notice that a great many points satisfy this condition of production efficiency every point on the production- possibilities frontier is production efficient.

To be on production possibilities frontier, all resources must be used. Unemployed resources indicate that more goods and services could be produced, which means that the economy was not on the frontier initially. In addition, resources must be used properly.

3.1.3Production possibilities frontier

The Production possibilities frontier (PPF) shows the maximal combination of two goods that can be produced during a specific time period given fixed resources and technology and making full and efficient use of available factor resources. APPF is normally drawn as concave to the origin because the extra output resulting from allocating more resources to one particular good may fall. This is known as the law of diminishing returns and can occur because factor resources are not perfectly mobile between different uses, for example, re-allocating capital and labour resources from one industry to another may require re-training, added to a cost in terms of time and also the financial cost of moving resources to their new use.

To be on the Production- possibilities frontier, all resources must be used. Unemployed resources indicate that more goods and services could be produced, which means that the economy was not on the frontier initially. In addition, resources must be used properly. If society randomly assigns people to jobs on the basis of political reliability, it will not produce as much as it could. It will require some people with little strength and endurance to perform jobs that demand much strength and endurance. If switching people among jobs can increase output, the original situation was not on the Production- possibilities frontier and thus not economically efficient (Rahman, 2002).

3.1.4 Technical Efficiency

Technical efficiency is just one component of overall economic efficiency. However, in order to be economically efficient, a firm must first be technically efficient. Profit maximization requires a firm to produce the maximum output given the level of inputs employed (i.e.be technically efficient) (Kumbhakr and Lovell 2000).These concepts can be illustrated graphically using a simple example of a two input(x_1,x_2) and two output(y_1,y_2) production process(Figure 3.1).Efficiency can be considered in terms of the optimal combination of inputs to a chive a given level of output (an input-orientation), or the optimal output that could be produced given a set of inputs(an output orientation).

In figure 3.2(b), the firm is producing at a given level of output (y_1^{*}, y_2^{*}) using an input combination defined by point A. The same level of output could have been produced by radially contracting the use of both inputs back to point B, which lies on the isoquant associated with the minimum level of inputs required to produced (y_1^{*}, y_2^{*}) (i.e. Iso (y_1^{*}, y_2^{*})). The input –oriented level of technical efficiency (TE_1(y,y)) is defined by 0B/0A.

The production possibility frontier for a given set of inputs is illustrated in Figure 1(b) (i.e. an output-orientation). If the inputs employed by the firm were used efficiently, the output of the firm, producing at point at point A, can be expanded radially to point B. Hence, the output oriented measure of technical efficiency ($TE_0(y,x)$), can be given by 0A/0B.This only equivalent to the input –oriented measure of technical efficiency under condition of constant return to scale. While point B is technical efficiency, in the sense that it lies on the production possibility frontier (Kumbhaker and Lovell, 2000).

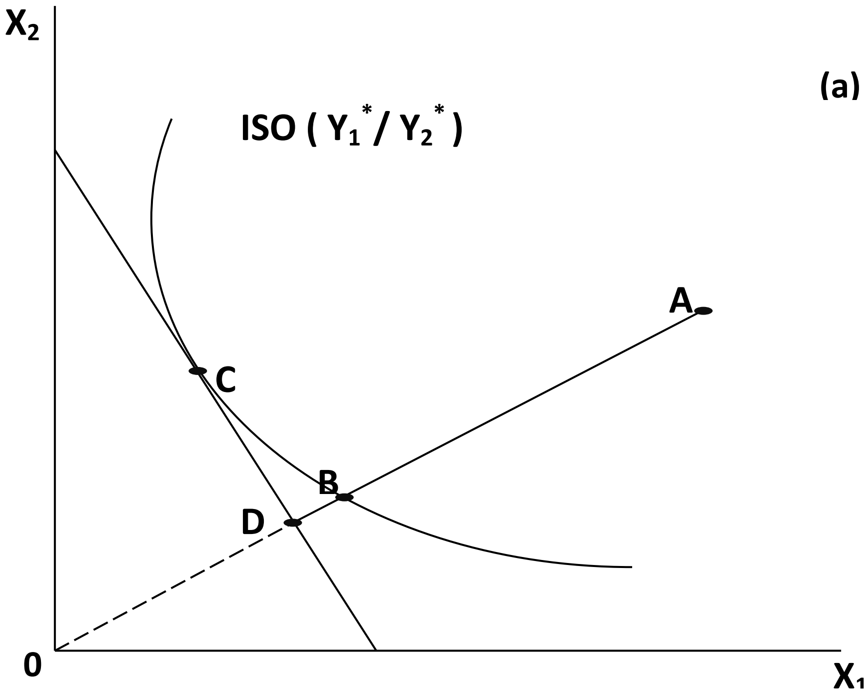


Figure 3.1(a): Input - orientation efficiency measure

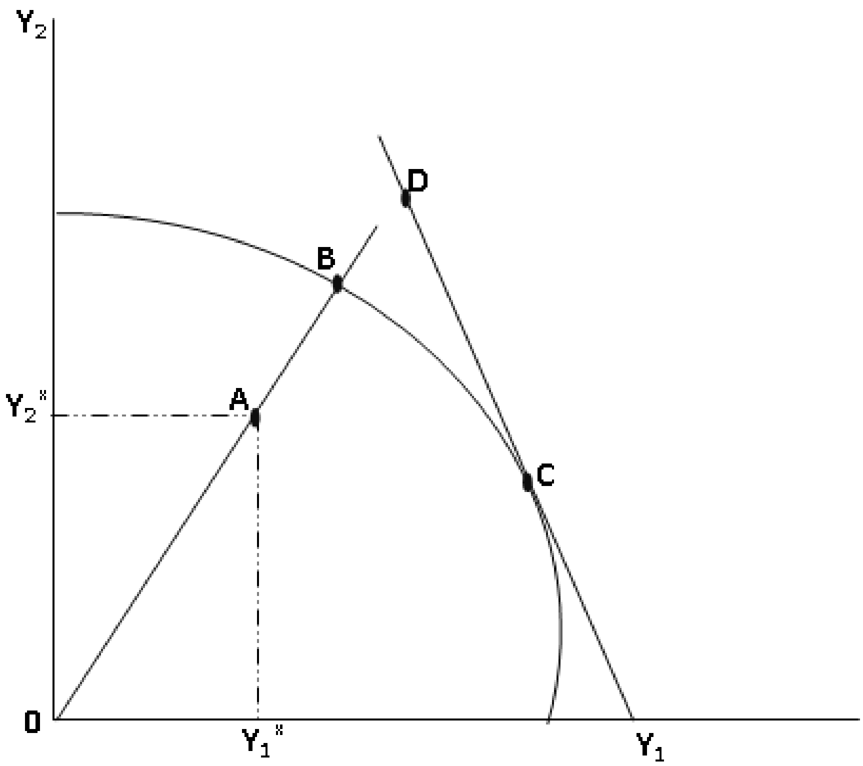


Figure 3.2(b): Output - orientation efficiency measure

Y_2|

3.1.5 Stochastic production frontier (SPF)

Farrell,s,(1957) article has led to development of several techniques for the measurement of efficiency of production. These techniques can be broadly categorized into two approaches: parametric and non-parametric. The parametric stochastic frontier production function approach and non-parametric mathematical programming approach, commonly referred to as data envelopment analysis (DEA) are the two most popular techniques used in efficiency analysis. The main strengths of the stochastic frontier approach are that it deals with stochastic noise and permits stochastic tests of hypotheses pertaining to production structure and the degree of inefficiency (Sharma et al, 1999).www.en.wikipedia Org/ wiki/stochastic frontier analysis).

Stochastic frontier production function (SFPF) have been the subject of considerable econometric research during the past two decades, originating with a general discussion of the nature of inefficiency in Farrel,(1957). In traditional economic theory, efficiency is generally assumed as an outcome of price-taking, competitive behavior. In this context (and assuming no uncertainty), a production function shows the maximum level of output that can be obtained from given inputs under the prevailing technology. However, variation in maximum output can also occur either as a result of stochastic effects(e.g; good and bad weather states), or from the fact that firms in the industry may be operating at various level of inefficiency due to mismanagement, poor incentive structures, less than perfectly competitive behavior or inappropriate input levels or combination. The econometric technique developed by Battese and Coelic (1998), www.unedu.an/staff/g Battese, allows for a decomposition of these effects and precise measure of technical inefficiency defined by the ratio of observed output to the corresponding(estimated) maximum output defined by the frontier production function, given inputs and stochastic variation(Kompas,2001). The stochastic production frontier (Aginer, Lovell, and Schmidt (1977), Battese and Corra (1977) and Meesusen and Van den Broeck (1977)) is motivated by the idea that deviations from the production frontier may not be entirely under the control of the production unit under study. These models allow for technical inefficiency, but they also acknowledge the fact that random shock outside the control of producers can affect output. They account for measurement error and other factors, such as effects of weather, luck, etc., on value of the output variable, together with combined effects of unspecified input variables in the production function. The main virtue of stochastic frontier models is that at least in principle these effects can be separated from the contribution of variation in technical inefficiency (Kebede, 2001). Rahman, (2002) stated that several methods have been developed for the empirical estimation of the frontier models. These different methods to estimate the frontier efficiency models can be categorized according to:

(a) The way the frontier is specified: the frontier may be specified as parametric function of inputs or as deterministic nonparametric function. The main distinguishing characteristic of the parametric frontier is the assumption of an explicit function from given technology and thus the frontier is expressed in a mathematical form. Nonparametric is not based on any explicit model of frontier or the relationship of the observations to the frontier (Forsund, et al; 1980).

(b) The frontier may be estimated either through programming techniques or through the explicit use of statistical procedures;

(c) The deviation from the frontier is interpreted; deviations may be interpreted simply as inefficiencies or they could be treated as mixtures of inefficiency and statistical noise; that is, frontier may be deterministic or stochastic;

(d) The frontier is optimized (dual approach); the frontier may be production frontier or cost frontier.

Stochastic frontier production function was there after developed to overcome the efficiency (Ogundari and Ojo, 2006). The frontier production function model is estimated using maximum likelihood producers. This is because it is considered to be asymptotically more efficient than the corrected ordinary least square estimators (Coelli, 1995), (Battese and Coelli, 1995), www.springerlink.com /index/h5x6j80852428mp1. The maximum likelihood estimates for all the parameters of the stochastic frontier and inefficiency model, defined by equation simultaneously obtains by using the program, FRONTIER VARTION 4.1, which estimates variance parameters in terms of the parameterization.

3.1.6 The stochastic production frontier with the Cob-Douglas production function

The Cob-Douglas production function is probably the most widely used form for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady and Dillon, 1969, Fuss et al, 1978). The Cob-Douglas production function has convex isoquants, but it has unitary elasticity of substitution, it does not allow for technically independent or competitive factors, nor does it allow for stage I and III along with stage II. That is MPP and APP are monotonically decreasing function for all X- the entire factor- factor space is stage II given $0<b<1$, which is the usual case. However, the Cob-Douglas may be good approximation for the production processes for which factors are imperfect substitutes over the entire range of inputs values. Also, the Cobb-Douglas is easy to estimate because, in logarithmic form, it's linear in parameters; it's parsimonious in parameters (Beattie and Taylor, 1985). A stochastic Cob-Douglas production frontier model may be written as:

$$Yi=f\ (XiB)\ exp.\ (Vi-Ui) \ldots\ldots.(1) \qquad I=1, 2 \ldots N$$

Where the stochastic production frontier is (XiB) exp. (Vi), Vi having some symmetric distribution to capture the random effects of measurement error and exogenous stocks which cause the placement of the deterministic Kernel (XiB) to vary across firm. The technical inefficiency relative to the stochastic production frontier is then captured by the one side error component U≥0. The explicit form of the stochastic Cob-Douglas production frontier is given by:

$$Yi = \beta_0 + {}^{n}\Sigma_{j=1}\ \beta_j lnX_{ij} + v_i - u_i \ldots\ldots (2)$$

Where: y_i is the frontier output, β0is intercept, βj the elasticity of yi with respect to X_{ij}, X_{ij} is the physical input, V_i-U_i a composed error**.**

3.1.7 FRONTIER 4.1

FRONTIER 4.1 has been created specifically for the estimation of production frontiers. As such, it is a relatively easy tool to use in estimating stochastic frontier models. It is flexible in the way that it can be used to estimate both production and cost functions, can estimate both time- varying and invariant efficiencies, or when panel data is variable, and it can be used when the functional forms have the dependent variable both in logged or in original units.

FRONTIER offers a wide variety of tests on the different functional forms of the models that can be conducted easily by placing restrictions on the models and testing the significance of the restrictions using the likelihood ratio test. The FRONTIER program is easy to use. A brief instruction file and a data file have to be created. The executable file and the start- up file can be downloaded from the internet free of charge at the CEPA http:// www.uq.edu.au/economics/cepa/frontier.htm.

3.2 Linear programming techniques

Linear programming is an important analytical tool made available to economists. It has been found beneficial in many important applications and it offers exciting opportunities in the future. It can serve as an important management aid to individual farms or marketing firms (Heady and Candler, 1973).

Linear programming deals with problems in which the objective function is to be optimized (i.e. maximized or minimized) subject to linear equality constraints and sign restrictions on variables. The LP model may include constraints. Moreover, the variables maybe non-negative or unrestricted in sign (Taha, 1982).

A linear programming has three quantities' components: an objective, alternative method or process for attaining the objective and resources or other restriction (Heady and Cander, 1973).In order to develop a general solution method, the linear programming problem must be put in a common which is called the standard form.

3.2.1Linear programming (LP) in brief

From an application perspective, mathematical (and therefore, linear) programming is an optimization tools, and/or technological decisions required by contemporary techno-socio- economic applications.

3.2.2 Definitions of LP

Heady and Candler(1973) defined linear programming as an efficient way of determining optimum plans only if there are numerous enterprises or processes and numerous restrictions attaining specific objective such as maximizing farm profits or minimizing production costs . The (LP) can serve as an important management aid to individual farms or marketing firms. Gass (1964) stated that, programming is concerned with the efficient use or allocation of limited resources to meet desired objectives. Bazaraa and Jarvis (1977) see a linear programming problem as a problem of minimizing or maximizing a linear function in the presence of linear constraints of the inequality and /or the equality type.

Another definition reported by Dent, Harrison and wood ford (1986) is that linear programming is one of a class of operations research methods referred to as mathematical programming; the linear programming technique is a general methodology that can be applied to a wide range of determining a profit maximization combination of farm enterprises that are feasible with respect to a set of fixed farm constraints, Mohamed (1986) reported that, LP provides a means to find the level of decision variable(s) that would maximize the objective function subject to a set of constraints. A linear programming problem is asocial case of a mathematical programming problem. From an analytical perspective, a mathematical program tries to identify an extreme (minimum or maximum) point of a function which furthermore satisfies a set of constraints i.e.; linear programming is the specialization of mathematical programming to the case where both, function and the problem constraints are linear (Kouruma, 1982).

3.2.3 Assumptions of LP.

Several assumptions are used in linear programming. If these assumptions do not apply to the problem under consideration linear programming may not provide a sufficient precise solution. These assumptions are explained below:

Additively and linearity

The activities must be additive in the sense that when two or more are used, their total product must be the sum of their individual products. An equivalent statement is that, the total amount of resources used by several enterprises must be equal to the sum of the resources used by each individual enterprise. Thus no interaction is possible in the amount of resources required per unit of output regardless of whether activities are produced alone or in various proportions.

Divisibility

It is assumed that factors can be used to produce commodities that can be produced in quantities which are fractional units. That is, resources and products are considered to be continuous to be infinitely divisible.

Finiteness

It is assumed that there is a limit to the number of alternative activities and to the resource restrictions which need to be considered.

Single- value expectations

In general, the linear programming method used widely to date employs the standard linear programming assumption that resources supplies, input- output coefficients, and prices are known with certainty (Heady and Candler, 1973).

Other assumptions summarized by Hazel and Norton (1986) are:

Optimization

It is assumed that an appropriate objective functions either maximized or minimized.

Fixedness

At least one constraint has a non-zero right hand side coefficient.

Homogeneity

It is assumed that all units of the same resource are identical.

Proportionality

The gross margin and resource requirements per unit of activity are assumed to be constant regard less of the level of activity used.

3.2.4 Why use LP

The great advantage of programming is that it allows one to test a wide range of alternative adjustments and to analyze their consequences thoroughly with a small input of managerial time (Beneke and Winterbo, 1973). Linear programming is a powerful tool of analysis which can be used to look at several budgets of a farm at a time and depict the optimal enterprises in profit maximization or cost minimization context (Kouroumes, 1982).Bazarra and Javis (1977) emphasized that the simplex method of linear programming enjoys wide acceptance because of:

1- Its ability to model important and complex management decision problems and

2- Its capability for producing solutions in a reasonable amount of time. Malik (1994) sees the most important advantages of linear programming is the flexibility in stating objectives that will satisfy the consumption requirements of the house hold. Furthermore, the byproduct of the solution provides rich information on economic issue like shadow prices and average productivities. One should be careful in utilizing linear programming results in explaining farmers' behavior, because of the normative nature of L.P analysis and due to its dependence on the degree of accuracy of the coefficients and assumptions which were used in the model formulation. Never the less, LP still provides an essential indicator of the degree to which farmers are market- oriented and gives an adequate analysis of input-output relationship (Malik-1994).

3.2.5 Limitations of the LP model

The LP technique suffers from several limitations which can be stated as follows:

1- Programming cannot help the manager in the difficult task of formulating price expectations.

2- Activities that involve decreasing costs cannot be treated adequately with programming methods.

3- Restraints are sometimes difficult to specify.

4- LP is of little help in estimating input- output relationship, it can only specify data needed.

5- LP proceeds as if the price and input-output expectations we have formulated were reliable for all farm products, and the result is that farms treated as they were equally without risk i.e risk preference of the operator doesn't take into consideration.

6- One of the assumptions of the LP is that each additional unit of the output requires the same quantity of the input. But if you recall the law of diminishing return to scale, the amount of dairy production declines as more feeding is used per kilogram.

3.2.6 The objective function

For the typical farm management or marketing efficiency problem, the objective will be maximum income or minimum cost. There is, however, no reason why the objectives should so restrict. If the manager wishes to make certain other specifications, as to this objective, these can easily be included.

Although the standard linear programming model can be of either the maximization or the minimization type, it is sometimes useful to convert one form to another. The maximization of a function is equivalent to negative the minimization (Taha, 1982).

3.2.7 The constraints (restrictions)

A linear programming problem doesn't exist unless resources are restricted or limited for most planning or choice problems. For most planning or choice problems, there are restrictions which set limits on the kinds of plan. For a producing firm, restrictions are defined by fixed quantities of certain resources. While fixed resources represented the main types of restrictions, there also can be subjective, institutional, or other types of restrictions.

For example, protein, fiber and fat percentages may specify minimum requirement for a feed- mix problem (Heady and Candler, 1973).

A constraint of the type (≤, ≥) can be converted to equality by adding (subtracting a surplus variable from, a slack variable to the left side of the constraint. The right side is always made negative multiplying both sides by (-1), in case of equality constraints an artificial variable is added to the left side of the constraint.

3.2.8 The variables

An unrestricted variable y_i can be expressed in terms of two non-negative variables by using the substitution:

$$Yi = y_i' - y_i''$$

Where:

$$y_i', y_i'' \geq 0$$

The LP is normally solved in terms of (yi') and (yi'') from which (yi') is determined by reverse substitution.

An interesting property of (y_i') and y'' is that in the optimal LP solution only one of the two variables can assume appositive value but never both. Thus when ($y_i' > 0$), ($y_i''=0$) and vice versa. In the case where (unrestricted) y_i represented both slack and surplus, we can think of (y_i') as a slack variable and of (y_i'') as surplus variable since only one of the two can appositive value at a time (Taha, 1982).

3.2.9 Alternative methods or processes

Given the objective, it is obvious that unless it can be attained in more than one way, there is no problem to be analyzed.

Given several methods or processes, we choose from among them the methods or processes which are most efficient in converting resources into the objective (Heady and Candler, 1973).

The term process is more or less synonymous with activity, except that activity is sometimes used to describe a somewhat broader category of the analysis more specifically; activity is used to indicate the thing being produced, as a method of attaining the objective. The process is conventionally used to denote differences in enterprises and techniques. A process is represented by a vector of input-output coefficients or per unit resource requirements for a particular activity.

A process is a method of converting resources, or other restriction on planning into product. In general two processes are the same properties (Heady and Candly, 1973).

3.2.10 Types of processes or Activities

In order to distinguish between types of activities or processes, we use the term real or commercial to indicate those activities which are produced for sale in the market or are purchased in the market in the case of resources purchased. The term disposal is use to designate activities (variables) included to allow non-use of resources. The term intermediate is used to designate commodities which may be produced, but, which sub-sequently become resources for other activities of the firm (Heady and Candler, 1973).

3.2.11 Application of linear programming technique in livestock sector

There are several individuals who contributed to the development of linear programming among them Von Neumann, Leontief, Laplace, Weyl, Wood Stigeler, Cornfield, Koopmans and Dantzing. Abdel aziz, 1999. Abdala (2005) mentioned that many researchers in the world applied linear programming in the last years among them Majmder (1998), Darwish et al (1999), Neto et al(1997), Salinas et al(1999) Pennel (1999), Frizzone et al(1997), Kassie et al (1998), Goswami(1997) and Zahoor(1997). On the other hand, Heyer (1996), Delgado (1979), Schultz (1964) and Metson (1978) contributed to the application of linear programming in African agriculture (Abdel aziz, 1999).

Linear programming was applied also in agricultural and the livestock sector of Sudan among them,Abdel aziz (1999), Ahmed(1988) Fayga (1994), Brima(2004), Elbadawi(1990) and Ahmed(2005). Faki and Ahmed (1992 and 1994) applied linear programming for investigating the prospects of technology in small pump schemes in Wad Hamid and Rubatab areas in the River Nile State (Abdelaziz, 1999).

Elbadawi (1990) and Abdelraouf(2010) applied linear programming method in New Halfa Agricultural production Corporation. Mahgoub (2015) applied linear progrraming in the Gazira Scheme, for the following reasons and justifications which are similar to reasons that justify application of LP technique in this study:

1-Lp is suitable to examine constraints of production and the behavior of the farmers.

2- Homogeneity of the farming in the area of study.

3- Studying least cost diet and optimal feed combination of feed.

Fayga(1994),applied linear programming in the university of Khartoum farm to know optimal combination of feed dairy cow and minimize cost between two resource (berssem and Abu 70), and choice of the production function with minimum cost of feeding.

3.3 Budget analysis

A profitability measurement technique is employed after calculating the product budget. This requires calculation of total returns and total variable costs. Gross margins for the different farm products are to be calculated and compared. The comparison between margins for different products in study area will give a clear picture about the profitability of the different products.

For estimation of gross margins, some fixed costs are omitted and mostly variable costs are considered. Kay (1981) stated that, the gross margins are estimated for single unit of each enterprise, and they are the difference between total returns and total variable costs.

Calculating the gross margins; on the other hand, requires best estimates of yield or production levels for each enterprise together with expected output price. Total income per unit is equal to output price time's yield or production. These estimates directly affect the estimated gross margin. The calculation of total variable costs requires a list of each variable input needed, the amount required and the price of each. Also, cost estimates are obtained to determine the relative effect of each item on the total cost.

3.4 Forecasting Analysis:

3.4.1. Auto-Regressive Integrated Moving Average (ARIMA method)

(i) Model identification

At the outset, the stationary of the series is examined. In case the data is found to be non-stationary, stationarity is achieved by differencing technique. For instance, the differencing of first order is

$Z = Y_t - Y_{t-1}$

The next step in the identification process is to find the initial values for the orders of non-seasonal parameters p and q, which are obtained by looking for significant correlations in the auto correlation function (ACF) and partial autocorrelation function (PACF) plots.

For identifying the orders of AR component, a common practice is to see for significant spikes in the first few lags of the PACF graph and for, MA component, that of ACF graph.

1-Autoregressive integrated moving average (ARIMA) model

The ARIMA model has been extensively studied and applied in studies of forecast due to their attractive theoretical properties and because of the various empirical supporting evidences. In addition, ARIMA model has equivalence with most models of exponential smoothing, except for the multiplicative form of Holt-Winters. The ARIMA model was popularized by George Box and Gwilym Jenkins in the 1970s, with application in time series analysis and forecasting. The underlying theories described by (Box and Jenkins et al, 1970) and later by (Box, Jenkins and Reinsell ,1994) are sophisticated, but easy to understand and apply. Any forecasting method involves two steps (Delurgio, S. a, 1998): (i) the analysis of time series and (ii) the selection of the forecasting model that best fits to the data set. Likewise, for ARIMA, is used a similar Sequence of analysis and selection by decomposition methods and regression Box and Jenkins et al (1970). In this sense, this section is divided in two main parts: first, the basic concepts of autoregressive moving average models that support the ARIMA model are described, and then, the application of this model in time series forecasting.

3.4.2. ARIMA model for time series data

The regression model takes the form:

$Y_t = b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_p x_p + e_t$ ……………………….. (1)

Where Y is the predicted variable, X_1 to X_p are explanatory variables, b0 to bp is linear regression coefficients and e_t represents the error. If, however, these variables are defined as $x_1 = y_{t-1}$, $x_2 = y_{t-2}$, $x_3 = y_{t-3}$, $x_p = y_{t-p}$, the equation (1) becomes:

$Y_t = b_0 + b_1 yt\text{-}1 + b_2 yt\text{-}2 + \ldots + b_p yt\text{-}p + e_t$.............................. (2)

Equation (2) still represents a regression equation, but differs from Equation (1) since it has different explanatory variables that are, in fact, previous values of the predictor variable, called autoregressive (AR). Just as it is possible to regress past values of a series again, there is a time series model that uses past errors as explanatory variables:

$Y_t = b_0 + b_1\, ye_{t-1} + b_2\, ye_{t-2} + \ldots + b_p\, ye_{t-q} + e_t$ …………………. (3)

In Equation (3), a dependency relationship is established between successive errors and the equation is called a moving average model

(MA). Many stationary random processes cannot be modeled purely as moving or as auto-regressive averages because they have qualities of both types of processes. In this situation, the autoregressive (AR) can be effectively connected to the moving average model to form a common and general class of time series models called autoregressive moving average models (ARMA).

The ARMA model can only be used on stationary data. In practice, many of the time series are non-stationary, so that the characteristic of the underlying stochastic process changes over time. To extend the use of the ARMA model for non-stationary series is necessary to differentiate the data set. In this situation, the model is now called the autoregressive integrated moving average (ARIMA), name popularized by (Box and Jenkins in 1970).

It can be said that y_t is stationary homogeneous of order *d* if $w_t=\Delta d\ y_t$ is a stationary series. Considering thatΔ denotes the difference:

$\Delta y_t = y_t - y_{t-1}$

$\Delta 2y_t = \Delta y_t - \Delta y_{t-1}$ …… (4)

And so on.

With a series w_t is possible to come back to y_t by the sum of w_t in a total of *d* times. It can be written as $y_t = \sum d w_t$, where$\sum$ the summation operator:

$\sum w_t = \sum_{i=-\infty}^{t} wi$

$\sum 2\ w_t = \sum_{j=-\infty}^{t} \sum_{i}^{j} -\infty wi$……. (5)

And so on. It is worth noting that the summation operator$\sum$ is merely the inverse of the difference operator Δ. Since $\Delta y_t = y_t - y_{t-1}$, it can be written that Δ=1-B and thus$\sum = \Delta^{-1} = (1 - B)^{-1}$. When calculating this sum for an effective series, begins the first observation of the original series without differentiating (y_0) and then adds up successive values of the series in difference. Thus, if $w_t = \Delta Y_t$, y_t can be calculated:

$y_t = \sum w_t = \sum_{i=-\infty}^{t} wi = \sum_{i=-\infty}^{0} wi + \sum_{i=1}^{t} wi = y_0 + w_1 + w_2 + \ldots + w_t$……….(6)

If y_t was differentiated twice, such that $w_t = \Delta 2y$, would be possible to calculate y_t from $w_{t.}$ by the sum of this term twice. After differentiating the series y_t to obtain the stationary series $w_{t.}$, is possible to model $w_{t.}$ as an ARMA process. If $w_{t.} = \Delta d\ y_t$ is an ARMA (*p*,*q*) process, then it can be said that yt is an autoregressive integrated moving average process of order (*p*,*d*,*q*) or simply ARIMA(*p*,*d*,*q*).

If $y_t = \sum w_i$ increases linearly along the time, the series has a linear trend over time which is independent of the random disturbances, in other words, is deterministic (Box and Jenkins et al, 1994). Any homogeneous non-stationary time series can be modeled as an ARIMA process of order (*p*,*d*,*q*). The practical problem is to choose the most appropriate values for *p, d, q*, i.e. Specify the ARIMA model (Pindyck ,R.S; 2004) .This problem is solved in part by examining the autocorrelation function and partial autocorrelation function for the time series of interest. The first step is to determine the degree of homogeneity *d*, that is, the number of times that the series needs to be differentiated to produce a stationary series. Then it examines the correlation and partial autocorrelation function to determine possible specifications of *p* and *q* (Pindyck, R.S; 2004)

Evaluation Metrics

The mean absolute percentage error (MAPE) is the mean absolute error as a percentage of demand. This method presents problems when the series have values for closed (or equal to) zero. These problems can be avoided by including in the analysis only data with positive values; however, this artificial solution limits the application of the method in various situations (Delurgio, S. a, 1998).Because of the heavy penalty on the positive errors

compared to negative errors (Gooijer, j. C et al, 2006). In practice, a MAPE value lower than 10% may suggest a forecast potentially very good, lower than 20%, potentially good and above 30%, potentially inaccurate Lewis, C;D(1997). The MAPE can be expressed as
Follows:

$$MPAE_n = \sum_{t=1}^{n} \left| \frac{Et}{Dt} \right| /n*100 \ldots\ldots\ldots\ldots (7)$$

Where:

|ET|=absolute error value in the period *t*;

|DT|= absolute value of real demand in the period *t*;

n= all the periods

The Theil inequality index (U-Theil) is a relative measure, in percentage terms, of the discrepancies one step ahead committed with the forecast (Thiel .H; 1996), this metric assumes a decisive role in the determination of use whether or not of a forecasting technique. This model evaluates the adjustment of the series referred to the original series closer to zero, the greater the range of adjustment provided in respect of the original series. In contrast, values near the unit indicate that the model was unable to make good predictions (Souza, G.P; et al, 2002). Thus, the U-Theil can be expressed as:

$$\text{U-theil=} \quad x = \frac{\sqrt{\frac{1}{ny}\sum_{i=1}^{ny}(\text{yi}^* - \text{yi})2}}{\sqrt{\frac{1}{ny}\sum_{i=1}^{ny}(\text{yi}^*)2}\sqrt{\frac{1}{ny}\sum_{i=1}^{ny}(\text{yi})2}} \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where y* is the forecasted value for the period t, *yt* is the observed value and *N* the number of observations.

(ii) Estimation

The parameters are estimated by modified least squares technique appropriate to time series data.

(iii)Diagnostic checking

For the adequacy of the model, the residuals are examined from the fitted model and alternative models are considered, if necessary. If the first identified model appears to be inadequate then other ARIMA models are tried until satisfactory model fits to the data.

The ARIMA model is given by (taken Zt as the already first differenced series, in our case d=1

$(z_t$-μ)- $α_1$ $(z_{t-1}$-μ)-………-$α_p$ $(z_{t-p}$ -μ) …………..(9)

= e_t-$β_1 e_{t-1}$-…….- $β_q e_{t-q}$…………… (10)

Is called ARIMA (p, 1, q) of order (p.q),

Different models are obtained for various combinations of AR and MA individually and collectively (Makridakisetal.1998).The best model is obtained on the basis of minimum value of Akaike information criteria (AIC) given by.

AIC=-2logL+2m ……… (11)

Where:

M=p+q and L is likelihood function.

The performances of different approaches have been evaluated on the basis of Mean Absolute Percentage Error [MAPE] and Root Mean Square Error [RMSE].

Which are given by:

MAPE=$\frac{1}{n}\sum_{t-1}^{n} \quad \left| \frac{yt-ft}{yt} \right|$ *100

RMSE=$\sqrt{\frac{1}{n}\sum_{t-1}^{n}(yt-ft)2}$

Where:

yt: is the original milk yield in different years and

ft: is the forecasted milk yield in the corresponding years and

n: is the number of years used as forecasting period

CHAPTER FOUR

STUDY AREA AND RESEARCH METHODOLOGY

4.1 The study area

Khartoum state lies between latitudes 15◦ 15′ and 16◦ 40′ north and longitudes 34◦ 25′ and 31◦ 35′ east. It occupies an area of about 2.1 thousand km^2. Khartoum state composed of three towns, Khartoum, Khartoum North and Omdurman.

Khartoum North is the leading town in term of dairy production followed by Khartoum and Omdurman. The distribution of dairy farms in Khartoum North is scattered around the town especially Hilat Kuku, Dar Elslam, ELselait, Shambat. On the other hand, while the distribution of dairy farms in Khartoum town is concentrated around(Soba, Elazhari, Lamab, Kalakla, Juabal Aulia etc),In Omdurman it is concentrated south Elftehab(Jabal Toria dikkak), Wad-elbakheit and Elmarkhiat.

4.2 RESEARCH METHODOLOGY

4.2.1 Data collection

Data collection is an important step of the sampling procedure and the result of any study depends on the accuracy and reliability of data. The accuracy and reliability of data are mostly dependent on the method of data collection.

Both primary and secondary data were collected to test the requirements of the objectives of the study.

4.2.1.1 Primary Data

Primary data were collected by using a structured questionnaire using a random sampling technique through direct personal interviewing. The primary data were collected during 2016/2017.The primary data include information about the socio- economic characteristics of producers such as, age, education level, occupation, number of family members, marital status, and experience. Herd structure in Kuku farms was homogenous and therefore random sampling was used. The Sample size was 85 farms out of 600 farms.

4.2.1.2 Secondary data

Secondary data were collected from the relevant institutional sources, which include Ministry of Agriculture and Forests, Ministry of Animal Resources, Information Center, Central Bank of Sudan in addition to different documents, records, books, internet, papers, journals, and reports.

4.2.2 Analytical techniques (Methods of analysis):

To a chive the objectives of the study a variety of analytical techniques were used. Tabular as well as simple descriptive statistics were used throughout the study to describe the socio-economic characteristics of the producers. Gross margin analysis, forecasting of milk production in Khartoum (ARIMA) models were used, stochastic frontier production function technique and linear programming (L.P) models were used in the analysis.

In order to estimate the level of technical efficiency in a manner consistent with the theory of production function, a Cobb-Douglas type stochastic frontier production function was specified. The Cobb-Douglas production function has some well-known properties that justify its wide application in economic literature (Rahman, 2002).

Linear programming technique was used to determine the optimum plan and course of actions, among many which are possible, for production of the dairy production in Kuku farms in way that minimizes farms cost and satisfies domestic consumption.

4.2.3 Specification of Stochastic Production Frontier model

The model includes farm's factors influencing the producer technical efficiency. Stochastic production frontier model of Cobb-Douglas form was used to find out the farms technical efficiency for dairy production in Kuku farms. In total, 8 parameters were estimated in stochastic production frontier model including five parameters and three parameters in the inefficiency model.

4.2.3.1Technical Efficiency of dairy production

$InYi= In\beta i + \beta 1InX1i + \beta 2InX2i + \beta 3InX3i + \beta 4InX4i+ \beta 5InX5i+ \beta 6\ InX6i + Vi – Ui............ (1)$

Where Y = annul Total milk production (litter)

X1= Herd Size (Number),

X2 = Labour (Number),

X3 = Health cost (SDG),

X4 = Quantity of roughage (kg),

X5 = Quantity of concentrates (kg),

$\mu i = \delta 0 + \delta 1Z1i + \delta 2Z2i +\delta 3Z3i$............................... (2)

4.2.3.2 Inefficiency Effect Model:

The u_i in the stochastic production frontier model is non-negative random variable, associated with the farm's technical inefficiency in production and assumed to be independently distributed, such that the technical inefficiency effect for the i^{th} farm, μi, will be obtained by normal distribution with mean and variance ,such that

$$\mu i = \delta 0 + \delta 1Z1i + \delta 2Z2i + \delta 3Z3i \text{..............................(3)}$$

Where:

Z_1, Z_2 and Z_3 respectively, represent, age, educational level and experience of farmers, these are included in the model to indicate their possible influence on the technical efficiencies of the farmers. The β's, σ's are scalar parameters to be estimated. The variances of the random errors, σv2 and that of the technical inefficiency effects σu2 and overall variance of the model σ2 are related thus: σ2 = σv2 + σu2 and the ratio γ = σu2/ σ2, measures the total variation of output from the frontier which can be attributed to technical or inefficiency (Battese and Corra, 1977). Where the γ parameter has value between zero and one, the parameters of the stochastic frontier production function model is estimated by the method of maximum likelihood, using the computer program, FRONTIER Version 4.1.

4.2.4 Empirical specifications of the Linear Programming Model

4.2.4.1 Linear programming technique

Linear programming is considered as an appropriate technique for economic analysis of ration formulation because it provides a means of finding the level of decision variable(s) that would minimize the cost (the objective function), subjected to a set of constraints. However, the results to be produced by such technique are based:

-Firstly; the decision making to which it is applied always involves constraints on the decision making body.

-Secondly; input and out-put prices are assumed to be constant.

-Thirdly, the firm's input- output, output- output and input- input relations are presumed to be linear.

4.2.4.2 The structure of the LP model

The formula of least cost ration can be stated as kg per day, method of reporting the output. The formula is valid only under the specified set of feed prices and ration constraints (Bath et al 1985). A constraint is a specified limitation, minimum, maximum or equality, on nutrients, feeds, or other ration characteristics that must be fulfilled by the formula; as prices change, or as ration constraints change, the least cost formula also changes.

4.2.4.3 The objective function

The objective function of the representative farm model minimizes cost of feeding that used in feed dairy cows. The statement of the L.P model could be described by the following formula (Chianng, 1984).

$$\text{Minimize } Z = \sum_{j=1}^{n} c_j x_j$$

Subjected to

$$\sum_{j=1}^{n} aijxj \geq bi \qquad (i=1,2,\ldots, m) \text{ And}$$

$$x_j \geq 0 \text{ and } (j=1,2,\ldots, n)$$

Where:

z= objective functionvalue.

c_j= cost of jth activity or decision variable

m= number of activities in the model

n= number of restrictions in the model

a_{ij}= input-output coefficient of the ith constraint used or contributed by the $_j$th activities.

1- The activity set (Source)

The activity set includes the following feed sources which are currently used in the dairy farms.

2- The current average ration provided by Animal production research-Centre, Kuku, was:

X_1= Sorghum grain (25%)

X_2= Groundnut cake (17%)

X_3= Molasses (35%)

X_4= Hulls (20%)

X_5= lime stone (2%)

X_6= Sodium chloride (Salt) (1%)

X_7= Roughages.

3- The constraints set:-

The constraints set of the model includes the following restrictions:

1- Metabolize Energy (M E).

2- Crude Protein(C P).

3- Calcium (Ca).

4- Phosphorus (p).

1- Metabolize Energy (M E).

Metabolizable Energy represents by the minimum amount of Mega Joules of energy in the feed mix. Indifferent plans Metabolizable Energy is restricted to at least 11.2 MJ/kg.

2- Crude Protein(C P).

Crude protein represents the grams of digestible crude protein in the feed-mix. In the different plans, crude protein. Is restricted to at least 173 g/kg.

3- Calcium (Ca).

Calcium represents the grams of the mineral in the feed-mix. In different plans, calcium is restricted to at least 11.0 gm/kg.

4- Phosphorus (p).

Phosphorus represents the grams of the mineral in the feed-mix. In different plans, phosphorus is restricted to at least 7gm/kg.

4.2.5 Forecasting technique (ARIMA Model)

The ARIMA model is given by taken Zt as the already first differenced series, in our case d=1

$(z_t$-μ)- α_1 $(z_{t-1}$-μ)-………-α_p $(z_{t-p}$ -μ)

= e_t-$\beta_1 e_{t-1}$-…….- $\beta_q e_{t-q}$

Is called ARIMA (p, 1, q) of order (p.q),

Different models are obtained for various combinations of AR and MA individually and collectively (Makridakisetal.1998).

The performances of different approaches have been evaluated on the basis of Mean Absolute Percentage Error [MAPE] and Root Mean Square Error [RMSE].

Which are given by:

$$\text{MAPE}=\frac{1}{n}\sum_{t-1}^{n} \left| \frac{yt-ft}{yt} \right| *100$$

$$\text{RMSE}=\sqrt{\frac{1}{n}\sum_{t-1}^{n}(yt-ft)2}$$

Where:

yt: is the original milk yield in different years and

ft: is the forecasted milk yield in the corresponding years and

n: is the number of years used as forecasting period

CHAPTER FIVE

RESULTS AND DISCUTION

In this chapter, results are presented and discussed in forms of tables and figures that include descriptive statistics, technical efficiency analysis, linear programing and forecasting models.

5.1 Socioeconomic characteristics of the producers

5.1.1 Producers age

Producer age is expected to have influence on productivity and output of an individual as it affects his mental and physical abilities. Upton (1979) stated that the farmer age has an influence on management performance although the overall direction of this influence is not clear. On the one hand as man ages, he gains experience and would expect his decision making ability to improve. On the other hand, it was found that goals change, with increasing age people usually towards leisure and reducing work. He also found that younger producers adopt new ideas more readily than older producers. The average age of the sample producers is 36 years. Table (5. 1) shows the age distribution of the sampled producers. As seen from the table, most of the producers (96.45%) are within the active age between 18-65 and about 3.5% less than 18yars.

Table 5.1: Distribution of interviewed studied sampled Producers According to Age of Producers

Age group	**Frequency**	**Percent**
Less 18 years	3	3.5
18- 35	40	47.05
35-50	30	35.29
50-65	12	14.11
Total	85	100.0

Source: Filed Survey, 2016

5.1.2 Education level

As shown in table (5. 2), most of the producers (93%) has attained some sort of education. The illiteracy level is 5.9% of the sample, 1.2% of them received some khalwa, 45.8% of them have joined primary education, about 25.8%, 21, 17% received secondary and university education, respectively. This means about 47 % of producers received good education. Although, farmers have a high experience in the dairy industry and many obligations to improve their milk production and /or reduce the costs but still their low education levels inhibit them from adopting advanced milk production techniques. Rania (2007) mentioned that, there are positive relationships between educational levels and milk production, as higher educational level dairy producers have the higher capability of adopting improved techniques in dairy production. Further, higher educational levels usually associated with good management and ability to take the right decision.

Table 5.2: Distribution of farmers according to education levels

Education years	Frequency	Percent
Illiteracy	5	5.9
Khalwa	1	1.2
Primary	39	45.8
Secondary	22	25.8
University	18	21.17
Total	85	100

Source: Field Survey, 2016.

5.1.3 Number of household members working in the farm

The average family member works on farms was found to be 14 persons. Table (5.3) shows the distribution of the sampled (producers) according to the number of persons per household working in the farms. The majority of the sampled producers (52.7%) have family size of about (2) persons. Families have (1) person working in farms represent 21.8%, families have (3)members of household work in farms represent 18.2% and families have 4 members work in farms represent 7.3% of the sampled producers. Household member are expected to work with their parents in the farm, hence reducing their costs.

Table 5.3: Distribution of Producers According to numbers of household Members working in Farms

Number	Frequency	Percent
1	12	21.8
2	29	52.7
3	10	18.2
4	4	7.3
Total	55	100.0

Source: Field Survey, 2016.

5.1.4 Marital Status

All surveyed farms are managed by males. Result of Table (5. 4) shows that, most of dairy producers (97.6%) in the study area were married. Producers who are married pay more responsible than single, bearing in mind the additional financial and social obligations that married households heads are facing. It is expected that dairy producers work harder and use their resources efficiently to increase their returns. These results coincide with (Yahia, 2010), who mentioned that marriage plays a positive role in encouraging and settling farmers, hence pushing them towards improving their production. Marital status has a positive effect on dairy production in the study area.

Table 5.4: Distribution of Producers According to Marital Status

Marital status	Frequency	Percent
Married	83	97.6
Single	2	2.4
Widow	-	-
Divorced	-	-
Total	85	100.0

Source: Field Survey, 2016.

5.1.5 Farm experience

The survey showed that the majority of the sample farmers (64.7%) have spent more than 10 years in the farms work with an average experience in farms work of about 15.7 years (Table 5.5). This long experience in farming activity is due to the land ownership in the Kuku dairy farms, as most of the producers in the Kuku are owners. These experiences are expected to have positive effect in dairy production, hence improving production and decreasing production cost.

Table 5.5: Distribution of Dairy producers According to Experience

Experience (years)	Frequency	Percent
10	6	7.06
11-20	55	64.71

More than 20	24	28.24
Total	85	100

Source: Field Survey, 2016.

5.1.6 Types of cows' breeds raised in the study area

Producers in Kuku farms raised animals usually as direct investment, sometimes the producer may sell some of his livestock (goat, sheep) when his production is less than his family needs or to meet cash needs. Animals are considered one of the sources of farm income. Table (5.6) shows the types of cattle cow owned by respondent farmers. The main type of cattle raised in farms was hybrids (cross- breeds) cows in their milk production, whether (Kenana + Friesian, (55.3%)) and (Butana + Friesian, (44.7%)).This result indicates that dairy producers in the study are well aware about the best types of local breeds in terms of dairy production, as Kenana and Butana breeds are characterized by high milk producing animals adapted to the country's conditions (Abd elaziz, Salah Eldain, 2007).

Table 5.6: Types of Cows Breeds Raised In the Study Area

Type of cattle	**Frequency**	**Percent**
Hybrid (Kenana+Frizian)	47	55.3
Hybrid (Butana+ Frizian)	38	44.7
Kenana	-	-
Butana	-	-
Total	85	100

Source: Field survey, 2016.

5.1.7 Off-farm occupations

The off-farm activities are of a great importance in the Kuku farms in providing alternative income sources to the producers, (diversity of income sources). As shown in table (5.7), the majority of the sampled producers (69.4%) were fully occupied in dairy production (i.e. had no off- farms activities), 46.15% were farmers (work with agricultural activity), and 26.92% were traders. Generally, the trading business is somehow good among livestock producers. 15.38% were employees and 11.53% of sampled farmers have other occupations (drivers. etc.).

Table 5.7: Off-Farm Occupations of the Sampled Farmers

Off- occupation	Frequency	Percent
Farmer	12	46.15
Trader	7	26.92
Employee	4	15.38
Others	3	11.53
Total	26	100

Source: Field Survey, 2016.

5.2 Technical Efficiency Analysis

5.2.1Summary Statistics of Efficiency Estimate from the Stochastic Frontier Model of Small and Large Farms

The summary statistics of variables for the production frontier estimation is presented in Table 5, 8. The table shows that the average total milk produced at studied farms was 4,45E5 and 1,69E5 liters per year with a standard deviation of 218884, 27liters and 127468, 014liters per year for Large and small size farms, respectively. The large variability of the standard deviation implies that the farmers operated at different levels of herd sizes which tend to affect their output levels. The mean herd size (dairy cows) was 45, 18 and 20, 92 animal with a standard deviation of 12,682 and 11,661 per year for Large and small size farms studied, respectively. The mean total family and hired labour used was7, 50 and 3, 79 With a standard deviation of 1,439 and 2,266 per year for Large and small size farms, respectively. The average amount of roughage feed was 5,14E5 and 3,67E5 kg with a standard deviation of 246,408, 87 Kg and 138,590, 34 Kg per year for Large and small farms, respectively. Average amount of concentrates (kg) was 2,12E5 and 1.02E5 Kg with a standard deviation of 60836,192 Kg and 56942, 533per year for Large and small farms, respectively, average health cost (SDG) was 4765.91 and 3647.4, with standard deviation of 2456.449 and 56942.533 per year for Large and small size farms, respectively.

Table 5.8: Summary statistics of efficiency estimate from the stochastic frontier model of studied small and large farms

Variables	Unit	Large Farms		Small Farms	
		Mean	Standard deviation	Mean	Standard Deviation
Total milk produced	Liter	4,45E5	218,884,27	1,69E5	127,468,014
Herd size(lactating cows)	Number	45,18	12,682	20,92	11, 661
Labour	Number	7,50	1,439	3,79	2,266
Quantity of roughage fodder	Kg	5,14E5	246,408,87	3,67E5	138,590,492
Quantity of concentrates	Kg	2,12E5	60836,192	1,04E5	56942,533

Health cost	SDG	4765,91	2456,449	3647,46	2469,206
Age of farmer	Years	38,18	10,381	35,81	10,056
Education level	Years	11,91	4,450	8,95	4,946
Farming experience	Years	16,73	4,52	15,56	6,698

Source: Field Survey, 2016.

5.2.2 The Dairy Farms Technical Efficiency Analysis

Stochastic frontier version 4.1 program (Coelli, 1996) was used to estimate the level of technical efficiency for dairy production. The maximum likelihood (ML) estimate of Cobb-Douglas stochastic production frontier model with assumption of half-normal distribution for small and large farms production efficiency, and technical in-efficiency were presented in table (5.9).

Table 5.9: Maximum Likelihood Estimate for the Parameters of Stochastic Frontier Production Function and Technical Inefficiency Effects Model in the dairy farms

Variables	**Parameters**	**Coefficient** **Large Farms**	**Coefficient** **Small Farms**
Constant	B0	5.536	9.88
Herd Size (No)	B1	1.39**	1.09**
Labor (No)	B2	0.70**	0.022**
Quantity of roughage fodder (Kg)	B3	0.055*	-0.137**
Quantity of concentrates (Kg)	B4	0.040**	0.111**
Health cost (SDG)	B5	-0.07 **	-0.034 **

Inefficiency Model			
Constant	δ0	-0.003	2.026**
Age of farmers (Years)	δ 1	-0.019**	-0.098**
Education Level (No of schooling years)	δ2	-0.004**	-0.169**
Farming Experience (No of years)	δ 3	-0.016**	-0.33**
Sigma square	δ 2	0.21	0.18
Gamma γ	Γ	0.98	99
Log likelihood function	Llf	0.23	14
LR			11
Mean TE		76	60
Min. Efficiency		42	23
Max. Efficiency		96	99.9

Source: Field Survey, 2016.

** Level of significant at 1 percent

* Level of significant at 5 percent

Table (5.9) presents ML estimates of small and large farms. Stochastic frontier and inefficiency effects models in the kuku dairy farms. Most of the estimated β co-efficients of the stochastic frontier model for all farms models have the expected signs.

***Herd size**: herd size is an important factor affecting on dairy yield. The coefficient of herd size has positive sign and significance at one percent level of significant for small and large farms. Positive significant parameter of herd size means that technical efficiency increases with increase in the number of herd size due to increase in number of lactating cows, that means herd size is one of the main determinants of dairy production in Kuku farms. This means that when herd size increases by one unit the technical efficiency increases by1.09 and 1.39 units respectively, for small and large farms.

*** Labor:** the coefficient of labour numbers had a positive sign and significant at 1 percent level of significance for small and large farms. Labour required for carrying out dairy cow activities (drinking, feeding, milking activities). That means labour is one of the main determinants of dairy production in Kuku farms, positive significance means that technical efficiency increases with the increase in labour, this result is conformity with the findings of Adam (2015) and Rania (2001).

***Quantity of roughage and concentrates:** roughage and concentrates feed also is a very important factor affecting production of milk. The coefficient of roughage and concentrates amount has a positive sign and significant at 1% level of significance for small and large farms but roughage had negative sign for small farms, this may be the reason for the use of high amount of roughage than needed, negative sign reflects the bad effects of increasing amount of roughage on production level of milk; similar result was obtained by Pandiana et al (2004) that quantity of roughage had negative sign and significant for small farms.

***Health expenditure:** the coefficient of health expenditure has negative sign and significant at 1 percent level of significance for small and large farms. Negative sign reflects the bad effects of increase of health expenditure on production level of milk; Negative sign parameter of health expenditure means that technical efficiency decreases with the increase of health expenditure due to expenses of more amount of money to care the cattle from diseases or to reduce the infection.

5.2.3Small farms production efficiency

As shown in table (5.10), the mean technical efficiency of small and large farms of dairy production was 0.60 in the small farms, with a minimum of 23% and maximum of 99.9%. This means that on average, the farms produced only 60 percent of output that attainable by best practice, given their current level of production input and technology used. This implies that respondents can increase their dairy output by 40 percent from given mix of production inputs if the farms are technically efficient.

Table 5.10: Frequency distribution of large and small farms technical Efficiency

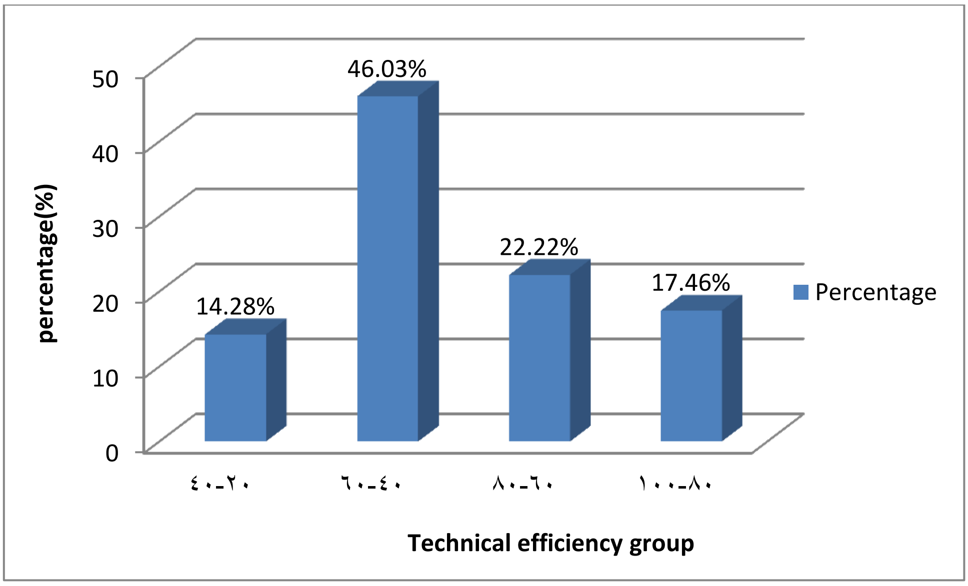
Farm in T E category	Farms umbers	Mean TE	Min. TE	Max. TE
Small Farms	63	60	23	99.9
Large Farms	22	76	42	96

Source: Field Survey, 2016.

5.2.4 Large farms production efficiency

As shown in table (5.10), the mean technical efficiency of large production farms was 0.76with minimum of 42% and maximum of 96%. This means that on average, the farms in the study area produced 76 percent of output that attainable by best practice, given their current level of production input and technology used. This implies that the respondents can increase their dairy output by 24 percent from given mix of production inputs if farms are technically efficient. The mean technical efficiency of small and large farms that presented indicates that the respondents operate at 0.60, 0.76 level of technically efficiency for small and large farms of dairy production, respectively in Kuku (farms). An important result is that the variance ratio parameter γ is large and significant and has a value of, 0.99, and 0.98. This result expresses that about 99and 98 percent of small and large deviations are caused by differences in farms level of technical efficiency as opposite to the conventional random variability.

5.2.5 Frequency Distribution of small Farms Technical Efficiency

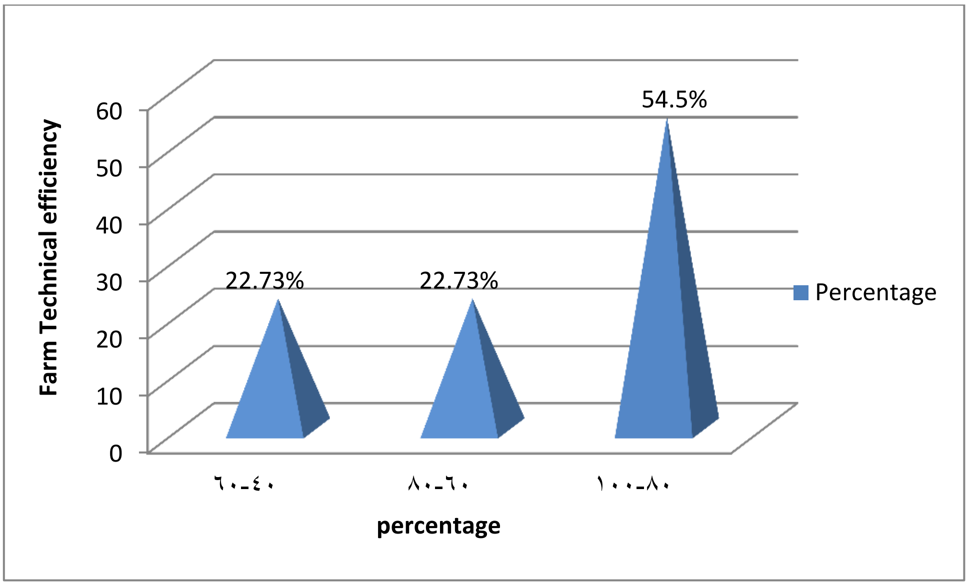


Source: Field Survey, 2016.

Figure 5.1: Frequency distribution of small farms Technical Efficiency

Frequency distribution of small farms Technical Efficiency, dairy farms have a wide range of technical efficiency ranging from 23 percent up to 99.9 percent for small farms. The frequency distribution of the efficiency estimates obtained from the stochastic frontier for small farms (figure 5.1) shows that82.5 percent of the farms operate with efficiency ranging between (20and 80) and 17.5 percent of them operate with efficiency ranging between (80and100). This implies that on average, the small farms producing dairy in Kuku farms achieved almost 60 percent of the potential stochastic frontier dairy production level given their current level of production inputs and technology used. 82.5 percent of small farms model for producers in the Kuku farms operated below 80 percent of maximum of small farms production, obtained by the fully efficient and 17.5percent operated above the 80 percent level of technical efficiency in the small farms model.

5.2.6 Frequency Distribution of large Farms Technical Efficiency



Source: Field Survey, 2016.

Figure 5.2: Frequency distribution of large farms technical Efficiency

Frequency distribution of large farms Technical Efficiency of large dairy farms have a wide range of technical efficiency ranging from 42 percent up to 96 percent. The frequency distribution of the efficiency estimates obtained from the stochastic frontier for large farms (figure 5.2) shows that45.5 percent of the farms operate with efficiency ranging between of 40and80, and 54.5 percent of them operate with efficiency ranging between of 80and100. This implies that on average, the large farms producing dairy in kuku farms achieved almost 76 percent of the potential stochastic frontier dairy production level given their current level of production inputs and technology used. 45.5 percent of large farms model for producers in the kuku farms operated below 80 percent of maximum production, obtained by the fully efficient and 54.5percent operated above the 80 percent level of technical efficiency in the large farms model.

Table 5.11: Estimate ML stochastic Inefficiency Model of Small and large farms in (Kuku Farms)

Inefficiency Model	Co-efficient	Large farms	Small farms
Constant	δ0	-0.003	2.026
Age of farmers (Years)	δ 1	-0.019**	-0.098**
Education Level (No of schooling years)	δ2	-0.004**	-0.169**
Farming Experience (No of years)	δ 3	-0.016**	-0.33**
Sigma square	δ 2	0.21	0.18
Gamma γ	Γ	0.98	99
Log likelihood function	Llf	0.23	14
LR			11

Source: Field Survey, 2016.

** Level of significant at 1 percent

* Level of significant at 5 percent

5.2.7 Inefficiency Model

Table (5.11), presents ML estimates of small and large farms stochastic inefficiency, the estimated δ coefficients associated with explanatory variables in the model for inefficiency effects for the Kuku dairy farms. Most of the estimated δ coefficients of the stochastic frontier model for all farms models have expected signs.

Age of producers: the age of producers have negative sign and significant at 1 percent level of significance for small and large farms. Age has an important effect on productivity and output of the individual as it affects the mental and physical abilities. Negatively significant parameter of age means that technical inefficiency decreases with the increase of age of producers due to accumulated experience and knowledge, this, result ensures the justification of experience coefficient result. The result shows that the inefficiency of small and large farms decreases by 0.098, 0.019 unit respectively, when age of producers increased. , indicating that the technical inefficiency decreases with increasing number of years the producer engaged in animal production, This result is in conformity with the finding of Hamza(2008), Colli and battese(1996) argued that the positive effect of age upon the size of economic inefficiency effects could be expected due to the fact that older farmers are likely to be more conservative and thus less willing to adopt new practices.

Education level: The coefficient education level had negative signs and significant at 1 percent level of significance for small and large farms. A negatively significant parameter of education level means that technical inefficiency decreases with increase in education of farm operators. This is a normal result, which means education adds to producer's knowledge and indicators of their awareness and their abilities of taking decisions on how and what to produce and adopting new technologies (Rahman, 2002).Therefore education, awareness and knowledge reduce the inefficiency, which was the same result obtained by Ahmed(2015).

Experience: the coefficients of experience had negative signs and significant at 1 percent level of significance for small and large farms. A negative sign parameter of experiences of farms means that the inefficiency effects decrease with increase in experience years. This result is in conformity with the finding of Rahman(2002). He found a negative association between the technical inefficiency and farmers' experience. Farms experience show a positive association with farms technical inefficiency, indicating that the technical inefficiency increases with increasing number of years the producer engaged in agricultural production. This unexpected coefficient sign can be attributed to the fact that, farm with relatively high number of years as producers are expected to be relatively old. Old producers may be less educated, as well as, they are more conservative to adopt the new technologies and hence expected to be more inefficient, which was the same result obtained by Ahmed, 2015.

Return to Scale

The return to scale relationship between inputs and output could be seen from the sum of the regression coefficients (elasticities). It is assumed that the sum of elasticities of one, the return to scale is constant, if the sum is less than one; the return to scale is decreasing, and if the sum of elasticities is greater than one indicates increasing return to scale. That means for equal proportion increase in inputs, the response of milk output is at equal proportion, the scale is constant, the response is less than proportional, the scale is decreasing, and the response is greater than proportional, the scale is increasing. The sum of efficiency coefficients (elasticities) for small and large size farms was 1.052 and 2.11, respectively. The scale relationship between inputs and output (return to scale) were in the range of increasing return to scale for all farm size categories. These results indicated that, for 100% increase of the inputs in the production, the milk output would increase by 105% and 211% for small and large size farms, respectively. The increasing return to scale might be the results of economies of scale because of the factors of production may become efficient and more productive

5.3 Linear programming model analysis

5.3.1 Linear programming model's technical input-output coefficients

A total of 23 small dairy farmers (who used traditional feed method), Micro Soft Excel Solver is used to solving linear programming problems

,linear programming models result shows that the least cost feeding plan reduced the ration cost for dairy cows from 32.36 to 13.64 SDG (Table 5.12). The least cost ration only used 4 ingredients compared with 10 in the original feed plan, from 21.04 to 13.79 Kg and 7 kg less was needed to meet calculated requirements than what was originally fed to the cows. The principle component of the least cost ration was sorghum germ meal, compared with sorghum fodder in the original diet.

Wheat bran and Molasses supplied energy and some of minerals were the principal components of energy, while groundnut cake supplied protein. Thus, the feed cost was reduced while keeping the essential source of nutrients for supplying energy, protein and minerals. The producers use 10 ingredients more than the amount of optimal plan.

5.3.2Marginal cost of nutrients

Marginal cost of nutrients or shadow price under the given set of conditions indicates the potentiality of nutrients (Table 5.13). It could be observed that, the activities in the solution at non-zero values have zero shadow prices; those reported at zero level have a negative shadow price indicating reduction in cost by that amount when one unit of the particular nutrient is decreased.

The level of slack activities for protein and energy were 188 and 39kg respectively, which indicated that crude protein and metabolized energy restriction, were completely used (ineffective).This means that the least cost combination of feeds and fodders which meets the requirements, sodium chloride, calcium requirements, phosphorus requirements and stomach capacity, also exceeds the protein and energy requirement by 188 and 39 Kg without any cost implication.

The shadow prices on the slack activities at zero level indicated how much the cost of the ration would be reduced when the constraint is relaxed by one unit.

A decrease in one unit (kg) of (stomach capacity) constraints will result in a reduction of cost by SDG 0.19 in the optimum. The marginal cost of sodium chloride was. 0.18. That is, for every decrease in one unit of restrictions, cost will decrease by SDG 0.81 and vice versa. The marginal cost of calcium and phosphorus were SDG 0.13 and SDG 3.7. This means that for every decrease in one unit of these restrictions, the cost will decrease by SDG 0.13 and SDG 3.7 for calcium and phosphorus, respectively.

Table 5.12: Optimal Plan Compared with the Existing Plan for Daily Feeding Dairy Cow in Kuku Farms- East-Nile locality Khartoum state

Source content	Existing plan		Optimal plan	
	Quantity (Kg)	Cost (SDG)	Quantity (Kg)	Cost (SDG)
Sorghum(Feterita)	2.53	6.439	-	-
Sorghum Germmeal	1.31	1.013	10.29	7.396
Sorghum (Abu70)	4.84	10.65	-	-
Wheat Bran	3.04	5.79	0.735	1.399
Bagasse	4.63	2.33	-	-
Groundnut Bran	1.04	1.174	-	-
Molasses	2.21	2.23	0.962	0.971
Groundnut cake	1.105	2.02	1.807	3.305
Limestone	0.17	0.57	-	-

Salt	0.16	0.65	-	-
Total	21.04	32.36(100.0%)	13.79	13.64(42.2%)

Source: Field Survey, 2016.

Table 5.13: Level of Slack Activities and Shadow Prices for Dairy Cow Diet Nutrients

Particular	Level of slack activities(Kg)	Shadow price(SDG)
Crude protein(CP)	188	-
Metabolize Energy(ME)	39	-
Calcium	-	0.13
Phosphorus	-	3.74
Sodium chloride (NaCl)	-	0.18
Belly capacity	-	-0.19

Source: Field Survey, 2016.

5.3.3 Discussion of L p results

The results of the basic model were compared with the optimal situation. The information obtained from linear programming analysis includes the objective function value and the optimal feed combination.

The existing feeding plan followed by the dairy farmers contained large numbers of ingredients due to which the feed cost was observed to be high. There is an opinion that there is a scope to reduce the feed cost by formulating an optimum feeding plan by minimizing the number of ingredients. Therefore, there is a need to formulate an optimum least cost ration to reduce the feed cost. Least cost feed formulation is a combination of many feed ingredients in a certain proportion to provide the lactating cows with a balanced nutritional feed at the least possible cost.

This study suggested an optimum feed of locally available feed resources at recommended level for minimization of cost for lactating cows. Through the adoption of the plans, it is possible to reduce the feed cost while maintaining a balanced diet for the lactating cows. A number of workers, (Ballal (1994), Brima (2004), Djumaera et al. (2009) and Griffith (2010), have advanced the use of linear programming in formulation of least cost diet plans for dairy animals.

The preference to sorghum germ meal and groundnut cake in the result is due to their high nutrition values, good fodder quality and availability. The groundnut cake in the optimal feeding increased substantially thereby supplying more protein. Groundnut cake has a high crude protein composition for feed formulation.

Molasses and wheat bran can be used in rations to provide energy and some minerals.

Inclusion of wheat bran concentrates in the optimum ration plan is required, in spite of having a higher price per kg than per kg price of sorghum and groundnut bran and Bagasse because it is high in total digestible nutrients. Increase in the cost due to increase in the quantity of wheat bran in the optimal plan is compensated by

Using low cost locally available feed resource like groundnuts bran, sorghum (Feterita), in corporation of molasses in the optimal plan is essential to provide energy and some minerals like Na, Ca and P which are essential for increasing milk production. The dairy animal is more likely to suffer from lack of both Ca and P than from a lack of any other mineral, with the possible exception of salt (www.agriculture.kzntl). Sorghum Germ meal and Molasses supplied mainly the energy while groundnut cake provided the protein.

The shadow price of nutrient constraints in the models implied that, every increase in one unit of the nutrient will result in reduction of their respective shadow prices. In this study, all the nutrient constraints except CP and ME have positive shadow prices when the minimum constraint has been reached. The least cost will be increased by the amount of the shadow price if the minimum constraint is forced to be one unit higher. The zero shadow prices of CP, ME reveals that, the least cost combination of feeds and fodder after meeting all the requirements also exceed the feed requirement by 0.188 and 0. 39 kg without any cost implication.

Cost reduction to the extent of 42.2% is noticed in the optimum plan as compared to the existing plan.

Conclusion

The optimal plan showed how the locally sources of feed are available, cheap ingredients can be combined to formulate a least cost feed plan. The results suggested that, there was considerable reduction in total feed cost in the optimal plan while supplying all the nutritional requirements to the cows. This indicates that, there is considerable scope for minimizing the cost, under the given situations and restrictions. Confronted with the situation of growing resource scarcities at farm level, the result shows that CP and ME are available in excess quantities. The marginal quantities of feed items observed in the optimal plans act as a guide for efficient use of existing resources.

The results of this study can be very important for dairy farmers of the town. The residual amount in dairy feed cost could have impact on reducing farm cost and thus, lead dairy farms to be profitable and help producers to continue in process of dairy production and improve the process and adopt new methods in production to face the job market.

5.4 Profitability analysis (Gross margin)

5.4.1 Cost of milk production

The cost of production refers to the expenses incurred in producing a certain quantity of product in a particular time period. Table (5.14) shows the average costs of large and small farms, in kuku dairy farms. The following items should be considered in calculating the cost of production

5.4.1.1The variable costs of small and large farms:

The variable costs are composed of feeding, labor, drinking water, veterinary services, Zakat, rent and Gotaan taxes …etc. In small, medium and large farms the cost of feeding represents the highest item amongst all variable cost as reflected in table (5.14) below .The cost of feeding accounts almost to 63-67% of the total variable costs in both types of dairy farms.

Table 5.14.Average Variable Cost for Small and Large Farms

Cost item	Cost-small farm(SDG)	Cost- large farm(SDG)
Feeding	390,877	556,759,1
Labor	212,976,5	245,638,3
Veterinary Services	3647,5	4765,9
Water	702,7	680
Rent	6400	6800
Tools and equipment of milking	1843,7	2510,23
Gotaan	850,08	1112,8
Zakat	5704,5	9864
Total	623,002	828,130
Cost of milk production /liter	3.7	2.00

Source: Field Survey, 2016.

1. **Feeding**

Many studies of costs of milk production confirm that, the cost of feeding represents about 86% of the total costs (Madalia and Charan, 1975). Another study indicated that feeding constitutes more than 90% of the total costs of production in most of the traditional dairy farms and more than 60% of costs in modern dairy farms (Soad, 1994). In this study, the cost of feeding appears to be the primary item affecting the productivity in both small and large farms.

The cost of feeding constitutes about 63%and 67% of the average total cost in small and large farms, respectively. On average, feed cost was 390,877 SDG, and 556, 759, 1 SDG in small and large farms, respectively .It was clear that, the cost of feeding/animal/year differ greatly between these types of farms. This result indicates that the cost of feeding in large farms was higher than cost of small farms, this means that the producers in large farms purchase a lot amount of feed, because of the higher total number of heads than small farms.

2. Cost of Veterinary services

Veterinary services are very important in milk production, especially in the rearing period when diseases can cause great losses in animals if not vaccinated. Thus, it is very important to protect flocks by sound vaccination, vitamins, drugs and periodic use of antiseptics to avoid the great loss (Intisar, 1995).

This cost is incurred to meet the medicinal care of livestock. This is considered crucial in the case of milk production. The cost of veterinary services includes the cost of drugs and vaccines, in addition to cost of the veterinarian services. Generally, the producers obtain their requirements of vaccines from the official veterinary service offices.

The cost of veterinary services was found the same in large and small farms.

According to the result, the average, cost of veterinary services/animal/year was about (3647, 5) SDG in small (1%) of total cost and (4765,9) SDG in large farms (1%) of total cost. table (5.14)

3. Cost of Labour

In this study, labours include milk collectors, technicians and mangers. Labours tasks in dairy farming work in feeding, watering, cleaning, milk collection in addition to application of drugs and vitamins . Many producers stated that, labours represent a big problem to them because some workers do not perform their jobs (tasks) perfectly.

The result showed that, the minimum average wage rate is (3100) SDG per month. On average labor cost /animal/year was found to be (212, 976, 5) and (245, 638, 3) SDG in small and large farms, respectively. This cost constituted about (34%) and (30%) in the two categories of farms, respectively. The small farms had greatest labour cost than large farms, this because small farms hold a largest of labour to works and to service their animal, largest numbers of farms need great amount of labour.

4. Cost of Water

Most of the producers have artesian wells and few of them get their supply from (channel) and national corporations. On average, the cost of water/animal/year was (702) SDG in small farms represent (0.1%) of total cost, and (680) SDG in large farms represent (0.1%) of total cost of production. This small difference was attributed to the fact that, the small farm paid the same price that paid by the large farms.

5. Gutaan tax:

It is an additional fee paid by livestock owners to the government. Similarly, the Gutaan taxes in the (large) farms were found to be higher than in the case of the small farms. Again this rate of fees is levied on the number of heads of animals raised by one person.

On average, tax on unit per year was 850, 1 SDG in small farms and 1112, 8 SDG in large farms. This cost accounted about 0.1 % and 0.1% of the average total cost in in small and large farms, respectively in Khartoum state.

6. Zakat

It is a religious fee paid by livestock owners to the government in a specified amount of money per head when the total number of heads reaches a minimum level of 30 heads by type of livestock.

The volume of Zakat in large farms was larger 9863,6 SDG than the small farms 5705SDG with 1% and 1% percent, respectively.

5.4.2Total Costs of production

Among the variable costs, feed cost was found to be the higher cost component with 390,877SDG (63%) and 556, 759, 1 SDG (67%) on small and large farms, respectively. Human labour was the next component with 212, 976, 5 SDG (34%) and 245, 638, 3 SDG (30%) on the corresponding farms. Rent cost amounted to 6400(1.1%), and 6800 SDG (1%) on small and large farms, respectively. veterinary services cost 3647, 5 SDG (1%) and 4765 SDG (1%) on small and large farms, respectively. Tools and equipment cost 1843, 7 SDG (0.3%) and 2510 SDG (0.3%) on small and large farms, respectively.

On average, the total cost of milk production/ animal/year was highest in large farms at 828,130 SDG and lowest in small farms at 623,002 SDG.

The average cost of milk production per liter was about 3,7SDG/liter in the small farms, while it was 2, 00SDG/liter in large farms

Large farms had the highest cost of production due to high costs of feed used (Table 5.14).

In small farms, the low cost of production was attributed to low rent expenses.

5.4.3Analysis of milk returns:

5.4.3.1 Gross returns of small and large farms:

The gross returns of both farms are calculated by multiplying the quantity produced for sale by its respective price. The items produced for sale included milk, calves, old cows and cattle dung. Below is given the items in details (table 5.15).

The average gross returns of milk production per farm/year was about 1,309,708 SDG/year in the small farms, while it was 3, 201, 387, 84 SDG/year in large farms. This result was attributed to the relatively higher productivity observed earlier in large farms.

Table 5.15: Revenue of small and large farms

Items	Small farms	Large farms
Sale of milk	1,270,986	3,201,387,8
Sale of calves	22602,92	33238,64
Sale of old cows, cattle dung	16119,05	14181,8
Total gross returns	1,309,708	3,248,808,3
Total variable costs	623,002	828,130,00
Gross margins(net returns)	686,706,4	2,420,678,3

Source: Field Survey, 2016**.**

1. Gross returns from sale of milk:

Milk is the main product in small and large farms. The gross returns of milk production was found to be higher in the large farms and low in small farms, the large farms used large numbers of milking cows.

However, it was observed that milk yield per cow was higher in the case of large farms as they select and raise improved cattle breeds, in addition to performing better management. The gross return obtained by multiplying the quantity of milk produced for sale by its price.

2. Gross returns from sale of calves:

This is a primary product of the two types of farms. Similarly, it was observed that the gross returns obtained from the sale of calves were higher in the case of large farms than in case of small farms. This is because farmers in the large farms keep the calves for sometimes and feed them until have high value in the market, whereas in the case of small farms they have amount of cows and farmers sell them immediately after fasting at low prices.

3. Gross returns from sale of old cows and cattle dung:

This is also an important source of additional revenue to the cattle farms. From (table 5.15) above, it observed that the gross returns of old and dung cattle was higher in the case of small farms than large farms. This is because small farms are save old cow than large farms and therefore were expected to have larger numbers of old cows and dung that were offered for sale.

5.4.3.2 Gross margins

Gross margins measure the difference between gross returns and total variable costs. In this study, as depicted in table (5.15) the average gross margins value for the small and large farms was found to be 686, 706, 4 and 2,420,678, respectively. The gross margins value of large farms was higher than small farms. This is due to the large farms had larger numbers of milking cows (table 5.15).

Revenue in a dairy enterprise accrues from sale of milk and animals. There were differences between returns in small and large farms. The returns were lowest in small 686,706,45SDG and highest in large farms at

2,420,678, 3 SDG /liter (Table 5.15). The high returns in large farms were due to big amount of milk produced. The large farms evidently received better income and could able to reduce the cost comparatively. It is due to higher milk yield in large farms because of large herd size and better management practices.

5.4.4Farm profit

The profit rate ratio was about 2.1 and 3.92 in small and large farms, the revenue covers the cost in all sampled farms in study area. This result is comparable with finding of Soad (1994) and Rohr (1991). Soad (1994) said that "an adequate profit can only be realized when the average cost/unit of product is minimized''. Rohr (1991) stated that "as feed cost constitutes the greatest portion of total cost in ruminant production, it is important to make maximum use of the cheapest source of feed. Consequently, replacement of some of the concentrate feeds with lower cost forage is an essential requirement on farms with sufficient area of fodder crop.

5.4.5 Budget analysis

Budget may be defined as a detailed quantitative statement of farm plan, or change in farm plan, and the forecast of its financial situation (Ahmed, 1995).

Farm budget for milk production for small and large farms is presented in table (5.16).

Table 5.16: Budget analysis of milk production of small and large farms in Hilat Kuku

Cost item	Cost-small farm(SDG)	Cost- large farm(SDG)
Feeding	390,877	556,759,1

Labor	212,976,5	245,638,3
Veterinary services	3647,7	4765,9
Water	702,7	680
Rent	6400	6800
Tools and equipment of milking	1843,7	2510,23
Gotaan tax	850,05	1112,8
Zakat	5704,5	9864
Total variable costs	623,002	828,130
Total gross returns	1,309,708	3,248,808,3
Gross margin(net return)	686,706,4	2,420,678,3
% of return /costs	2,10	3,92

Source: Field Survey, 2016**.**

5.5 Forecasting analysis (ARIMA model)

5.5.1. ARIMA model

Table 5.17 shows the yearly milk production for the period 1989/1990 to 2017/018. Figure 5.3 of milk production revealed that there is an increasing trend in milk production from2017/018 to 2030/031(figure. For a precise performance of a forecasting model, it is necessary to make adjustments to the parameters for each technique. Within this context, for the application of ARIMA model, the data adjustments were generated by SPSS statistical software for 13 periods, in defining the components of level, trend, and a tool contained in the Excel software. As demonstrated in (Table 5.17), the ARIMA model, due to the lower value of MAPE, the following adjustments parameters (p, d, q) were considered as shown in Table 5.18.

ARIMA model the stationary check of the series revealed that it was non-stationary. Using the first differencing technique, it was made stationary (Fig. 5.4) and thus the value of d was 1. The graphs of sample ACFs and PACFs were plotted (Fig. 5.5 and 5.6). On matching plots with the theoretical ones of various ARIMA processes, the PACF of AR (1) compared well with the sample PACF as spikes cut off after lag 1. Hence, the order of AR component P was taken as 1.Plot of differenced series over years (Figure 5.6).

Table 5.17: Milk Production in Khartoum State for the Period 1989 to 2018.

s.n	Year	Milk production(million ton)
1	1989	4. 95
2	1990	4.99
3	1991	5.02
4	1992	5.49
5	1993	5.52
6	1994	5.55
7	1995	5.58
8	1996	5.61
9	1997	5.64
10	1998	5. 67

11	1999	5. 70
12	2000	5.73
13	2001	5.79
14	2002	6.24
15	2003	6.27
16	2004	6.30
17	2005	6.31
18	2006	6.29
19	2007	6.02
20	2008	6.05
21	2009	6.09
22	2010	6.12
23	2011	6.27
24	2012	6.27
25	2013	5.99
26	2014	6.27
27	2015	6.37
28	2016	6.46
29	2017	6.81

Source: Ministry of Agriculture and Animal Resource, Khartoum, 2018

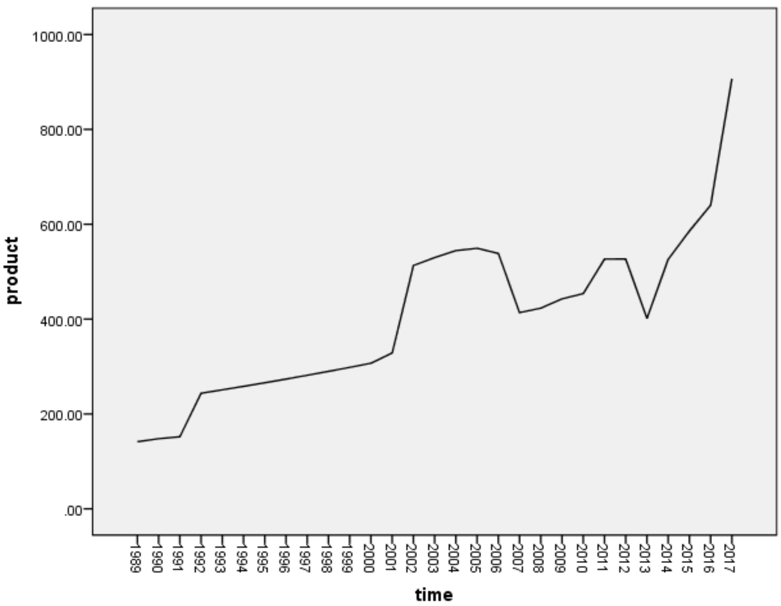


Figure 5.3: Khartoum milk production in (million tons) over years

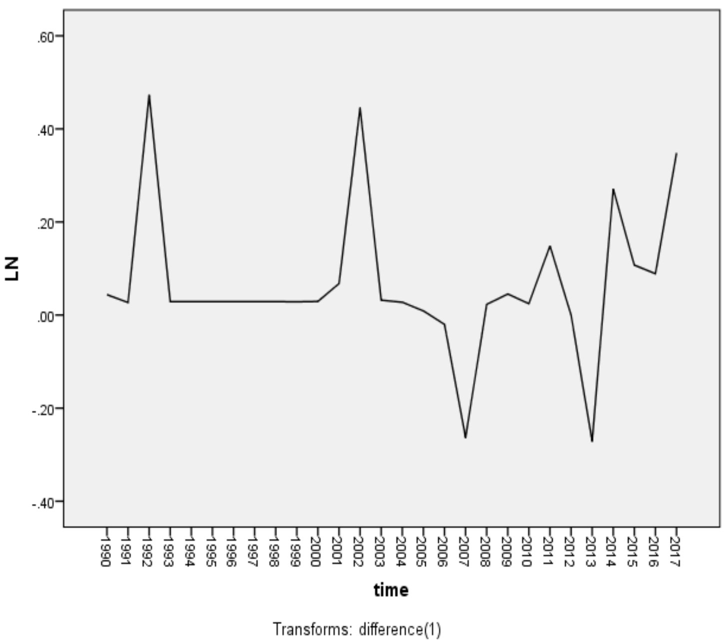


Figure 5.4: Difference Series over the Year

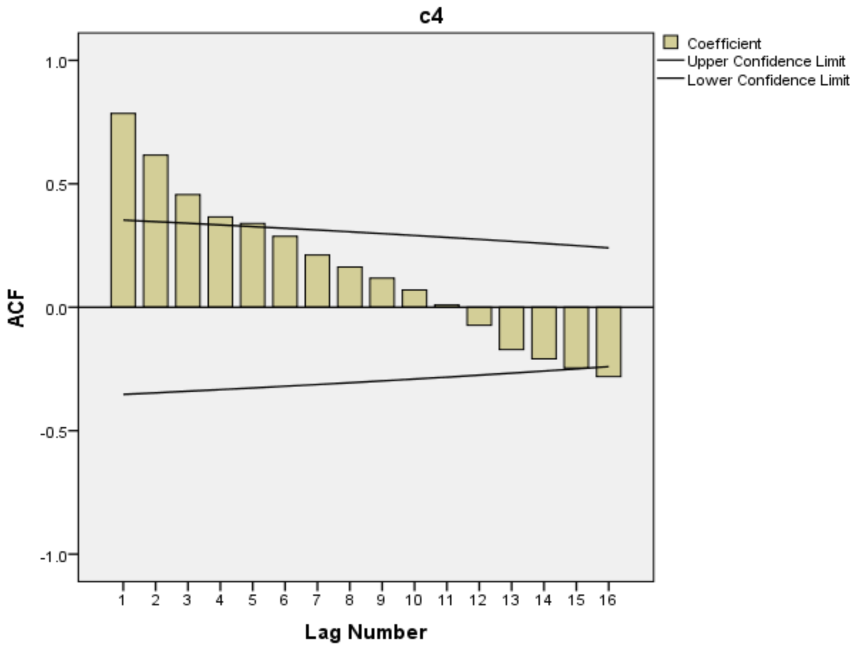


Figure 5.5: Auto-correlation function in ARIMA model

Source: data analysis -SPSS

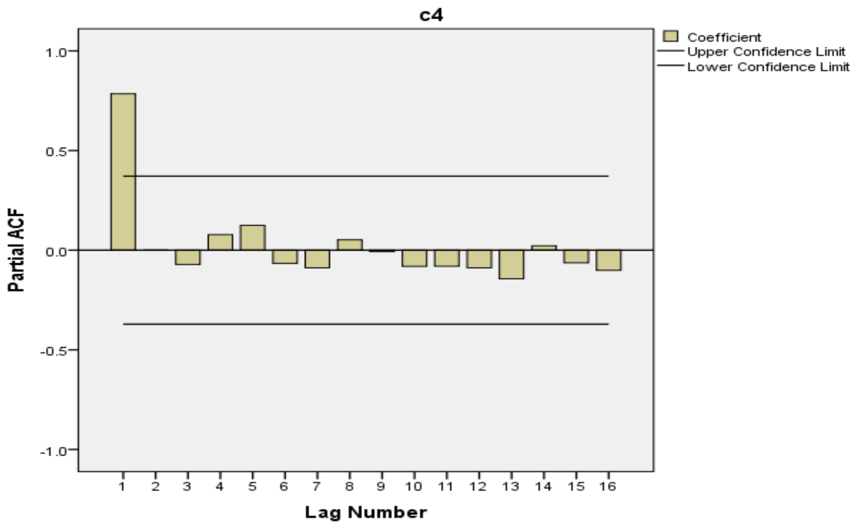


Figure 5.6: Partial Auto correlation Analysis
Correlation and autocorrelation residue analyses
In the ARIMA model
Source: data analysis -SPSS

Table 5.18: ARIMA parameters (Adjustment parameters) Forecasts of Milk Production in Khartoum State- Sudan using ARIMA parameter (p,d,q) models.

s.n	Year	Lcl	Ucl	ARIMA(1.0.0)
1	2018	6.50	7.18	6.84
2	2019	6.46	7.30	6.87
3	2020	6.47	7.38	6.92
4	2021	6.50	7.44	6.97
5	2022	6.54	7.50	7.02
6	2023	6.59	7.56	7.07
7	2024	6.64	7.63	7.13
8	2025	6.70	7.69	7.19
9	2026	6.76	7.75	7.27
10	2027	6.81	7.81	7.31
11	2028	6.87	7.87	7.35
12	2029	6.93	7.94	7.43
13	2030	6.99	8.00	7.49
MAPE				1. 611
RMSE				0.156

Source: Data Analysis -SPSS

The forecast adjustments were made from 1989 to 2018 in order to project future forecast for the year 2030, in the 13 period as shown in table 5.18.

Also, in order that the proposed model adequately represents the data and at the same time have lesser number of parameters, an MA component of order 1 was also added to the Model. In addition, using SPSS package for different values of p and q (0.1 or2), various ARIMA models were fitted and the appropriate model was choosing corresponding to minimum value of selection criteration. e.g Akika Information Criteri in this way ARIMA(1.0.0) model was found to be the best model (table 5.18).

The fitted model is given by

$Y=\delta+\alpha iYt-i+u$

For this model, the MSE came out to be 0.156 which is less than that fitted model. MAPE and RMSE were comparison of the results revealed that among the models fitted; ARIMA (1, 0, and 0) model came out to be performing better when the forecasts were validated.

Based on Table 5.18 and on model performances, the (ARIMA) model, according to MAPE. The actual production in 2030(Period2018 -2030), according to data shown in Figure 5.6, the ARIMA achieved an accuracy of 1,611% MAPE and. within this context, the model reached a compatible performance for the time series analysis. For Lewis, a MAPE below 10% is considered a good forecast (Pankratz; (1938).The figure 5.7 shows forecast from 2018 to 2030).

Forecasting from 2018 to 2030

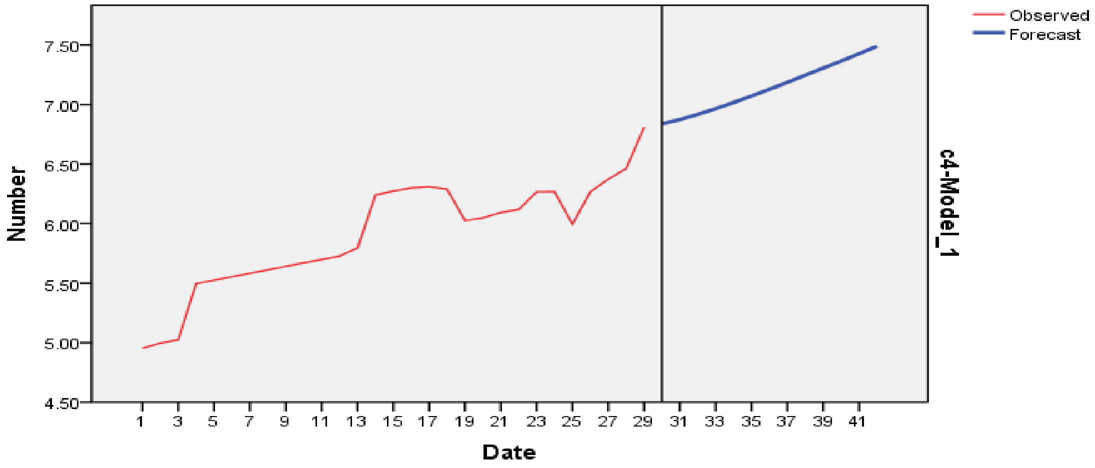


Figure 5.7 Actual production and application of ARIMA Model
Period: 1989 to 2030
Source: data analysis SPSS.

CHAPTER SIX

Summary, Conclusions and Recommendations

This chapter includes summary, conclusions and recommendations

6.1 Summary

This study was conducted in East-Nile locality in Khartoum North. The main objective of this study was to analyze the resources use in dairy production in Kuku dairy farms, more specifically were to: study socio-economic characteristics of producers, estimate production and profitability of milk production, forecasting of milk production in Khartoum State and also evaluate producers technical efficiency and investigate the main factors behind their technical inefficiency in producing milk, and determine the optimum feed combination that minimizes producers costs. Both primary and secondary data were used for the study purposes. Primary data were collected through a structured questionnaire using sampling techniques. A sample of 85 producers was selected during 2016-2018; secondary data were collected from different relevant sources.

To achieve the objectives of study a variety of analytical techniques were applied, tabular as well as general descriptive statistics, a gross margin analysis, Stochastic Frontier Production Function and linear programming models and ARIMA forecasting models use.

6.2Summary of the main results

The descriptive statistics of socio- economic characteristics, showed that the average age of the sampled producers was36 years. Most of the producers 96.4% with in active age of (18-65). Most of the producers (92%) have attained some sort of education. This means that about 47%of the producers received good education. Average family member working in farms was found to be14 persons. All surveyed farms were managed by males , about 98% of the producers were married. The stochastic frontier production function analysis revealed that mean technical efficiency of producers was 60% and 76% for small and large farms, respectively. This shows that there is scope for increasing 60 and 76 productions by 40% and 24%, respectively with present technology.

Analysis of the determinants of technical efficiency indicated that herd size, labor, amount of roughage and concentrate, veterinary expenditure were significant variables for improving technical efficiency. Education level, experience years and age of producer were significant in explaining technical inefficiency in Kuku farms.

The results of the optimal plan were compared with actual plan, it is clear that most of the feed including sorghum germ meal, wheat bran, molasses and groundnut cake enter in the optimal plan. Sorghum feterita , sorghum hay(Abu70), Bagasse, groundnut bran, limestone and salt did not enter in the optimal plan. In the optimal plan sorghum germ meal, used about 10.29 kg, followed by groundnut cake 1.81 kg, molasses 0.962and wheat bran 0.735, the level of resource used revealed difference between the actual total plan and optimal total plan. Which were 21.04Kg and 13.69 kg, respectively.

The profitability analysis results of dairy production are (2.1, and 3.9 small, and large) farms. There records showed the highest total costs and gross margin per farms in large farms than small farms.

6.3 Conclusions

The study concluded that, most of the producers in Kuku farms were in the active age group, attained some sort of education, and most of them were married and had good experience in the dairy farms. The producers' socio-economic characteristics had positive effects on technical efficiency of producers in Kuku dairy farms. More than 99and 98% of small and large farms of the dairy production deviation among the producers were caused by differences in producers level of technical efficiency. Also, the results revealed that herd size, labour, roughage, concentrates and health expenditure were significant variables for improving technical efficiency,

The study showed that the increase of roughage and health expenditure had negative effects on production level of small large and farms.

The results of LP models revealed that the total farm cost in the optimal model was less the current situation .Costing (32.36 to 13.64) less than routine feeding plan followed by the farmers, reducing the feeding cost by 42.15% as compared to the existing ration plan followed by the farmers. Trend milk forecasting is increasing over years.

6.4 Recommendations

Based on the findings of the study, the followings are recommended.

1. Adoption of the recommended improved technologies.
2. Raise the current level of efficiency of producers.
3. Government policy should focus on ways to attract and encourage young investment in dairy production.
4. More coordination between producers in Kuku farms and Ministry of Animal Wealth, and Ministry of Agricultural and Animal Resource and Irrigation to provide and strengthen veterinary and extension services.
5. Encourage participation of the family labour and / or adopting policies which facilitate hiring labour e.g. allocation of more funds for recruitment, increase wage rate, provision of better services.
6. Also, the livestock farmers should be given assistance in form of loans in order to cope with the increasing costs of inputs.

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APPENDIXIES

بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

قسم الاقتصاد الزراعي

بحث لنيل درجة الدكتوراة في الاقتصاد الزراعي

بعنوان:تحليل اقتصادي للموارد المستخدمة في انتاج الالبان بولاية الخرطوم

استبيان

أ) المعلومات الاساسية

1. الاسم او الرقم
2. القرية او المدينة:
3. العمر:
4. الحالة الاجتماعية:

متزوج( ) عازب( ) مطلق( ) ارمل( )

5. عدد افراد الاسرة الذين يعملون معك:
6. عدد سنين الدراسة:
7. المهنة الرئيسية:

مزارع( ) مربي ابقار( ) تاجر( ) موظف( ) اخرى حددها( )

8. عدد سنين مزاولة المهنة الرئيسية:
9. المهنة الثانوية:

مزارع( ) مربى ابقار( ) تاجر ( ) موظف ( )
اخرى حددها( )

10. سلالة الابقار:

هجين(كنانة+فرزين) ( ) هجين(بطانة+فرزين) ( ) فرزين( ) كنانة( )
بطانة ( ) اخرى حددها( )

ب) تركيب القطيع

1.تركيبة القطيع

البند	عدد الذكور	عدد الاناث
منذ الولادة حتى عام		
من عام الى ثلاثة اعوام		
اكثر من ثلاثة اعوام		

2.عدد ابقار اللبن

جافة الحلوب

اكثر من ثلاثة سنوات

3. عدد مرات الولادة فى عمر البقرة --

4.متوسط العمر عند اول ولدة --

ج) التكاليف:

i .الحظيرة

1.نوع الحظيرة :ايجار ( ) ملك( )

2. اذا كانت ايجار ماهى التكلفة ------------------------جنيه/الشهر

3.اذا كانت ملك التكلفة هى

التكلفة ج/السنة

تكلفة انشاء الحظيرة

تكلفة الشراء او الحيازة

ii. العمالة الدائمة والمتغيرة

1. هل لديك عمالة نعم ( ) لا( )

2.اذا كانت الاجابة بنعم

الوظيفة	العمالة الدائمة		العمالة المتغيرة	
	العدد	الاجرة جنيه/الشهر	العدد	الاجرة جنيه/الشهر
مدير				
حلاب				
كلاف				
خفير				
راعى				
اخرى حددها				

iii. القطيع:

1. مصادر القطيع:

شراء ( ) ورثة ( ) هبة ( ) اخرى حددها ( )

2. اذا كان المصدر شراء ماهى التكلفة:

من الولادة حتى عام		من عام حتى ثلاثة اعوام		اكثر من ثلاثة اعوام	
العدد	سعر الوحدة	العدد	سعر الوحدة	العدد	سعر الوحدة

vi. المياه:

1.مصادر المياه حسب الاستهلاك:

ابار ( ) ترعة ( ) مواسير( )

2. متوسط تكلفة المياه للقطيع -----------------------------جنيه/الشهر

vii. الادوات والمعدات:

الادوات والمعدات	العدد/السنة	سعر الوحدة
معالف		
شرابات		
ادوات حليب		
اخرى حددها		

viii. التطعيم والادوية والعلاج والمطهرات

ا. التطعيم

1. هل تقوم بتطعيم القطيع ضد الامراض المختلفة؟ نعم ( ) لا( )
2. اذا كانت الاجابة بنعم ماهي تكلفة الفاكسينات والامصال للقطيع ------------------------- جنيه/العام

ب. العلاج والادوية والمطهرات

1. هل تقوم بشراء الادوية المختلفة لعلاج البهائم المريضة؟ نعم ( ) لا( )
2. هل تقوم باستخدام المطهرات والمواد المعقمة؟ نعم( ) لا( )
3. اذا كانت الاجابة بنعم ماهى التكلفة
4. هل يقوم الطبيب البيطرى بزيارة المزرعة؟ نعم ( ) لا( )
5. اذا كانت الاجابة بنعم ماهى التكلفة

متوسط عدد الزيارات فى العام تكلفة الزيارة الواحدة التكلفة الكلية/العام/القطيع

6. ماهى طبيعة الاشراف؟ دائم ( ) دورى( ) حسب الحوجة( )

viiii. القطعان

1.هل تدفع الض
2.كم تبلغ الضـ
3.هل تقدم لك الدولة خدمات نظير تلك الضرائب؟ماهى
4. كم تبلغ الزكاة التى دفعتها؟
5.هل هناك اى غرامات مدفوعة خلال هذا العام؟ نعم ( ) لا ( )
6.اذا كانت الاجابة بنعم كم تبلغ؟-----------------------------جنيه/العام
7.هل هناك رسوم اخرى تقوم بدفعها؟ نعم ( ) لا( )
8.ماهى تكلفة الرسوم المختلفة؟-----------------------------جنيه/العام

x. العليقة

1.هل تستخدم المكزات فى تغذية الابقار الحلوب؟نعم ( ) لا ( )
2.اذا كانت الاجابة بنعم ؟ماهى نوع المركزات التى تستخدمها
3.هل تستخدم الاعشاب المالئة؟ نعم ( ) لا ( )
4.اذا كانت الاجابة بنعم ؟ماهى نوعها

تركيبه العليقة	منذ الفطام حتى عام		عام حتى 3 اعوام		اكثر من 3 اعوام	
	الكمية	التكلفة/الشهر	الكمية	التكلفة/الشهر	الحلوب	الجافة
البرسيم						
ابوسبعين						
امباز الفول						
امباز السمسم						
امباز بذرة القطن						
المركزات						
الفايتمينات والاملاح						
اخرى						

د) العائدات

1.متوسط عدد ارطال اللبن

متوسط عدد الابقار الحلوب	متوسط حلبة الصباح للبقرة(رطل/للبقرة/اليوم)	متوسط حلبة المساء للبقرة(رطل/ للبقرة/اليوم)

2.متوسط سعر الرطل عند باب المزرعة-----------------------------جنيه/الرطل

3.متوسط فترة انتاج اللبن للبقرة في العام---------------------------------يوم/العام

ج) الاسلوب الانتاجى

1.انواع الاسلوب الانتاجي المفضل لديك؟ أ/انتاج تقليدى ( ) انتاج متخصص( ) اخرى حددها( )

2.هل من السهولة الحصول علي انتاجية عالية؟ نعم ( ) لا ( )

3.اذاكانت لا ماهو السبب ---

-4.هل نقص الكوادر الارشادية المدربة لها تاثير مباشر على الانتاجية؟ نعم ( ) لا ( )

5.اذا كانت الاجابة بلا ماهم السبب---

6.ماهى المشاكل التى تواجهك من الحصول على انتاجية عالية

7.من وجهة نظرك ماهى الحلول لهذه المشاكل