CHAPTER ONE

INTRODUCTION

1.1Sugar cane harvest process:

The sugar cane harvest typically prologues in May, sometimes April and begins to November, the time of the year when the sugar cane plants normally reach their maturation peaks. The maturation of sugar cane is measured in percentage of sucrose in the sugar cane, denoted to Poll and reduced sugar, denoted to AR. The maturation periods vary widely around the world from six to 24 months.

Manual and mechanical cutting crews cut the plants on the fields, chopping down the stems but leaving the roots to re-grow in time for the following harvest. The harvest is then immediately transported to the industrial sector, i.e. sugar cane mills, by trucks, rail wagons or by manual carriage

Sugar cane grows for 12 to 16 months before being harvested between June and December each year. When harvested, the cane stands two to four meters high. Queensland's sugar cane is harvested by self-propelled harvesting machines. Some growers contract machine owners to harvest their crop, while others own their machines or share ownership with other growers.

There are two methods used to harvest cane. In some cane-growing areas it is possible to harvest the cane green. The left over cuttings form a mulch which keeps in moisture, stops the growth of weeds and helps prevent soil erosion. In other areas, the sugar cane is burnt to remove leaves, weeds and other matter which can make harvesting and milling operations difficult In both processes the harvester moves along the rows of sugar cane removing the leafy tops of the cane stalks, cutting the stalks off at ground level and chopping the cane into small lengths called 'billets'. These are loaded into a haul-vehicle travelling alongside the harvester. The cane is then taken to a tramway siding or road haulage delivery point for transport to the mill.

After harvesting, the stubble left behind grows new shoots, producing a "Raton" crop. Two or three ratoon crops can be grown before the land is rested (or planted with an alternative crop such as legumes), ploughed and replanted for the cycle to start again.

(www.bundysugar.com)

Problem:

Problem may be summarized in the following points:-

Un availability of labor to harvest sugarcane in some of the sugarcane projects at the right time , Mechanical harvesting of sugarcane lack availability of machine and experienced labor.

Objectives:

Evaluation of sugarcane combine harvester used in aljoined scheme. This evaluation included :-

Actual and theoretical field capacities , Field efficiency Losses , which included the remainder of the cane after harvest , Fuel consumption and productivity.

CHAPTER TWO

Literature Review

2.1Introduction:

Prior to the secession of the South Sudan, agriculture represents the main sector of the economy in Sudan. It contributes over 30% of the national gross product and more than 95% of the foreign trade (Bank of Sudan, 2010).

In actual fact agriculture provides a living for more than 50% of the population. Future economic development is also based on agriculture, because out of 84 million hectares of cultivable land only 15% is under cultivation. According to (Mohammed 2011) the secession of Southern Sudan has deprived the country of 25% of its total area, 24% of population, over 80% of its oil income. Moreover, it has separated with 75% of it vegetation cover and 30% of potential arable land. In addition, Sudan stands to tolerate at least 25% of its water resources. Economic situation precarious with the Darfur rebellions, the inception of Southern Kordofan’s region civil strives and the inflamed complaints in its Blue Nile region. That resulted besides deprivation of oil revenues and other potentials to increased cost of national security and expenditures on additional revenues to meet such funds for securing peace (Mohammed, 2011).

Under these adverse economic conditions, the sugar industry in Sudan is well established with proven track records on production efficiencies and technological advancements.

Since the establishment of the first sugar factory in 1962; the domestic sugar industry has sustained steady growth and expansion. In addition to progressing on the knowledge and expertise accumulated over its 50 years history, the Sudan sugar industry is also advancing amid global technological developments in the fields of bio-energy: cogeneration and ethanol (Federal Ministry of Agriculture, 2010).

Sugar is considered as one of the major strategic commodities in the country, sugar production started for the first time in Gunied (1962–1963). Later other sugar factories came into operation at New-Halfa (1965–1966), North West Sennar (1976–1977), Assalaya (1980–1981), Kenana (1980–1981), and finally White Nile Sugar Company (2004).

This improvement in performance and the increase in the rate of crushing made the harvesting and transportation of sugarcane to the factory an important factor for the success of the season.

Sudanese Sugar Company in the last ten years incurred a high cost in harvesting to attract the labor, the price per unit land increased year after year plus some incentives are paid but still the labor shortage occurs at the time of the peak sugar content (October–November). This could attribute to the acute competition between sorghum and sesame harvesting and sugarcane harvesting on the available labor force taking into consideration that cutting sugarcane is a physical exhausting task that demands a high level of muscular strength and resistance, vigorous men take this job under stressful conditions and use their force to the level of exhaustion as they are paid by production, not by earning fixed wages. Due to this tough nature of work most of the labor prefers working in other crops rather in sugarcane fields.

The problem of labor shortage lead to introduction of mechanical cane harvesting to overcome the scarcity of labor and to control the rising labor wages since late 1980 during the period of labor unavailability.

Sudanese Sugar Company introduced mechanical harvester properly to cover about 30–40% of the total area under harvest in each season since the year 2000, the uncertainty of the constant daily cane supply associated with manual cane cutting was the reason behind the increase of the mechanically harvested area.

As a result of comprehensive peace agreement (CPA) and finally the secession of the South Sudan in July, 2011 and anticipation of funds from donors to develop war affected areas in Kordofan and Darfor, besides the developing oil industry in various parts of Sudan affected the labor market and it is expected that this environment may encourage many of the labors to return home or some of them may seek other jobs better than cane cutting especially with the vertical expansion in sugarcane yields in all factories which make the manual cane harvesting (hand cutting) more difficult for them.

In Brazil, sugarcane can be harvested manually or mechanically. Almost all manually harvested sugarcane fields are burned before manual harvesting to reduce harvesting costs and labor (Jeongwoo , 2012). He added that, on the other hand, mechanically harvested sugarcane fields can be either burned or unburned. According to(Macedo 2008) and (Seabra 2011), the fraction of mechanically-harvested fields that are unburned is rising along with the total share of fields that are unburned and it is expected that all mechanically harvested fields will be unburned in the near future.

To overcome the problem of labor shortage Sudanese Sugar Company started to increase the mechanically harvested area. Hence the present paper aimed at analyzing sugarcane harvesting systems namely hand cut and the mechanical loading vs mechanical harvest (cut and load mechanically), with regard to productivity, cost effectiveness, cane loading tonnage, cane losses and trash percent in Sennar sugarcane factory

Sugarcane is the source of sugar in all tropical and subtropical countries of the world. Several species of Saccharum are found in Southeast Asia and neighboring islands and from these cultivated cane probably originated.

The total area of sugarcane grown in the world is about 20.3 million hectares. The total production is about 1325.6 million tons at an average productivity of 65.3 tons per ha. Many factors affect the yield of sugarcane such as variety, soil, plant husbandry, climate and age of the crop.

Historically, Sudan has been importing thousands of tons of sugar each year, at a substantial cost in precious foreign exchange. It was strongly felt that with its abundant natural resources, Sudan could prevent the outgo of precious foreign exchange and invest the same in setting up a massive and profitable sugar-producing complex.

Manual harvesting will continue for years in Asia and South America having available labor, or where the irrigation systems interfere with machinery as the case of India. In this system the cane is cut by manual labor using cutting blades. And then put in rows and loaded into trucks or tractor trailed trailers to deliver it to the mill. Manual cutting of cane leaves some centimeters above the ground that result in the following:

1. Provide hiding places for stem borers.
2. Poor tiller development.
3. Tiller will depend on the root system of the parent plant.

There are many advantages of manual cutting:

1. The prices are paid in local currency.
2. Labors assist in other operations such as cane planting.
3. Manual harvesting has an essential role if mechanical harvesting faced economical or political

problems in importing machines or spare parts. The cane cutters cut the cane at the ground level and stack it in windrows. Each windrow encompasses six successive furrows. The cane is neatly stacked on the two middle furrows in perpendicular position to the furrow so that the loader will be able to operate at maximum efficiency.

The cutters also cut the tops of the cane.

In many countries the crop is cut and loaded manually. It is estimated that only about 20% of more than thousands million tons of sugarcane produced annually around the globe is mechanically harvested, mostly by combine harvester. Chopper harvesters were used successfully, and were operating in more than 20 countries. In a large proportion of the crop the two methods of harvesting were combined. That is manual cutting and mechanical loading using a wide range of slewing and

non-slewing grab loaders . With the combine harvesting system a loader and a transloader is generally not needed. A truck or tractor pulling some type of self- dumping wagon runs parallel in the field besides the harvester. The combine cuts one row of cane per swath. Sugar stalks are cut into 300-360 mm (12-14 inch) billets

and loaded into the wagon. The loading is performed by a combine-mounted elevator. An extraction fan system on the harvester strips and removes leaf material and other extraneous matter from the

cane prior to loading into trucks and trailers.

One of the major advantages of combine harvesting is the high percentage of cane recovery in the field particularly in lodge cane (Salassi et al 1996). Machines can only be used where land conditions

are suitable and the topography is relatively flat. In addition the capital cost of machines and the loss of jobs caused make this solution unsuitable for many sugar estates.

There are many advantages of mechanical cane cutting:

1. Available at any time if the maintenance is done sufficiently and timely
2. Harvest high productive areas very efficiently.
3. Deliver the cane fresh in less than 12 hours maintaining sugar content.
4. Deliver chopped cane, which help milling process.
5. Increases the transporting capacity.
6. Cane losses are reduced especially if labors are trained..

In grab loading whole stalks of cane were cut manually and put in rows. A forked machine is used for
loading into trucks and trailers. The amount of cane loaded by the grab loader is less than that loaded by the combine harvester because the bulk density of chopped cane is higher than the wholestalk, and thus the cost of transportation of manually harvested cane is higher. A large number of transporting units is required in order to secure the daily quota of the crushing mill. The system is practiced in the Sudan at Elguneid, Assalaya, New Halfa and Sennar Sugar Factories.

In continuous loading a special harvesters used to load the cane. The cane was cut manually, windrowed and the harvester, as it moves forward, pick the cane, chop it and continuously load in trucks and trailers that move in parallel to the harvester. This system allows more of cane per unit of transportation as compared with grab loading system. In Sudan this system is only practiced in Kenana.

The cane cutters cut the cane at the ground level and stack it in windrows. Each windrow encompasses six successive furrows. The cane is neatly stacked on the two middle furrows in perpendicular position to the furrow so that the loader will be able to operate at maximum efficiency.

The cutters also cut the tops of the cane (King 1965).

In other countries the increasing importance of mechanizing cane harvesting occurs during the sixties and seventies and till now there is an increasing care with the aspects of cane mechanization.

Leaving one centimeter of cane above the ground results in a loss of 0.53 tons per hectare. High cane cut not only results in losing the part of the stem rich in sugar content, it also necessitate using of stubble shaver at a cost of 8.3 US dollars per hectare

2.2 Sugarcane

Sugarcane is cultivated in more eighty tropical and subtropical countries throughout the world. Cane has to be delivered to factory for processing into the final product, sugar, which is one of the cheapest sources of energy. At the mill the cane is crushed by heavy rollers to squeeze out of the juice. Then, like removing soap from sponge, small amounts of hot water are added and the fiber is again squeeze to remove as much juice as possible .This process is usually repeated several times. Lime is added to help filtering out fiber and soil from the juice. Lime prevents conversion of the desirable sugar “sucrose” into other non- crystallized form . The sucrose solution is concentrated by evaporating off water until raw sugar crystals formation is completed. As sugarcane consists of more than 50% water, therefore, about 6.5 kg of water must be removed from each kg of sugar. Raw sugar is a course. Brownish material containing impurities removed in a separate refining process. About 85% of the sugar stalk weight is juice. Out of the juice about 10% is sugar.

Sugarcane is crucial economic crop of Sudan. It is a perennial crop grown mainly as a source of sugar. The procedure for processing sugar involves harvesting the sugarcane stalks, then shredding them extracting the sugarcane juice. Raw sugar is produce from juice and is later refined into white sugar.(**Abd Elkraim2001)**

2.3 Nature of Sugar Cane and Cultivation

Sugar cane has been grown well in sunny area, high temperature (25°C - 35°C) with moist in various kind of soil, recommended loamy sand, welldrained and soil mineral at least 2% since starting until 7-8 months (Pontawepitanun, 2004). It requires sufficient water resource and essential nutrient. Contrastly, it need cool weather to store sweet juice before harvesting in lesser water soil condition. Sugar cane has clump like rice. Firstly, it grows as one stem, then split to lot of clump with bud. These buds grow up to become stalks. Sweet juice in sugar content is used for nourishing and stored up gradually until the highest growth and ripe, then harvesting. In each period, it requires different environment, especially more factors involving in higher growth period.

Sugar cane cropping in Thailand mainly depend on rainfall rate approximately 80 percent, so planting timeframe is up to quantity of rainfall in rainy season:

Planting in early rainy season: usually start in April until the end of June. Farmer who begins cropping after this month cannot harvest sugar cane in time.

Planting at the end of rainy season or go through drought season: starts on October until January. Farmers should be assure that there is no rainfall in that season anymore, otherwise; they will face with weeding problem, high density of surface soil. These problems are lead to bad growth. However, they will manually clear soil and plowing on field to avoid this problem.

2.4 Sugar Cane Cultivation for Industry

Sugar cane is an industrial crop need to send into factory. It has Sugar Cane Act which relevant people need to follow, including regulation from Sugar and Sugar Cane Committee, as following (Pontawepitanun, 2004):

Sugar cane farmer registration. Farmer can register with agricultural governor's officer in their local area that will be announced to farmer. This will provide many advantaged to farmer and supporting from public sector, for example, low loaning interest rate, cheap fertilizer chemical.

This practice is also a measure to guarantee farmer's security in sugar cane planting.

Access to Quota system or market for selling sugar cane. Farmer should contact with factory near their sugar crop.

2.5 Agricultural Mechanization

Many advancements in farming techniques and tools have been manifested since agriculture's beginnings thousands of years ago. The greatest strides have occurred in the last three hundred years. A substantial contribution to Oklahoma agriculture has been the escalation from manual and stock-animal labor to steam-and then gas-powered implements. Although steel plows, mowers, mechanical reapers, seed drills, and threshers contributed to the development of agriculture in the Great Plains and the West, tractors enabled the western farmer to sow and harvest large acreages with less manpower.

According to the purpose of an agricultural mechanization strategy (AMS) is to create policy, institutional and market environment in which farmers and other end –users choice of farm power and equipment suited to their needs within a sustainable delivery and support system .

2.6 Testing and Evaluation of Agricultural Machinery:

Agricultural mechanization is improve working comfort, enhance timeliness, reduce losses and increase productivity and production . Accordingly, use of better power viz., tractors and different types of agricultural machines in Indian agriculture has risen sharply on Indian farms to boost food and fibre production. But to safe guard the user s interest, to ensure better quality and reliability of machines and for sustained growth of farm machinery industry, there is a need for sound scientific testing and evaluation of farm machines by using

instrumentation and accepted methodology. Thus, testing and evaluation holds the proper key to standardization and quality control of agricultural machinery for better acceptability and sustained farm production. To satisfy the genuine need of different sectors, this book has been prepared. It is expected to serve as a textbook for the students of Agricultural Engineering degree and postgraduate degree programme. It may also serve the needs of professional engineers, scientists, testing institutions and research organizations dealing with testing and evaluation of agricultural machinery. This book will also cater to the needs of tractor and agricultural implement manufacturing industries, consultants, agricultural universities/colleges as a valuable reference for quailty imporvement and standardization.
(https://books.google.com)

2.7 Mechanization of Sugar Cane Farming

Sugar cane of important manufacturing crops that provide food items is an important strategic addition to the sugar industry , it is used in molasses, which is a popular diet rich in sugar, mineral materials , food industry.
Unlike Maysahm its sugar cane crop in black and honey production , the crop residue is used in more than 25 secondary industrial products such
Molasses (the remaining part is after the extraction of juice from sugar) and it is the alcohol industry , vinegar and dry beer yeast , potassium sulfate and Allston and Sucker is used in the manufacture of pulp and wood particleboard and wax reeds.
Tine and filters can be added to the new lands to increase new fertility to increase fertility because they contain many nutrients.
The remnants of the field where used Alqalouh green leaves dry in livestock feed alongside the lag in the ground from the ashes of a fire dry

leaves , which increases the fertility of the land can also be used in the work of the waste organic fertilizer industry .

World sugar production is estimated at 159.9 million tons of sugar 2009/2010 , and occupies Brazil initial Almerth in sugar production globally , producing about 36.85 million tons, representing 23% of the global production of sugar - as Brazil is one of the biggest exporters of sugar , where exports amounted to about 24.3 million tons raw sugar representing 47.4 % of the global volume of exports .

(http://digital.library.okstate.edu**)**

2.8 Important of Using Sugar Cane Harvester:

The earliest sugar cane harvesters date from the 1920s and a single machine could replace up to 100 laborers. In Australia, mechanical harvesters first appeared in the 1950s and were harvesting 85% of the crop by late 1960s. Today that figure is 100%.

However in places like India, where the terrain is too rough, the crop is still mainly harvested by hand.

Sugar cane is one of the most efficient photosynthesizes in the plant kingdom but requires 60cm of water a year. It can be harvested continuously for up to 10 years but three years a is an average lifespan. An average yield is 70t/ha (pretty much the same as for sugar beet) but this can hit 170t/ha in a good year. The biggest producers are Brazil (74m tones/year), India (342m tones/year) and China (115m tones/year). Mechanical planting of stems or billets has also become common in developed countries. However sugar cane leaves the land in a pretty rough state and serious horsepower is needed to bring the land into order.

Harvest technology drivers have quite a lot to do. A powered divider separates the tangle of cane to be harvested, while a topper cuts the tops off canes that can reach up to 3m high. The divider also has a share that allows the cane to be cut very close to the ground.

Sugarcane is harvested under a wide range of operations ranging from manual Labor to fully mechanized systems to harvest, load and transport the crop. Reduced labor availability and a very small profit margin mandate a careful selection of the extent to which the sugarcane handling processes to be mechanized. Intensive mechanization sometimes may result in increased losses and poor quality. In some cases partial mechanization could be an economical and practical choice .

Due to the fact that sugarcane fields are very diverse with regard to land use, soils, varieties and planting methods, it is not possible to use one machine or system to provide universal solution to cane harvesting. recognized that sugarcane harvesting was notoriously labor intensive.

Since the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), agricultural trade liberalization has become a very important issue. After liberalization, only the fittest will survive and benefit while non-competitive entities are likely to collapse and exit the market. Improving production efficiency will be very essential for future competition.

Introduction of mechanical harvesting not only can achieve improved timeliness, as there is a shortage of labor during the harvesting season, but also because of the problem of handling large labor and providing accommodation for them. As the harvested sugarcane starts decaying with any delay in the extraction of juice for producing sugar, transportation facilities from the field to mill are equally important.

It is necessary to increase the efficiency of the harvesting systems to reduce the production cost of sugar in order to compete in the world market. The manager should know the optimum number of transportation units needed for least cost harvesting system.

Parson et al. reported that some farmers machinery purchasing patterns have tended toward acquiring bigger machinery capacity than can, apparently, be economically justified. Yet this investment in a type of insurance against untimely field operations has been quite profitable for many a (Abdelkarim 2001)

2.9 Manual Harvest Losses Vs Mechanical Losses:

In this section cane losses categories namely: attached cane; high cut cane; fallen cane; and low-topping cane for both harvesting systems were estimated and discussed.

The t-test analysis showed that there is no significance difference between the two harvesting systems (manual and mechanical cane harvesting) with regard to the overall infield losses (Cane tone/Fadden) as well as to different cane losses categories with exception of the low-topping cane category.

Manual high-cut cane resulted in cane losses amounted to 0.27 ton/fed (14% of the total system losses and 0.64% of the potential yield) while mechanical harvesting losses were found to be 0.25 ton/fed (13% of the total system losses and 0.55% of the potential yield).

Comparing this result with other findings in Kennan where it was reported that losses due to high cut cane in Kennan estimated to be 3.3% and 2.8% of the potential yield for manual and mechanical harvesting, respectively Mohammed (1995) . The reason for the lower losses in this study compared to other studies may be ascribed to an improvement in manual and mechanical harvesting management.

Attached cane represents the long cane left attached to the root system. Mechanical harvesting showed a higher attached cane losses (0.34 ton/fed, 0.8% of the total potential yield) compared to that of manual harvesting (0.12 ton/fed, 0.2% of the total potential yield.)

The fallen cane losses represent the highest percent of the total infield losses in both harvesting system where it amount to about 60% of the overall infield losses. The manual harvesting showed a higher low topping cane losses (0.41 ton/fed, 21.29% of the total system losses and 1% of the potential yield.) than mechanical harvesting (0.16 ton/fed, 8.69% of the system losses and 0.36% of the potential yield.

2.9 Evaluation of Combine Harvesting:

To evaluation combine harvesting using those equations (Hunt ( ):

Calculated speed of combine harvesting :

$$S = \frac{X}{T} \text{ ....(1)}$$

Where: S is speed of combine harvesting , X is distance (m) , T is time of harvester(hr)

$$Efc = \frac{A}{T} \text{..(2)}$$

Where: Efc is effective field capacity (fed/hr) , A is area (fed) , T is time of harvesting (hr)

$$\text{TFC} = \frac{S*W}{C} \text{....................................(3)}$$

Where: TFC is theoretical field capacity (fed/hr) , S is Speed (km/hr), W is width, C is constant (4.2).

$$\text{EFF} = \frac{\text{Efc}}{\text{tfc}} * 100 \text{....................................(4)}$$

Where: EFF is efficiency EFC is effective field capacity (fed/hr), TFC is theoretical field capacity (fed/hr)

$$\text{FC (gallon/h)} = \frac{\text{N}}{\text{T}} \text{....................................(5)}$$

Where: FC is fuel consumption , N is number of gallon , T is time/hr

$$\text{FC (liter/h)} = N * 4.54 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where: FC is fuel consumption , N is number of gallon

$$\text{FC (gallon/fed)} = \frac{\text{N}}{\text{A}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where: FC is fuel consumption , N is number of gallon

$$\text{FC (liter/fed)} = N * 4.54 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where: FC is fuel consumption , N is number of gallon

$$\text{PD} = \frac{\text{P.M}}{\text{N.D}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where: PD is production per ton/day, P.M is production ton /month , N.D is number of day

$$\text{P H} = \frac{\text{PD}}{24} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Where: PH is production per ton/hr , P.D is production ton/day

$$\text{TS (time)} = \frac{\text{N.hr}}{\text{N.D}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Where: S is time of stoppage , N.HR is number of hours stoppage for month , N.D number of day for month

$$\text{S (tonnage)} = \frac{\text{PH}}{\text{ND}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Where: S is tonnage of stoppage , PH production tonnage of stoppage per hours , ND number of day for month

$$\text{S (\%)} = \frac{\text{PT}}{\text{PM}} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Where: S is tonnage of stoppage percentage , PM is production for month

$$L = \frac{L * 4200}{1000} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(14)$$

Where: L is losses per fedan , l is losses per square meter

CHAPTER THREE
MATERIALS AND METHODS

3.1 Materials:

3.1.1 study area

El Gunned lies between latitudes 14 19 – 15 00 north and longitude 33 19 – 33 27 east . El Gunned was established in 1964 as governmental scheme . two German companies (Buchan Wolf and BMA) designed and built the factory . the construction commenced 1958 and was completed in 1962.

3.1.2 Elguneid Sugar Factory:

Elguneid Sugar factory is the first sugar factory in the Sudan ; it is one of the four Sudanese Sugar company factories. El Gunned sugar factory is the only sugar estate in Sudan that has farmers , whilst all other sugar estates are integrated companies whereas the company owns the factory and the farm as well . El Gunned is irrigated through pumps from Blue Nile River .

The materials which have been used in the research:

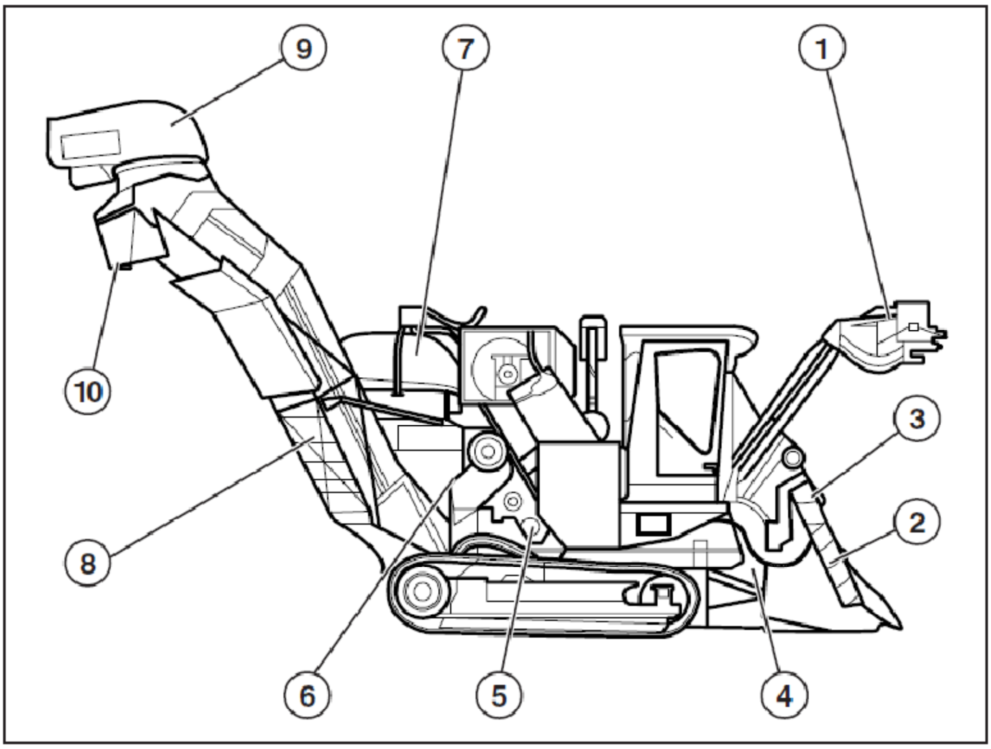
plate No (1) square meter

3.1.4 Graduated cylinder plate NO (2)

3.1.5 Meters measure plate NO (3)

3.1.6 Sensitive balance plate NO (4)

MACHINE COMPONENTS



1. Standard / Shredder Topper
2. Cropdividers
3. Side Trim Knives
4. Basecutter Box
5. Roller Feed Train
6. Chopper
7. Primary Extractor
8. Elevator
9. Secondary Extractor
10. Exhaust Flap

3.1.7 Stop Watch

3.2 Methods:-

3.2.1 Introduction:

The sample harvester were subjected to general checks in the workshop daily and weekly maintenance were carried out in the following manner:-

1-check of fuel, oil levels in fuel tank, engine and hydraulic and leveling to the required height.

2- Cleaning of the siphon of the air clearer.

3- Greasing of movable parts.

When the harvester conditions were completely checked the following measurements were taken:

3.2.2 Actual field Capacity:

Harvesting was conducted on planted sugar field . The length of the harvested area (225 m)was measured using a meter tape and found to be .The harvester was set to work at the begining of the field . The pattern of harvesting was headland .The time to complete a specific area was recorded using a hand watch.

Reading showing area harvested in feddans, time taken in minutes were tabulated as shown in tables 2.

3.2.3 Fuel consumption:-

Fuel consumption for harvester was measured by toping the fuel tank at the start of each run and then retopping at the end of the specific run using a measuring cylinder in liters.

Readings showing the amount of fuel consumed in liter ,area harvester in feddans and time taken in minutes were tabulated as seen in table 3.

3.2.4 Forward speed:

Forward speed for harvester was measured by recording the time taken to travel a distance of 225 meters during harvesting operation using a hand watch.

Readings showing distance travelled in meters, time taken in seconds were tabulated in table 1.

3.2.5 harvester Losses:

The post-harvest loss account was found by throwing a square meter on the harvested area and then collecting the sugar cane left on the ground. This was repeated 20 times as shown in table 3.

CHAPTER FOUR

Results and Discussion

4.1 Results and discussion

The results of field tests carried were tabulated in tables from1 to 18.

Tables 1, 2 ,3,4,5 showed speed , actual field capacity , theoretical field capacity , efficiency and fuel consumption in Order .

Table 6 showed the total and average production and tonnage of Stoppage for the 6 months .details of these information were found appendix (2) and appendix (3).

Table 7 showed the losses tonnage per feddan.

Table no. (1):Speed of harvester:

NO	Time (mint)	speed(m/min)	speed(km/h)
1	2.38	94.54	5.67
2	2	112.50	6.75
3	2.41	93.36	5.60
4	2.07	108.70	6.52
5	2.3	97.83	5.87
6	2.09	107.66	6.46
7	2.25	100.00	6.00
8	1.47	153.06	9.18
9	2.03	110.84	6.65
10	2.04	110.29	6.62
11	2.2	102.27	6.14
12	2.32	96.98	5.82
13	2.45	91.84	5.51
14	2.15	104.65	6.28
15	2.25	100.00	6.00
16	2.55	88.24	5.29
17	2.3	97.83	5.87
18	2.5	90.00	5.40
19	2.09	107.66	6.46
20	2.01	111.94	6.72
Total	43.86	5.13	124.81
Average	2.193	104.01	6.24

the speed was found to range between 5.29 – 9.18kl/h with an averaged 6.24 kl/h

Table no (2) actual field capacity

No	area/fed	tie/hr	Efc
1	62.75	20	3.14
2	58.25	20	2.91
3	67.25	20	3.36
4	59.25	20	2.96
5	54.75	20	2.74
6	63.75	20	3.19
7	58	20	2.90
8	57.25	20	2.86
9	64	20	3.20
10	61	20	3.05
Average	60.625	20	3.03

The actual field capacity was found to range between 2.74 – 3.36 fed/h with an averaged 3.03 fed/h

Table no (3) theoretical field capacity

No	Speed	Width	Tfc
1	5.6	3	4
2	5.87	3	4.19
3	6	3	4.26
4	5.82	3	4.16
5	5.29	3	3.78
6	6.24	3	4.46
7	5.51	3	3.94
8	6.24	3	4.46
9	6.14	3	4.38
10	5.4	3	3.86
Average	5.811	3	4.149

Theoretical field capacity was found to range between 3.78 - 4.46fed/hr with an averaged 4.14

Table no (4) the efficiency

No	area/fed	time/h	A f c	T f c	Eff
1	62.75	20	3.14	4	78.4375
2	58.25	20	2.91	4.19	69.51
3	67.25	20	3.36	4.26	78.93
4	59.25	20	2.96	4.16	71.21
5	54.75	20	2.74	3.78	72.42
6	63.75	20	3.19	4.46	71.47
7	58	20	2.90	3.94	73.60
8	57.25	20	2.86	4.46	64.18
9	64	20	3.20	4.38	73.06
10	61	20	3.05	3.86	79.02
Average	60.625	20	3.03	4.149	73.18

4/The efficiency was found to range between 64.18 – 79.03 % with an averaged 73.18%

Table No (5) Fuel consumption

No	Area (fed)	Gallon	Time (h)	gallon/h	Liter/h	gallon/fed	Liter/fed
1	20.92	76.8	8	9.6	43.584	3.671128	16.66692
2	19.42	83.5	8	10.4375	47.38625	4.299691	19.5206
3	22.42	75	8	9.375	42.5625	3.345227	15.18733
4	19.75	92	8	11.5	52.21	4.658228	21.14835
5	18.25	54	8	6.75	30.645	2.958904	13.43342
6	21.25	85	8	10.625	48.2375	4	18.16
7	19.33	72	8	9	40.86	3.72478	16.9105
8	19.08	74	8	9.25	41.995	3.878407	17.60797
9	31.33	79	8	9.875	44.8325	2.521545	11.44781
10	20.33	81	8	10.125	45.9675	3.98426	18.08854
11	21.25	79	8	9.875	44.8325	3.717647	16.87812
12	18.11	69	8	8.625	39.1575	3.81005	17.29763
Total	251.44	920.3	96	115.0375	522.2703	44.56987	202.3472
Average	20.95333	76.69167	8	9.586458	43.52252	3.714156	16.86227

the fuel consumption was found to range between30.64 –52.21 liter/h with an averaged 43.52 liter/h

Table No (6) production and tonnage stoppage of harvester in season 2014-2015

months	production/ ton		
	month	Day	hr
11	16983.86	566.129	23.589
12	16765.3	540.81	22.53
1	8847.9	285.42	11.89
2	10113.27	361.19	15.05
3	11472.81	370.09	15.42
4	6513.2	310.153	12.923
total	70696.34	2433.792	101.402
average	11782.72	405.6	16.90

The production of the combine was found to range between 16983.86 – 65132 ton with an average each day the 6 month to be 11782.72 ton and 566.129 – 285.42 ton/day with an average 405.6 ton/day and 23.589 – 11.89 ton/hr with an average 16.90 ton/hr

Table No (7) losses after harvesting (Area (1 m^2))

Number	weight(gram)	weight(Kg)
1	622	0.622
2	388	0.388
3	501	0.501
4	670	0.67
5	937	0.937
6	272	0.272
7	672	0.672
8	250	0.25
9	246	0.246
10	0	0
11	530	0.53
12	206	0.206
13	419	0.419
14	322	0.322
15	313	0.313
16	703	0.703
17	243	0.243
18	544	0.544
19	298	0.298
20	253	0.253
Average	419.45	0.41945

Losses / fedan = 1761690= 1761.69 k

7/The losses after harvesting were found to be1761.69 kg sugar cane/feddan .

CHAPTER Five

Conclusion and Recommendations

5.1 Conclusion

The study which has been accomplished for the evaluation of the combine harvester performance was useful. I followed up the machine in the field and I found field capacities, fuel consumption ,observing mechanical break downs and the troubles that take place during work.

5.2 Recommendations:-

1. To carry out further studies and to follow up the performance of the combine harvester and compare the manual performance with the mechanical.
2. Also to recommend additional training for combine harvesters drivers.
3. Agricultural land to be well prepared and the divines in the plots to be leveled so as not to interrupt the movement of the com

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Table No (1) production of harvester in November 2014

Day	**Ton/day**	**ton/hr**
1	209.22	8.72
2	349.28	14.55
3	601.65	25.07
4	576.542	24.02
5	583.88	24.33
6	538.4	22.43
7	1040.942	43.37
8	391.62	16.32
9	618.74	25.78
10	641.388	26.72
11	547.8	22.83
12	531.64	22.15
13	545.52	22.73
14	485.48	20.23
15	451.36	18.81
16	261.3	10.89
17	418.44	17.44
18	371.86	15.49
19	338.74	14.11
20	560.65	23.36
21	480.3	20.01
22	703.54	29.31
23	944.28	39.35
24	727.84	30.33
25	597.92	24.91

Day	**Ton/day**	**ton/hr**
26	407.76	16.99
27	809.7	33.74
28	554.05	23.09
29	655.46	27.31
30	1038.56	43.27
Total	16983.862	707.66
Average	566.129	23.589

The production and of harvester in November were found 2014 to be 16983.862 ton

Table No (2) production of harvester in December 2014

Day	Ton/day	Ton/hr
1	566.76	23.62
2	345.48	14.40
3	346.4	14.43
4	423.68	17.65
5	583.82	24.33
6	1034.53	43.11
7	435.2	18.13
8	144.58	6.02
9	426.6	17.78
10	386.28	16.10
11	417.2	17.38
12	301.91	12.58
13	664.64	27.69
14	702.6	29.28
15	476	19.83
16	713.831	29.74
17	477.26	19.89
18	581.38	24.22
19	845.41	35.23
20	354.32	14.76
21	734.76	30.62
22	648.82	27.03
23	544.48	22.69
24	460.76	19.20
25	492.34	20.51

26	475.96	19.83
27	813.88	33.91
28	351.68	14.65
29	579.86	24.16
30	678.84	28.29
31	755.99	31.50
Total	16765.251	698.55
Average	540.81	22.53

The production of December were found to be 16765.251 ton

Table No (3) production of harvester in January 2015

Day	Ton/day	Ton/hr
1	455.14	18.96
2	595	24.79
3	472.98	19.71
4	373.62	15.57
5	533.94	22.25
6	209.18	8.72
7	442.96	18.46
8	632.17	26.34
9	369.82	15.41
10	676.86	28.20
11	79.28	3.30
12	0	0
13	17	0.71
14	0	0
15	215.62	8.98
16	365.32	15.22
17	478.08	19.92
18	425.48	17.73
19	287.26	11.97
20	470.66	19.61
21	502.64	20.94
22	258.96	10.79
23	244.64	10.19
24	330.25	13.76
25	306.28	12.76

Day	Ton/day	Ton/hr
26	78.14	3.26
27	0	0
28	5.84	0.24
29	0	0
30	20.78	0.87
31	0	0
Total	8847.9	368.66
Average	285.42	11.89

The production of harvester in January were found 8847.9 ton

Table No (4) production harvester in February 2015

Day	Production (ton)	ton/hr
1	0	0
2	173.22	7.22
3	0	0
4	0	0
5	738	30.75
6	657.84	27.41
7	321.88	13.412
8	468.64	19.53
9	392.6	16.36
10	272.42	11.35
11	394.88	16.45
12	354.42	14.77
13	613.88	25.58
14	390.45	16.27
15	384.88	16.04
16	172.58	7.19
17	662.18	27.59
18	375.2	15.63
19	207.08	8.63
20	49.7	2.07
21	486.12	20.26
22	503.96	21.00
23	673.02	28.04
24	481.26	20.05
25	512.68	21.36

Day	Production (ton)	ton/hr
26	242.3	10.10
27	355.6	14.82
28	228.48	9.52
Total	10113.27	421.386
Average	361.19	15.050

The production of harvester in February 2015 were found to be 10113.27 ton

Table No (5) production of harvester in March 2015

Day	Ton /day	ton /hr
1	411.36	17.14
2	545.86	22.74
3	200.64	8.36
4	523.4	21.81
5	184.68	7.70
6	550.8	23.0
7	432.4	18.02
8	347.5	14.48
9	231.78	9.7
10	491.3	20.5
11	287.76	11.99
12	330.06	13.75
13	444.88	18.54
14	529.51	22.06
15	561.89	23.41
16	419.84	17.49
17	251.98	10.50
18	286.58	11.94
19	234.28	9.76
20	392.7	16.4
21	232.26	9.68
22	584.45	24.35
23	311.84	13.0
24	523.88	21.83
25	274.26	11.43

Day	Ton /day	ton /hr
26	149.5	6.23
27	357.04	14.88
28	351.96	14.67
29	315.1	13.13
30	428.1	17.8
31	285.22	11.9
Total	11472.81	478.03
Average	370.09	15.420

The production of harvester in March 2015 were found to be 11472.81 ton

Table No (6) production of harvester in April 2015

Day	Ton/hr	ton /hr
1	273.6	11.4
2	361.58	15.07
3	442.28	18.43
4	414.28	17.26
5	142.74	5.95
6	260.54	10.9
7	462.52	19.27
8	247.14	10.3
9	312.22	13.01
10	398.82	16.6
11	196.34	8.18
12	340.06	14.17
13	296.99	12.37
14	314.66	13.11
15	400.49	16.69
16	101.54	4.23
17	156.42	6.5
18	255.68	10.65
19	374.8	15.62
20	401.14	16.71
21	359.37	14.97
Total	6513.21	271.38
Average	310.153	12.923

The production of harvester in April 2015 were found to be 6513.21 ton

Table NO (7) production of all season 2014-2015 (6 months) per tons

sugar harvester production(tons)							
Month Day	11	12	1	2	3	4	total/day
1	209.22	566.76	455.14	0	411.36	273.6	1916.08
2	349.28	345.48	595	173.22	545.86	361.58	2370.42
3	601.65	346.4	472	0	200.64	442.28	2062.97
4	576.542	423.68	373.62	0	523.4	414.28	2311.522
5	583.88	583.82	533.94	738	184.68	142.74	2767.06
6	538.4	1034.53	209.18	657.84	550.8	260.54	3251.29
7	1040.942	435.2	442.96	321.88	432.4	462.52	3135.902
8	391.62	144.58	632.17	468.64	347.5	247.14	2231.65
9	618.74	426.6	369.82	392.6	231.78	312.22	2351.76
13	641.388	386.28	676.86	272.42	491.3	398.82	2867.068
11	547.8	417.2	79.28	394.88	287.76	196.34	1923.26
12	531.64	301.91	0	354.42	330.06	340.06	1858.09
13	545.52	664.64	17	613.88	444.88	296.99	2582.91
14	485.48	702.6	0	390.45	529.51	314.66	2422.7
15	451.36	476	215.62	384.88	561.89	400.49	2490.24
16	261.3	713.831	365.32	172.58	419.84	101.54	2034.411
17	418.44	477.26	478.08	662.18	251.98	156.42	2444.36
18	371.86	581.38	425.48	375.2	286.58	255.68	2296.18
19	338.74	845.41	287.26	207.08	234.28	374.8	2287.57
20	560.65	354.32	470.66	49.7	392.7	401.14	2229.17
21	480.3	734.76	502.64	486.12	232.26	359.37	2795.45
22	703.54	648.82	258.96	503.96	584.45	0	2699.73
23	944.28	544.48	244.64	673.02	311.84	0	2718.26
24	727.84	460.76	330.25	481.26	523.88	0	2523.99
25	597.92	492.34	306.28	512.68	274.26	0	2183.48
26	407.76	475.96	78.14	242.3	149.5	0	1353.66
27	809.7	813.88	0	355.6	357.04	0	2336.22
28	554.05	351.68	5.84	228.48	351.96	0	1492.01
29	655.46	579.86	0	0	315.1	0	1550.42
30	1038.56	678.84	20.78	0	428.1	0	2166.28
31	0	755.99	0	0	285.22	0	1041.21
total/month	16983.86	16765.25	8846.92	10113.27	11472.81	6513.21	70695.32
Average/month	566.129	540.81	285.42	361.19	370.09	310.153	11782.553

The production of sugar cane for season (2014-2015) was found to range between 566.129 – 285.42 ton with an average (6 months) 11782.553

A diagram Showing the diemensions of field sugar farm