ANALYSIS OF ENERGY CONSUPMTION IN MAIZE FLOUR MILLING

A CASE STUDY OF (IDEAL FLOUR MILL KADUNA)

BY

OKECHUKWU, AMOBI CHRISTIANTUS.

98/7144EA

DEPARTMENT OF AGRICULTURAL ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

NIGER STATE

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A PROJECT SUBMITTED TO DEPARTMENT OF AGRICUALTURAL ENGINEERING, IN PATIAL FULFILMENT FOR THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) IN AGRIC. ENGINEERING, SCHOOL OF ENGNEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNVERSITY OF TECHNOLOGY MINNA, NIGER STATE NIGERIA.

NOVEMBER, 2004.

DEDICATION

This project work is dedicated to my God of all impossibilities, the Almighty one for his mercy and grace He has shown me. But thou, O Lord, art a shield for me; My glory and the lifter up of my head (Ps 3 v3) and my loving SAVIOUR, Lord and redeemer of my soul LORD JESUS CHRIST.

Luke 1v 68 – 79

DECLARATION

I hereby declare that this work Analysis of Energy Consumption in maize processing (Case Study ideal flour mill Industry ltd) was conducted by me under the supervision and guidance of Engr .A.C.Onuachu of the department of Agricultural Engineering ,Federal University of Technology Minna during the 2003/2004 academic session.

8/12/04

Sign and date

Okechukwu A.C

Name

CERTIFICATION

This is to certify that this project work was carried out by OKECHUKWU, AMOBI C. (98/714EA). AGRIC. ENGINEERING DEPARTMENT

SIGNATURE 25/11/04

A.C ONUACHU — DATE

(SUPERVISOR)

SIGNATURE 25.11.04

H.O.D

DR. D ADGIDZI — DATE

SIGNATURE 25/11/2004

EXTERNAL EXAMINER — DATE

ACKNOWLEDGMENT

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ABSTRACT

The consumption of energy in Ideal flour mill industry Ltd was studied. The major source of energy in the mill is through electricity. Human labour is used to supplement where electrical energy cannot be utilized due to technological limitations.

This project work presents the findings of case study, analysis the energy requirement for various unit operations involved in maize processing. At the same time the overall energy consumption of the mill was estimated. The experimental design made it possible for the energy consumption in each unit operation to be computed. Also, areas of waste were identified and remedial measure recommended.

The results indicated that the total amount of energy required to process a ton of maize into different components is 153.8kwh/t and human energy requirement 504kj/t.

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CHAPTER ONE

1.1 **Background to the problem**

Agriculture is usually the least energy – intensive sector in natural economic and the one with the highest economic and social return for each extra unit of energy input {palais, 2000]. It is a modest energy consumer, accounting for about 3.5 percent of commercial energy use in Industrialized countries and 4.5 percent in developing countries as a whole.

Yet, it remains the least developed sector in developing countries. This is the tragic paradox of poverty. It is not energy, but rather poverty, which is the limiting, factor for the poor. They are forced to live on meagre resources, and thus use inefficient equipment, because they have no saving for investment capital to purchase energy efficient devices, consequently, they end up paying many times over for a unit of delivered service.

Agro – based Industries are among the major sources of energy demand and account for 40-60 percent of all energy consumed in Industrialized countries and 10-40 percent in developing countries. Most trends points to a very rapid growth of Industries by the turn of the century; but the form and pattern could be marked different between Industrialized and developing countries. Industries in the former has been undergoing massive restructuring marked by a shift toward higher technologies, a substitution of synthetic for primary input and growing dematerialization of the economy.

Agriculture in developing countries, suffers from low level of energy use and productivity, the potential for increasing both is thus enormous. The main set back on increasing energy use for agriculture in developing countries and unbalanced; inequitable development policies. Energy efficiency should be the cutting edge of natural energy policies and sustainable development and measures to achieve. It deserves the highest priority on national agendas. In most developing countries of the world, ignorance tends to be the major contributing factor to inappropriate energy consumption, in that, many consumers, including large industries, do not know how to improve energy use, what it cost them, how cost can be minimized or how to go about reducing them. Farmers need energy to pump water for irrigation, processing of crops etc and thus agriculture production given that energy consumption is directly proportional to crop yield.

It is worthy to note that in agriculture most often, crop production is viewed as a "black box" during energy analysis and the computation of energy are made on aggregate basis. Even when they are treated separately, the attention is still on total consumption by " black box". The integration of energy calculation is good enough for regional energy databases and inter-regional comparism, but usually inadequate for making any useful recommendations, in that, it does not allow a simple identification of a particular stage in agriculture production. This implies that, the information is not suitable for our agricultural sector planners, the farmers engage in production process and decision maker in the government during policymaking and budget allocation.

In Nigeria, much has not been done, in the issue concerning energy use in agriculture production, given the fact that majority of the farmers are still on subsistence level and mechanization is still not outstanding, as in the developed countries of the world. The lack of available data in energy use in agriculture has resulted in poor policy implementation and affects the decision of the farmers on which machine to use in other to implement and achieve a resounding success in crop production processing. The farmers themselves don't keep records on the type of energy used and the magnitude of energy used, rather than interest is more on the crops input and cost implication of the farming activities. If this issue of energy use is not addressed now, the Nigeria farmer will be left behind, as the world agriculture accelerate to the next millennium, to provide food, security to the rest of the world, while Nigeria is threatened by hunger.

It is obvious that, not much study has been done, to determine energy consumption, in most of the crop produced in this country except rice production. The importance of this research field in agriculture should not be over emphasized. Such information will help in increasing output. Besides, it will enable the farmers to develop strategies for better control of their production operations; it will also enable them to modify areas of waste and properly appraise their energy consumption, in planning their production and marketing activities.

Nigeria agriculture has suffered some setback in recent years, due to inappropriate dispensation of energy in farm work. Also, lack of adequate information or data pertaining energy consumption in various farm operations, has done more harm than good to agriculture production, thereby making energy use in agriculture a delimma to farmers there is every need to articulate the use of cheap energy in agriculture operations. This will go a long way to provide the much needed solution to farming activities. Therefore, energy are related to both field and processing operation should be used at a minimum cost having determined the magnitude of substitution of one source of energy to another.

The major problem now is what type of energy and what quality should be used to produce which commodity without a substantial loss in energy consumption? Consequently, energy use in maize processing is studding. An existing maize processing factory is to be used as case study.

1.2 OBJECTIVES OF WORK

The objectives of this project were:

I. To measure the energy input per unit operation in a maize-processing factory.

II. To determine the magnitude of substitution on source of energy to another.

III. To establish the energy efficiency of the maize processing.

1.3 SCOPE OF THE WORK AND LIMITATION

This research work is limited to the study of maize processing in Nigeria. The operations considered is maize milling ie post harvest activities. The scopes of the work cover both conventional and mechanized energy use in maize processing.

In most of the developing countries full supply of commercial energy inputs on farm is not possible as a result of inherent factors. A complete mechanization of agriculture in Nigeria is not obtainable given the economical, social and political constrain it's militating against the country. The system of selective mechanization is suitable in other to improve the food and fiber production under the socio-economic conditions. There is unavailable on field reliable research data in Nigeria to justify the introduction of either partial or complete mechanization. However, some fragmented research result are available for selective mechanization cultivation of some crops, since no systematic study on energy use relationship has been undertaken to fulfill selective mechanization cultivation in the country, total assessment of energy use on the farm is lacking.

The limitations to this work is due to the lack of established data in Nigeria, which as the work proceeds more will be identified and noted.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of energy utilization in Agriculture

Energy, being the capacity to do work is the heart of all human activities, espercialy those concerning the production of goods and services {Hetz 1992} Energy use in agriculture has resin tremendously as far back as 1945, which accounts for the large increase in food and fibre production. However, energy consumption increased faster than food production, resulting in a reduction in the energy efficiency of most crops.

In Nigeria agriculture is labour – intensive and this current growth in the labour force is about 2.35% annually against the target of 3-5%. Moreover, agriculture is very much energy-dependent, using large amounts of fertilizers, fuels and biocides. Consequently, the major problem encountered in agriculture sector planning is usually maximizing of food production from limited arable land and minimization of energy input. The absolute knowledge of the relationship between crop yields and energy input in the form of tillage energy, irrigation energy, fertilizer energy etc are very necessary for the formation of energy policies. The efficient use of modern a menial- drawn equipment in seedbed preparation and operation up to sowing period would require25.8 to 36.8 kwh/kg {Roy1966} .The use of indigenous equipment would require 125to 184 kwha/hg.

However, an average of two intercultural operations using bullock-drawn cultivator and khurpies tractor would give an approximate of 9.2 kwh/ha using conventional sickle. This implies that in all the field operation with improved bullocks drawn implement and machine already developed and in use withing the country would require an average of 55.4kwh/ha compared to 351kwh?ha using conventional methods. An average of 1000 man-h/ha are expected in paddy production with the user of animal power. In Taiwan and Japan the figure is about 1300 while in countries where broadcasting, less inter- cultivation and less tillage are practiced, the figure is about 700 {mckolly, 1971}. The relationship between horsepower per cultivate hectare and average crop yield was developed and the illustrationis as shown in fig 1 {Gile 1975} later, it was discovered that the correlation did not consider the effect of other, impute like fertilizer, seed, pesticide etc. Consequently, the relation between response carve of yield to level of mechanization energy input is as shown in fig 2 . Which indicates that the highest partial energy production is achieved at the point of maximum mechanization energy impute and increasing mechanization energy increases crop yield at a decreasing rate {fluckand Baird, 1980}. Similarly the same response curve was obtained for irrigation and fertilizer energy input the information obtained from FAO statistic shows that in developed countries the average crop yield is 2631kg/ha with 19.4GJ/ha with one tenth as much commercial energy impute {stout, 1980}.

The farm management studies conducted in India on energy requirement for raising some crops is as shown in table 1.Likewise in South East Asia, it was observed that 7man-h were required to produce the same quantity .In USA it took 30 man-h to grow an acre of wheat in1850 and 3 man-h in1950. To date it takes about 30 man-demand 30-bullock days to grow an acre of wheat in India (srivastava, 19820). Also the analysis on energy requirement of agriculture for india, china, Taiwan, Japan and USA shows that as the use of irrigation and fertilizer increases the production per hectare increases and the total energy requirement per ton of the crop decreases rapidly [makhjani and Poole, 1975} However, a detailed analysis of energy imputes in different farms shows that the type of power yield, rather increase in yield are as a result of the different impute combined together. Notwithstanding, the intensive use of mechanical power within specific period enabled the farmers to use different methods of production to achieve annual increase in food production and commercial crops (singh and chanceller1975}.

Table 1. **Energy Required to Produce Selected Crops**

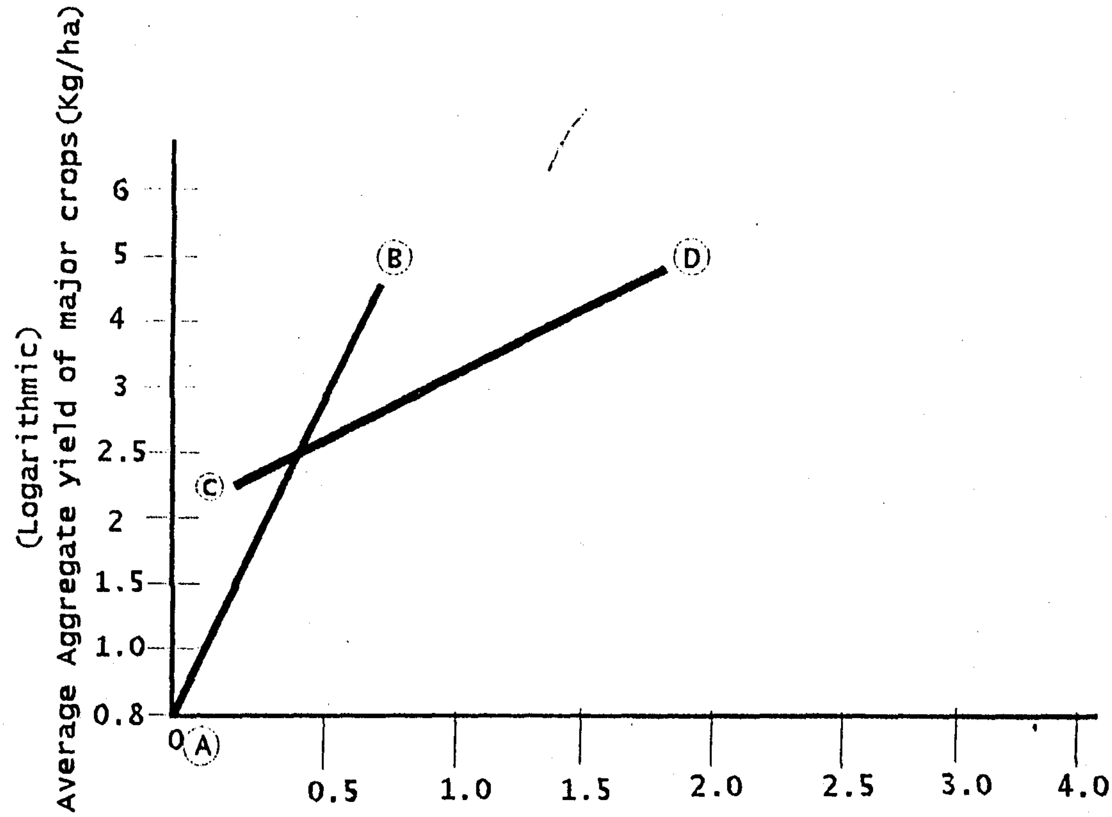
Crops	Man -days	Bullock –days
Paddy	150	50
Wheat	75	75
Jower	40	40
Cotton	40	20
Sugarcane	90	20

source; Srivastava 1982

The energy input in farms was classified according to their cultural operation as shown in fig .3 pre harvest energy input in the energy consumed before the crop mature. It is further divided into field operation energy, which comprises tillage energy, intercultural energy is the direct energy consumed in farm operations, while fertilizer energy is the distribution of fertilizers etc. Post- harvest energy input includes energy used for harvesting, threshing and transporting of matured crops, consequently, the amount or quality of crop handled. Also, the crop yield is assumed to depend on the the inputs applied before the crop is harvested

2.2 Energy use in production of some crops

Crops production is one of the major consumers of commercial energy in the form of diesel, electricity, fertilizer, agrochemicals, and machines etc. Energy is used basically for agricultural operations such as land preparation, interculture, irrigation, harvesting, threshing and transportation. However, it is used indirectly as fertilizers and pesticides. Commercial source of energy such as ban electricity and petroleum are mainly for farm irrigation (singhetal 1997).



Effective Horse power per hectare
Fig 1 Relationship between Yield and power Available
Source :Singh et al ,1992

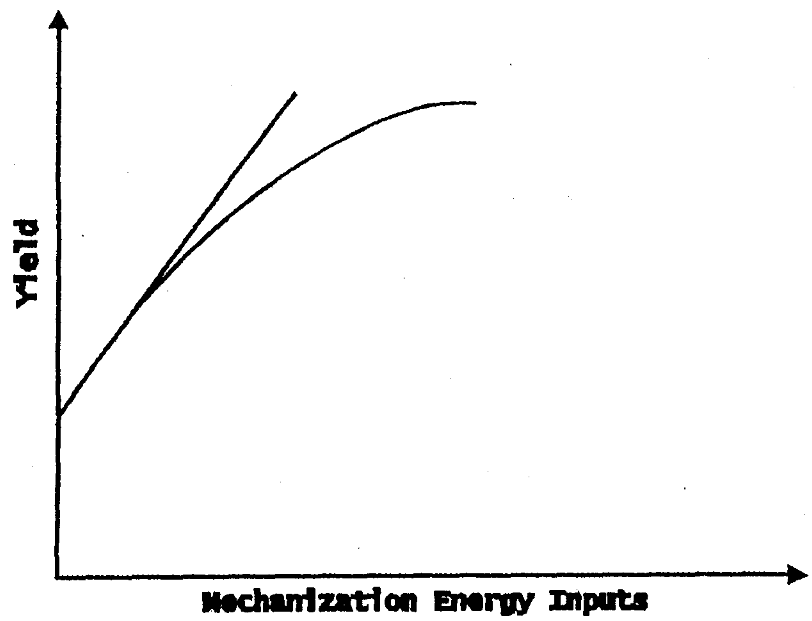


Fig 2 Yield vs Mechanical Energy inputs
Source :Singh et al

Energy requirement for different farm operations and energy source for various crops production are as shown in fig 4 and fig 5 respectively. Irrigation consumed 51.1% of the total energy used. Harvesting and threshing consumes 19.4% and seedbed preparation consumed 13% of the total energy used for crop production. This implies that the three operations consumed 83.3% against 16.5% of the energy consumed by other operations. The different source shows that chemical and fertilizers are responsible for maximum energy input of 28.5%. Diesel was the second highest energy input (26%) followed by electricity (16.4%). Seed (8.6%) and farmyard manure (7.9%). Therefore, the three main commercial energy source s, namely, chemical fertilizers, diesel and electricity together consumed 70.9% of the total energy input. The energy impute from animate source accounted for 10.7% and that of seed (8.6%) while energy impute from agriculture machine use only 1.9% of the total energy.

Energy requirement for the production of selected crop are as shown in table 2. Energy requirement for the cultivation of rice shows that irrigation consumed 15280mj/ha, which account for 73.3% of the total energy followed by nursery operation, which used 2214mj/ha, and the energy used for tilling the soil is 1584mj/ha. The operation that consumed the least energy is spraying and weeding. Moreover, the amount of irrigation energy equally affects the use of electricity in source – wise energy. Hence, the use the electrical energy took 58.3% of the total energy followed by fertilizer and chemical, which account for 27.6%. The seed has no effect on the energy consumption.

The energy requirement for the production of maize shows that 1765mj/ha was used for irrigation which accounts for 24.9% of the total energy which is 73.7% to esterblish that maize does not need as much water as rice. The next is tillage energy for the seedbed preparation followed by harvesting and threshing, which consumed 1128mj/ha in the source –maize energy direction. Farmyard manure

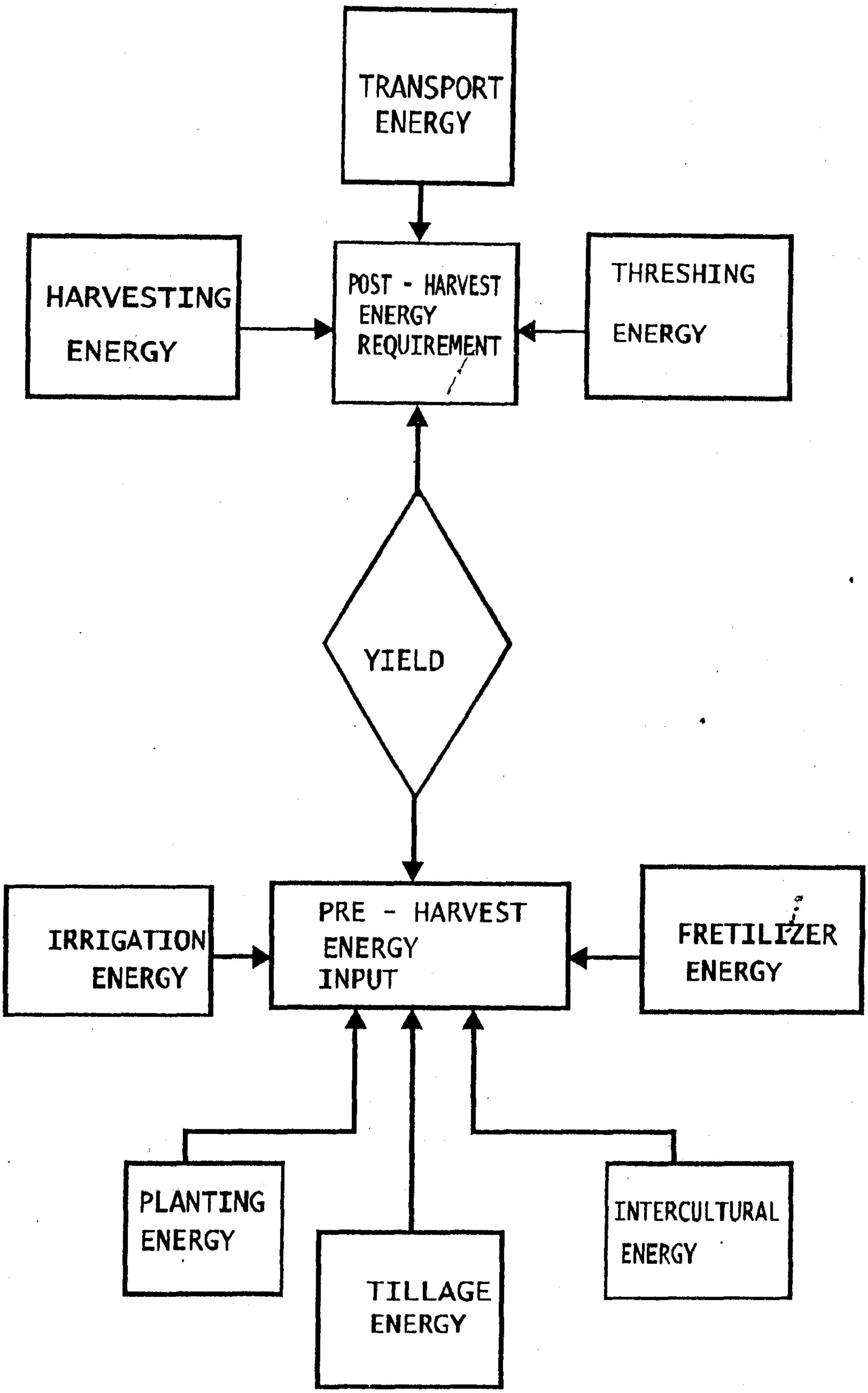


Fig 3 Classification of energy inputs and their interaction with crop yield

Source :Singh et al 1992

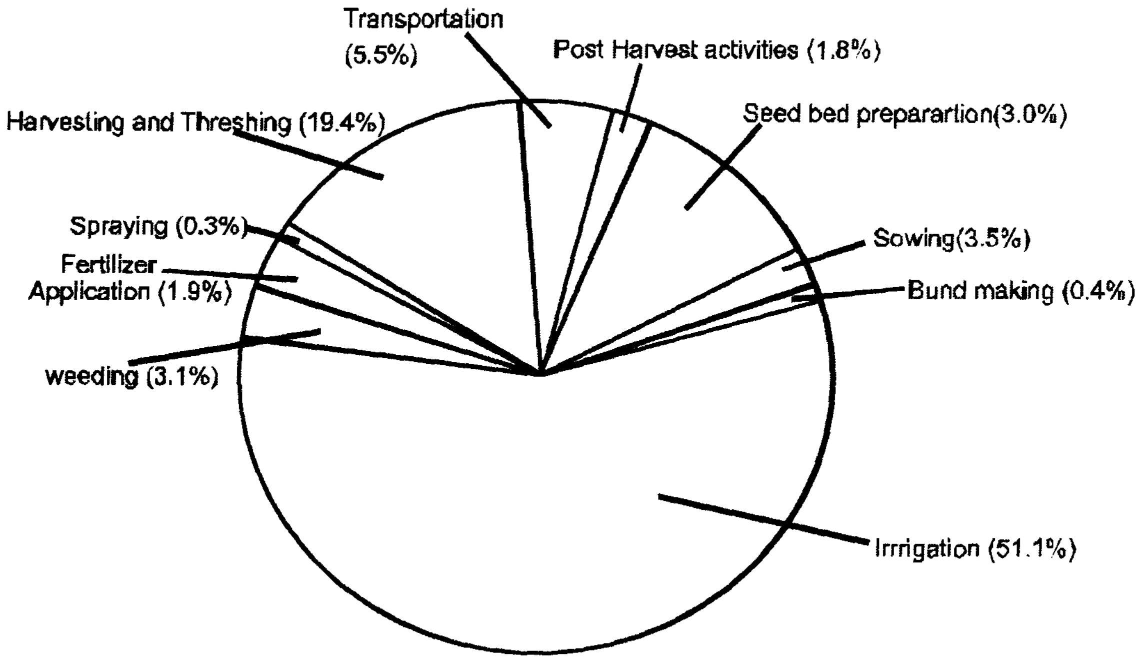


Fig 4 Contribution of Energy in different farm Operation in Agriculture
Source Singh et al.1997

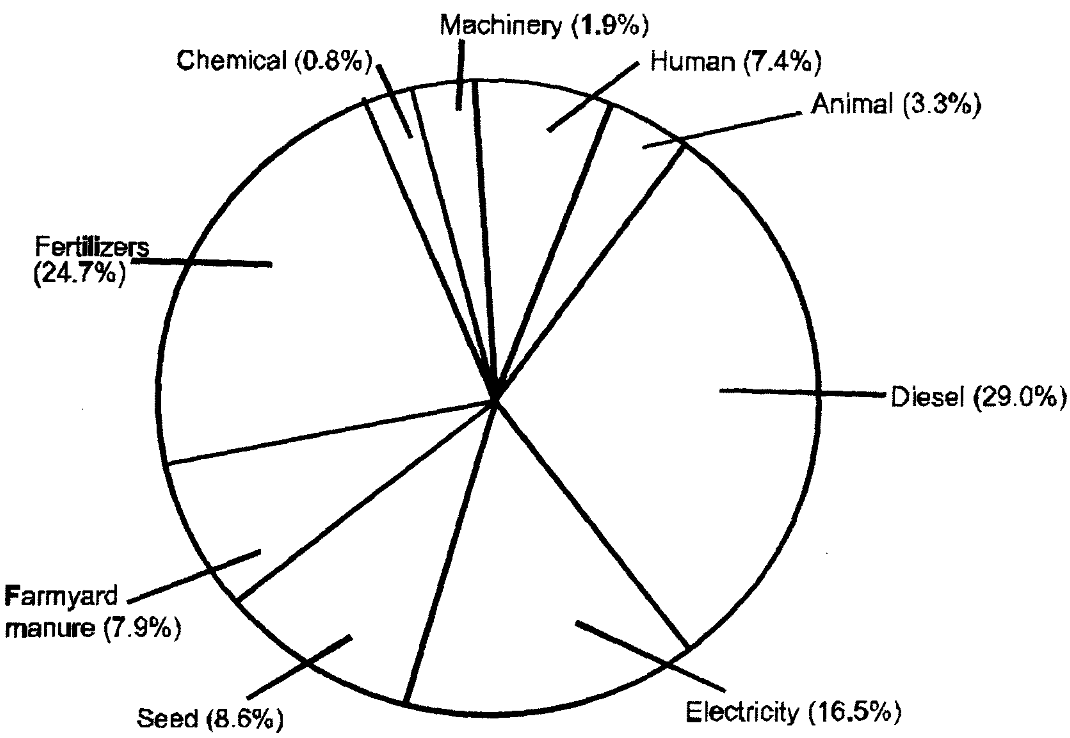


Fig 5 Contribution of different sources of energy Agriculture
Source Singh et al 1997

is the highest energy consumer ie. 4974mj/ha. Followed by diesel and electricity while machinery was the least ie 288mj/ha.

Energy requirement for groundnut production consumed the highest in irrigation, which account for 27.7% of the total energy followed by harvest and threshing while there is no energy consumed in spraying. Fertilizers and chemicals took the highest in source –wise direction followed by diesel and electricity. The yield is 1688kg/ha, which lead to a specific energy of 5.4 MJ/kg. Sugarcane cultivation required 8347MJ /ha of irrigation energy to be the highest energy consumer and it accounts for 39.5% of the total energy, followed by tillage enrergy which is 385 0MJ /ha and the least energy is18MJ /ha used for spray. The yield is encouraging 65298kg/ha and. The energy ratio is 6.67.

Energy consumption in cotton is the highest in irrigation ie 1849MJ /ha which account for 28 followed by weeding ie 1515MJ /ha which account for 23% and the least is fertilizer application which makes use of 15MJ/ha of energy. The source –use energy gave a total of 1301 MJ/ha and the yield is 1377kg/ha while the specific energy is 9.45MJ /ha. It was concluded from the table in operation – use energy that for the five crops, irrigation energy was mostly used followed by tillage energy and spraying is the least energy. Diesel and electricity is the highest followed by fertilizer and chemical, when energy from machinery is the least.

Energy Requirement For Production Of Selected Crops

Operation/source	Rice	Maize	Groundnut	Sugarcane	Cotton
Operation-mix energy mj/ha	//////////	////////////	///////////////	/////////////	////////////
Tillage	1584	1444	958	3850	1366
Sowing	421	338	175	500	335
Bound making	57	51	17	21	136
Irrigation	15280	1765	1354	8347	1849
Weeding	15	766	822	570	515
Fertilizer application	64	945	95	558	15
Spraying Harvesting and Threashing	783	1128	1035	3107	545
Transportation	249	288	331	2631	287
Post harvest-activities	46	357	102	1535	181
Nursery	2212	-	-	-	-
Total	20,719	7,091	4,889	21,137	6,591
Sources-wise energy mj/ha	///////////	////////////	////////////	////////////	////////////////
Human	2278	1534	901	2965	1257
Animal	349	1043	241	1811	146
Diesel and Elect.	19164	3832	2368	15035	4201
Seeds		304	1141	39642	528
Farmyard manure	1657	4974	1421	1872	17
Fertilizer and	9066	3210	2903	11150	6555

chemical.					
Machinery	378	288	147	1321	297
Total	32,892	15,185	9,122	73,799	13,011
Yield kg/ha	5696	1532	1688	65,298	1377
Energy ratio	3.96	5.74	5.97	6.67	8.35
Specific energy MJ/kg	5.77	9.91	5.40	1.13	9.45

Source: Research Digest 1988.

2.3 Unit Operation in Maize Processing

The processing of maize starts after harvesting. The most appropriate time for harvesting is when the plants attain physiological maturity. The crop is mature when the kemels reach the hard dough stage. The time of physiological maturity can be accurately determined by the development of the black layer at the point of attachment of the grain to the cob. At the time of harvest, maize has a moisture content ranging from 28-35 percent. The combination of unfavourable climate conditions (high ambient temperature and high humidity) and high moisture content is conductive to spoilage by micro-organism, fungi and insect pest. Spoilage is prevented wholly or partly either by appropriate storage of maize or by processing it into various storage products.

The maize kernel consists of three major parts, viz: the hull or bran, the germ and endosperm as shown in fig 6. The bran is about 5% of the kernel, which is used as feed. The germ is about 12% of the kernel and it contains most of the oil in the maize, moreover, it is a very nutritious portion of the kernel mass and it is made up of gluten and starch. The tip cap is the smallest portion of the kernel amounting to 1%.

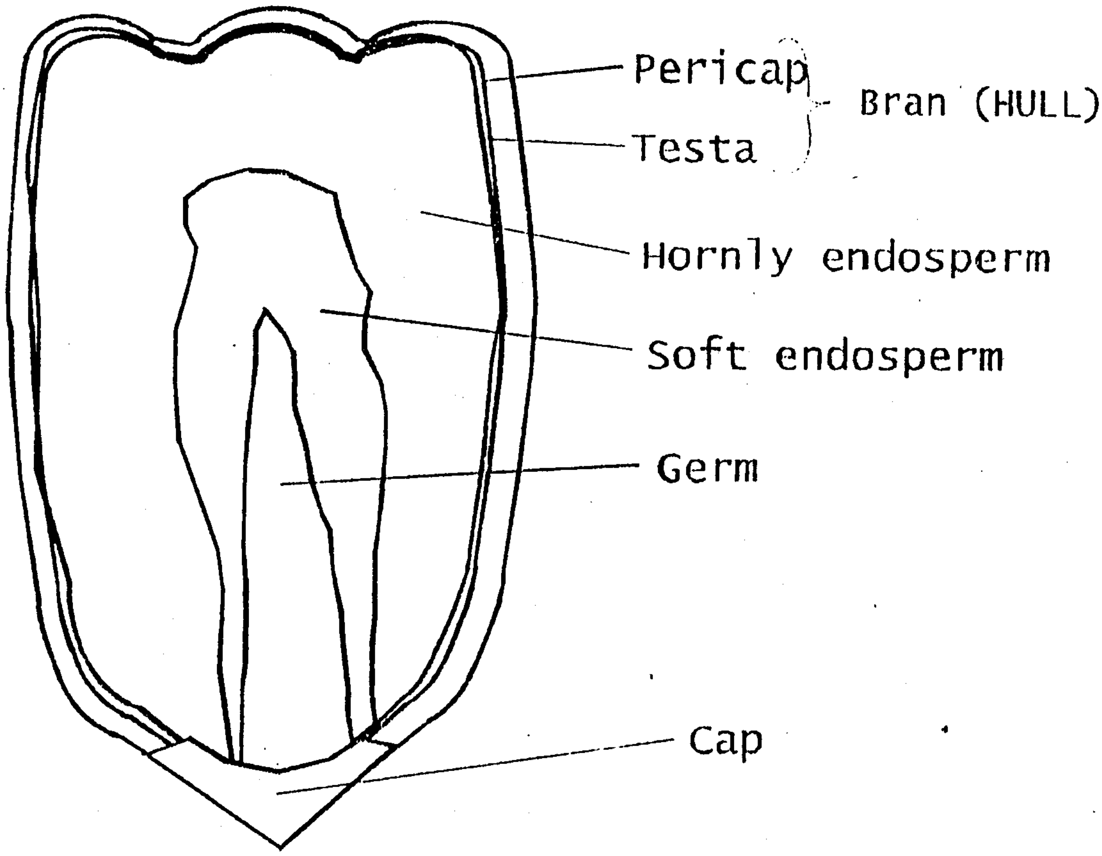


Fig 6 Structure of the maize Kernel
Source Asiedu 1989

There are two methods of maize processing viz: tratitimal and mechanized method. The fractional method makes use of mortars and pestles, grinding stone and manually operated mills, while the mechanized system makes use of machines. Maize processing mainly commences with soaking of the grain and grinding it between stones or pounding it in a mortar with pestle. During pounding it or grinding the bran is removed. The grain is winnowed at intervals to remove the bran from the kernel. The dehulled maize is then pulverized into four by further grinding or pounding. Processing of maize into desirable end products usually involves primary processing, which involves, viz: cleaning, grading, soaking, dehulling, ginding and sieving while the while the secondary processing involves blending, cooking, frying and baking.

Milling of Maize

Maize milling is of two types viz; Dry milling and wet milling. The two processing involves the separation of the germ from the rest of the grain in order to extract and recover the germ oil, the dry milling makes use of roller mills to pulverize the kernel, the removal of the germs to produce grits meal and flour whenever wet milling involves a steeping stage and complete disintegration of the endosperm, to enable the recovery of the starch and protain as separate product.

Dry milling

In dry milling the germs may be removed in a process known as degermine or May not (not-degerming) depending on the purpose or usage of the finished products. The non- degerming method produces meat with little or no removal of germ. The resulting product is rich in oil flavour because of its high fat content. The dgerming method frees the kernel of its hull and germ, and then recovers them as well as the endosperm fraction. Moisture is introduced to the corn in the conventional degerming system, under controlled conditions before degerming takes place. In the dry degerming process core having not more than

15 or 16 percent moisture is degermed without prior addition of moisture to produce grits, meal and flour.

Production Of Maize Flour

Buhler-maig method of the major production pattern for the production of low-fat maize flour as shown in fig 7. This method ensures those dry kernels are separated into flour various components by crushing the kernel in an impact-type corn degerm. The kernels are separated into various fragments as a result of difference in friability between the pericarp, endosperm and the germ. The original structure of the germ is maintained to a large extent without deformation. The corn fragment such as hull, germ and endosperm are separated by means of sifters as a result of the difference in particle size, density or its aerodynamic characteristics. The hulls are then removed by paeumatic aspiriators and the remaining frgments are sorted on a gravity table, then the germ-free fragments are milled into flour.

Production Of Maize Oil

The germs after being separated from maize kernel is the raw material used for extraction of maize oil. The germ contains about 85% of the oil in the kernel. The germs are washed, dried and heated prior to delivery into the oil extraction presses. Hydraulic presses, semi- continuous and contineous screw-type presses can be used for the extraction. If the screw – type presses are used, the germ are passed first through flaking rolls, until they are crushed into coarse meal. The meal is passed into steam- heated tempers and later into expeller unit, where they are forced under high pressure through slotted barrels made of steal sections in the form of rotating scream known as oil reel. At this stage, most of the oil is passed out through the slots while the fibrous portion and thjefoots are discharged at the end of the barred. Usually, the foots are returned to the

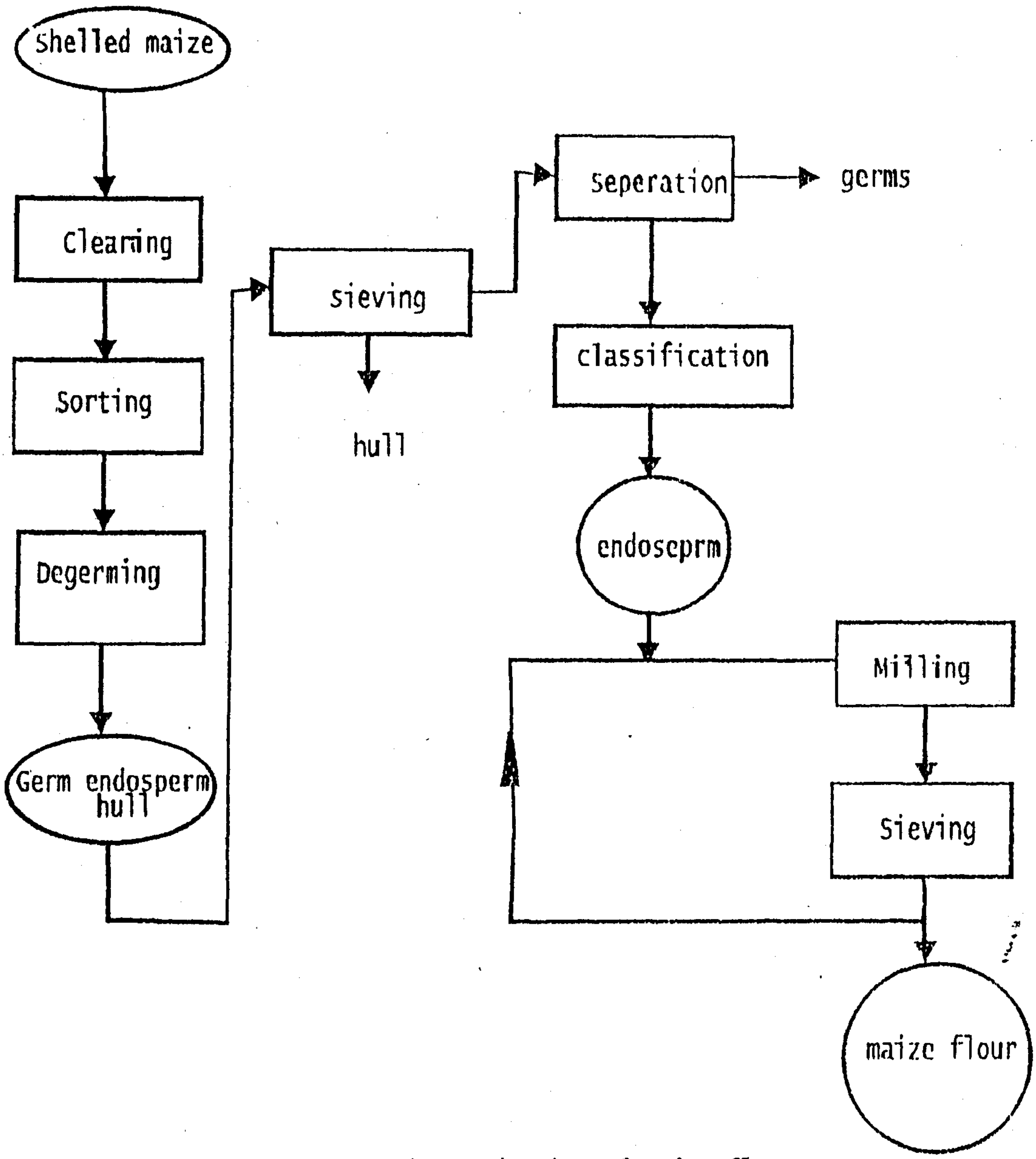


Fig 7 Flowchart for the production of maize flour
Source Asiedu 1980

expeller unit for repressing. Most often the residues still retains about 5-8 percent of its oil content.

The other method is combination of mechanical pressing and solvent extraction for obtaining oil from the germs. The solvent extraction is capable of reducing the oil content of the residue to about 0.5%. After which, the crude oil can be stored for a long time without appreciable deteriorating in that the favourable .The oil deteriation rapidly at temperature above 60 degree centigrade and the quality is drastically affected, if kept under this temperature for five days or more.

Wet milling Of Maize

Wet milling is a process, which commences with soaking the kernel to prepare them for the subsequent separation of compound. Separation is achieved by grinding, screening and centrifugal action. Maize dried at 82 degree centigrade or high is less suitable for wet milling than kernel dried at lower temperature. The former results in a lower starch yield due to the pressure of hardened endosperm particles, which become resistance to milling as a result of high temperature drying. Wet milling of maize gives the following components, viz: starch, oil, feed (glutenfeed, glutenmeal, germcake) and the hydrolysis products of starch such as solid, liquid glucose and syrup. The unit operations in maize wet milling are as shown in fig 8.

The steeping of maize is achieved by soaking the kernel in tri-oxo- sulphate (iv) acid water for 36-48 hours at a temperature range of 50-55 degree centigrade. The steeping is carried out to enable the maize produce optimum milling and separation qualities, that is to soften the maize kernel for grinding and to enhance disintegration of the protain that holds the starch granules together in their kernels and to remove solubles mainly from the germ in order to make it easier for recovery.

Tri-oxo-sulphate(iv) acid water which consists of 0.1-0.2 percent sulphur iv oxide in water prevents germination of the grain, undervariable microciological charge and limits fermentation but allow growth of reactic acid producing bacteria. The acid serves as a buffer to the PH value and increases soften of the kernel. The water is concentrated in vaccum everporation from 35-55 percent solids and it is used either in animal feed or in nutrient in some fermentation process.

The steeped maize at a moisture content of about 45 percent is passed to the degermination mill, when the oil-rich germs is separated from the starch, fibre, gluten and hull. The deherminating mill is a machine made of a stationary and a rotating metal plate with projecting teeth. It is design in such a way as to tear the soft kernels and to free the germs without counting them. The ground materials containing germs, starch and gluten are allowed to pass through hydrocychones or washed free of starch, dried and conveyed to the oil extraction plant

The removing components, after the degermination of the maize kernel are starch, gluten and hulls. These components are fed into altrition or impact mills, where the wet merh is sieved in ground to release the starch. The milled sloppy is sieved in screen to separate the fibre content from starch and gluten. The fibre is mixed together with steep water before drying to produce feed products.

Starch and gluten slurry known as milled starch contains about 5-8 percent protain, which is separated into individual components. A long narrow slightly inclined wooden trough usually called table is used in the separation of gluten from starch. The starch –gluten slurry is allowed to flow slowly down the tables and sedimentation occurs with the denser starch depositing at the bottom and the gluten being removed at the top of the lower end of the tables. The common traditional practice is to use a large wooden or concrete tub to' hold the slurry until the starch settles at the bottom.

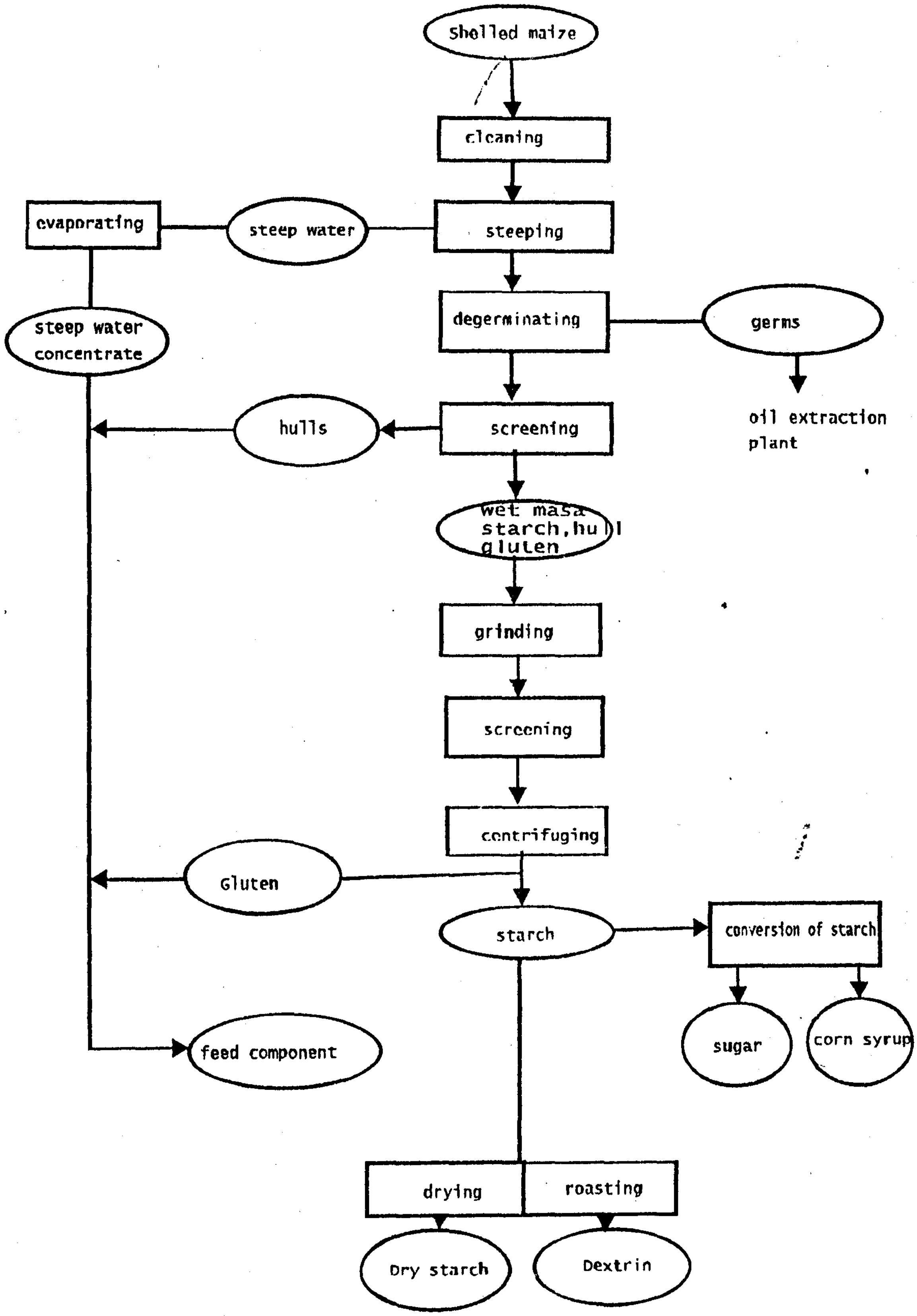


Fig 8 Simplified Flowchart for starch dextrin sugar ,corn syrup and feed component
Source Asiedu 1989

Modern production system makes use of centrifugal separator to achieve separation unlike the traditional methods. The making principle of the separators are facilitated, as a result of density difference, in that, heavier starch is separated from lighter gluten by centrifugal force. The wet starch from the centrifugal is deviated and finally dried in tunnel drers. The gluten after centrifugation is deviated and destarches in another centrifuge then filtered and dried as core gluten meal or core gluten feed or further processed to recover the protein (zien), which has many non- feed uses.

Corn-syrup and corn-sugar are produced by acid conversion of cornstarch. Syrups are made by partial hydrolysis of starch and corn sugar by complete hydrolysis (Asiedu/1989). Hydrochloric acid is usually preferred to catalyse the reaction despite the fact that, any other mineral can be used for the conversion. The process entails boiling the starch slurry with the required amount of dilute acid until the desired degree of conversion is reached. The reaction is terminated by the help of Sodium

Carbonate, which is used for the neutralization .The floating solid and other impurities, are filtered out before the syrup is finally bleached and concentrated to the desired density. During the production of corn sugar, the conversion is allowed to attain completion before the liquor is neutralized, filtered, clarified and concentrated; finally, the whole mass is allowed to crystallize into sugar corn syrups and dextrosehane many food application. They are used in pharmatical industry and feed produce.

Production of Pozol

Pozol is a fermented maize dough shaped into balls of various shapes and sizes, 10-12cm long and 5-8m wide, weighing 70- 170g each. Pozol is prepared by boiling maize kernel (1-1.5kg) for about one hour in 2 litre of water to which a hand full of lime has been added to give approximately 10percent of lime water.

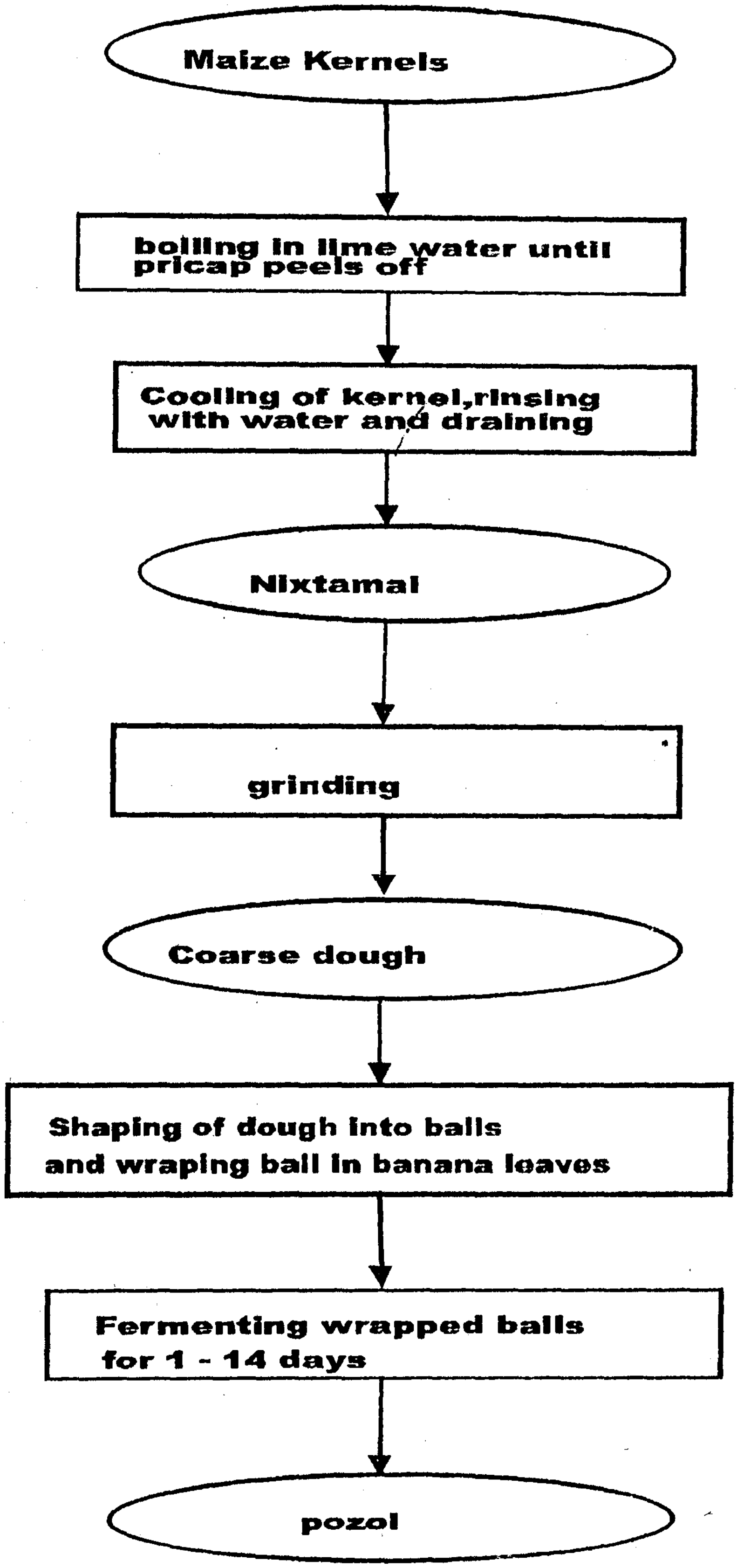


Fig 9 Flowchart for processing of pozol

Source Asiedu 1989

When the kernels are swallen and their pericarp peel off, they are cooled, rinsed with water and drained to obtain, what is called nixtamal as shown in fig 9. The nixtamal is ground into coarse dough, which is then shaped into balls by hand. The balls of pozol are finally wrapped in barma leaves and left to ferment for 1-4 days or more depending on the taste f the consumer.

Production of cornflakes

Cornflakes are obtained when maize product are treated hydrotherically. It is consumed worldwide due to their high nutrient values coupled with low caloric content and good digestability. Flaking is achieved by cooking fragments of cereal kernel, grits to a certain consistency and pressing the cooked mass between rollers to form flakes, after which the flakes are tasted at an appropriate temperature as shown in fig10.

Cornflakes are produced mainly from grits, which is obtained from the Horney endosperm of maize kernel. The grits left the removal of the germs and hulls are cooked for 2-2.5 hours at a temperature of 120 degree centigrade. When some ingredients such as core syrup, sugar, salt and vitamins are added. The cooked grits are passed into driers in which preheated air is blown to reduce the moisture content to about 15%. The dried materials are kept in tempering tunks for 6-8 hours to allow the residual moisture to spread equally in order to ensure uniform toughners for flaking.

The tempered grits are pressed into flakes in flaking rolls revolving at a speed of about 180-200rpm. The rolls are allowed to cool by internal circulation of water to avoid sticking of the flakes to the rolls and then he flakes with less than-5% moisture content are obtained from the oven and after cooling to room temperature are packed.

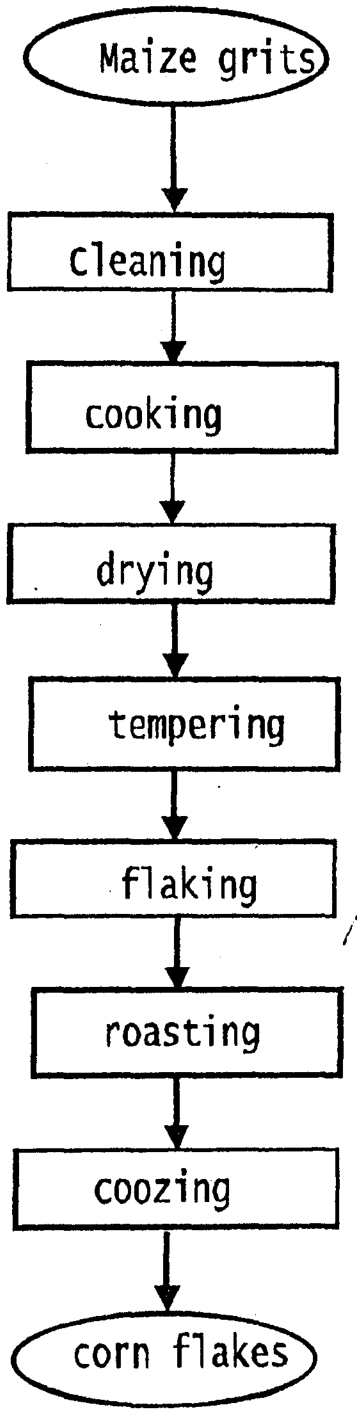


Fig 10 Flow chart for the production of cornflakes
Source Asiedu 1989

2.4 Previous Related Work

Onyenechinde (1884) studied energy consumption in post harvest processing operation of rice in Nigeria. The two mills used for the study were Adarice production limited and the World Bank Rice Project (WBRP) Adani, both located in Enugu state the study presented the energy used in all the unit operation of both mills. The unit operation involved in the processing are as follows viz: Pre- milling, pre_ parboiling cleaning, parboiling milling and post milling .One of the factories, Adairice production company is a semi-mechanized esterblishment. Parboiling in this mill was done by traditional drum method and lab, steam boiler and mechanical dryers. The different stages of energy consumption was determined and analysed , namely; pre- milling, milling and post- milling operation.

The harvested paddy undergoes some processes to be converted to the final primary product known as milled rice. The evolution of modern technology in rice processing has lead to high quality final product as well as increased energy efficiency. The technology employed and the quality of the paddy being processed determines the type and amount of the parameters required for energy computations.

The various machines and equipment used in processing operation consume energy in form of fossile fuel such as coal and natural gas, biomas, electricity and sofar energy. As the scale of operation increase, energy must be covered in the various production phases, as in the case in advanced countries.

The unit operation involved in the processing requires some level of energy in form of thermal, electrical and human energy. For WBRP the gross thermal energy consumed was computed and it gave 2680284kj/tornes of paddy which yield 416445kj/tunnes of rice. The value as obtained here represents the gross heat content of the diesel fuel used, which is not available in real practice. The electrical energy computed was higher than the actual energy consumed because the motors were not operated at their full capacities. The total human energy consumed to produce one tonne of rice was 3.482MJ/c.

The study equally showed that at Adarice, the thermal energy obtained was not used much except during the raining season. Moreover the total human energy requirement was 9.119MJ/t

Onyenechinde(1984) was able to estimate the total energy requirement in both mills. The results showed that for WBRP 1250kwh of energy was consumed to produce 1 tonne of rice while Adarice consumed 1286 kwh to produce 1 tonne of rice.

CHAPTER THREE

3.0 METHODOLOGY

The research method adopted in this project work was based on an investigative survey in an established industry. In addition, valuable information were obtained from the previous work done on energy consumption in rice processing operation in Nigeria (Ezeike, 1987).

IDEAL FLOUR MILLS LTD (IFM) was visited for data on energy consumed in maize processing of the factory. The data was collected using questionnaires, personal interviews with the workers and careful observations moreover, available documents and literature on maize processing were reviewed assumption were made where necessary.

The main source of energy in the factory is electricity and they depend solely on NEPA, which implies that they rarely use a stand by generator. They do use fuel or diesel to power their plant for their production. Consequently, the data on maize processing related to electricity and other relevant details were collected for the purpose of this work. The information includes quality of maize in kg, the electricity consumption in kwh and time of operation. Moreover, the name plate of the electric motors in the various sections was visited to collect the power rating of the motor where possible.

The energy required for different unit operation for both human and mechanical system was estimated. The human energy required to perform different operations were estimated from standard task rates using man-hours required to perform the unit operation. The information required for determining human energy input include number of persons engaged in the operation, quality of material handled at each stage.

3.1 HISTORICAL BACKGROUND

Ideal flour mill (LTD) limited is a company owned by 60% Nigerian and 40% Lebanese. The company was established in 1982 but it started production 1986. The company is located at Nassarawa Kaduna, Kaduna state of Nigeria.

The installed capacity of the plant is 72 tonnes per 24 hours and the major production activities are milling of maize and wheat. The production is mainly on request from customers and at full capacity. The major source of raw material is through direct sourcing from local suppliers especially from the northern part of the country.

The company has five departments, viz; Quality control, production, store, marketing and account as shown in figure 11. The finished products are bagged in 50kg and 10kg for industrial and domestic use respectively.

3.2 DESCRIPTION OF PRODUCTION PATTERNS

In Ideal flour mill ltd. Industry as soon as the maize arrives for processing. The quality control measures/test conducted in order to find out the quality of the maize before approval and storage in the silos are as follows;

1. Visual inspection which implies that the maize should be whitish in colour and of uniform size for maximum yield.
2. The maize must be free of weevils.
3. There should be no odor or aroma from the kernel mass.
4. The moisture content must be below 4.0 before cleaning to 4.8 minimum before milling.
5. There should be no form of infestation by micro-organism eg bacteria.
6. The maize must not contain more than 10% broken grains as well as stones.
7. The maize should be free of black spots, dust and impurities.

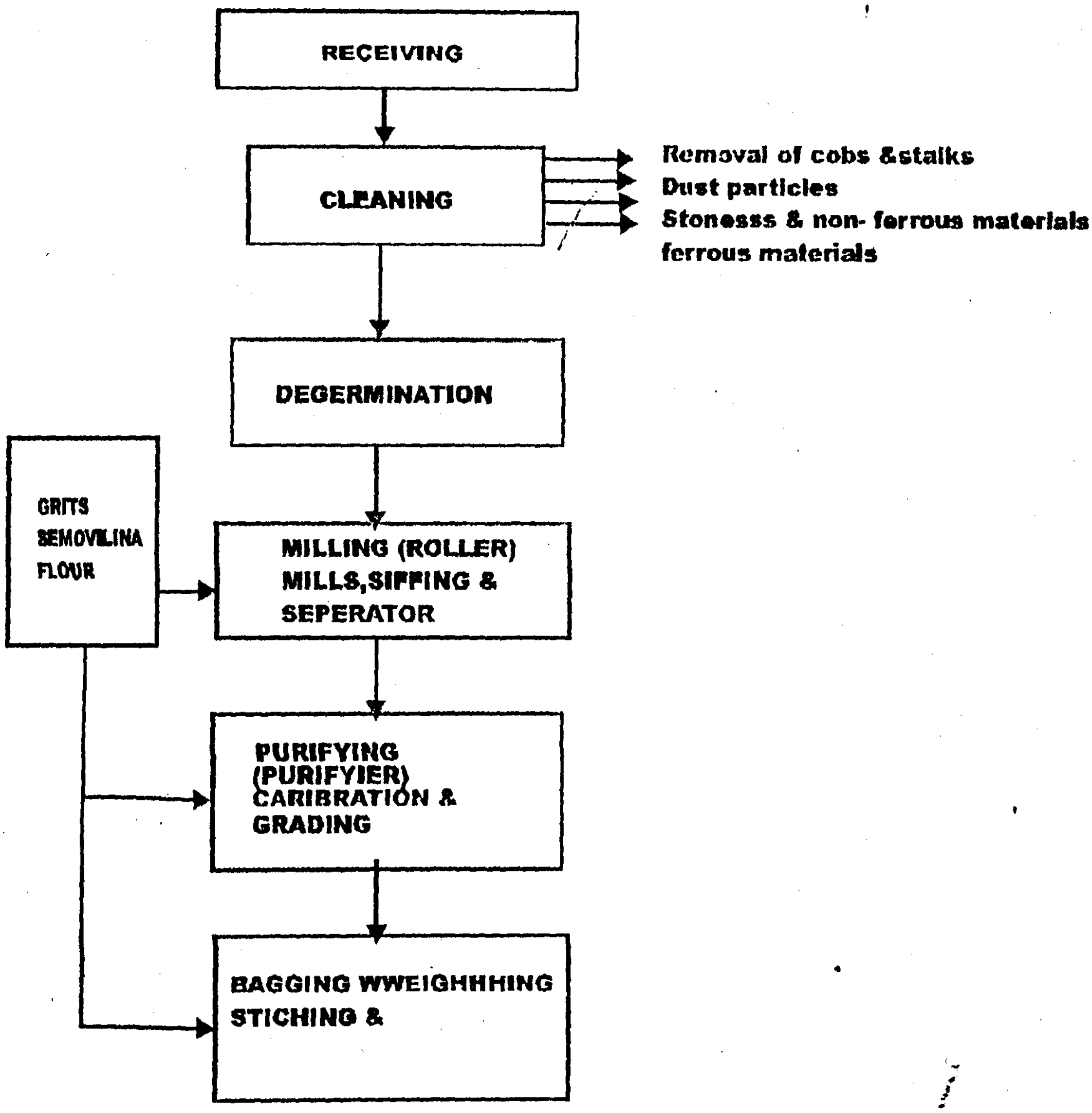


Fig 12 Unit operation involved in (I.F.M)

If the maize falls within the specification as regards the stipulated quality control standards. The lorry that is carrying the maize is weighed in the weight bridge to determine the quantity supplied. The bags containing the maize are discharged in the silos via screw auger. The maize is stored in the silos and the quantity received per batch is 30,000 tonnes, total silo capacity is 10,000 metric tonnes per cell of 20 cells.

Maize processing in Ideal flour mill (IFM) involves the following units operation, receiving, cleaning, degermination, milling, purification and packaging as shown in figure 12. the processing commences as the maize stored in the silos are delivered to the receiving hopper through the help of conveyors. The maize then was conveyed by screw conveyors to bucket elevator which lifts the maize up to the storage bin and as the maize was passing, the aspirator sucks up the dust particles before the maize proceeds to tempering bin for condition.

The scaling mechanism weighs 25kg of maize at a time after tempering to a conveyor, which transfers it to the grain separated from the rest of the maize. After cleaning the maize goes to the degermination machine, which tears the maize kernel apart to free the germs before passing it to gravity table. The table separates the germs from maize kernel after which all the other components were sent to roller mills for adequate size reduction. Each roller mill produces grits, semolina, semovita, flour and total depending on the amount of maize being processed and the end use. Metering mechanism which is in the form of a bucket and tips 100kg of maize when full with a timer depends on how fast.

Cleaning section

The pre-cleaning operation starts from the receiving section where big cobs, sticks and stalks are removed by wire mesh screen. The second stage of cleaning starts with aspirator fans which blows off light impurities such as dust particles as the maize falls down before entering the grain separator. The grain separator by its centrifugal action does the actual work or removing maize cobs, stalks and other non- ferrous materials.As the falls down from the grain separator it hits the magnet which was laid below the separator the first materials are magnetized by the magnet therefore, trapping them while the clean maize proceed to the degermination machine.

Degermination section

The degermination machine consists essentially of one stationary and one rotating metal plate with projected teeth designed for tearing the soft kernels apart and leaving the germs without crushing them. The fragmented maize is dropped in a worm conveyor, which is lifted in a bucket elevator to another worm conveyor that transfers it to the 1st sifter of 26 micro layers. This sifter does the initial work of separating the maize into different components by the help of the sieves.

The 1st layer of the sieves collects the brans or hulls, which is sent to the cones. The 2nd layer returns some torn maize to the degerminator. The 3rd layer no. 8 passes the components through receiver to gravity tables T1, which vibrates in order to separate components as a function of specific gravity. Then the grounded maize are carried by bucket elevator and through the help of a pneumatic electropan is sucked by negative pressure to plan sifter. The plan sifter contains a shaker, which vibrates in an anticlockwise direction centrifugally to achieve separation of material through sieves of different micron sizes. The purifier classified the products and dusty particles such as semolina and flour etc. are graded, after which most of the products were sent to bagging section.

3.3 Unit operation involved in maize processing of (IFM) receiving section

In IFM the maize to be processed are stored in silos beside the factory. During the processing operation the maize are passed through the receiving section where some of the foreign particles like maize cob and other particles bigger and smaller than the maize are removed see figure 13 and 14 for flow chart and plant layout respectively.

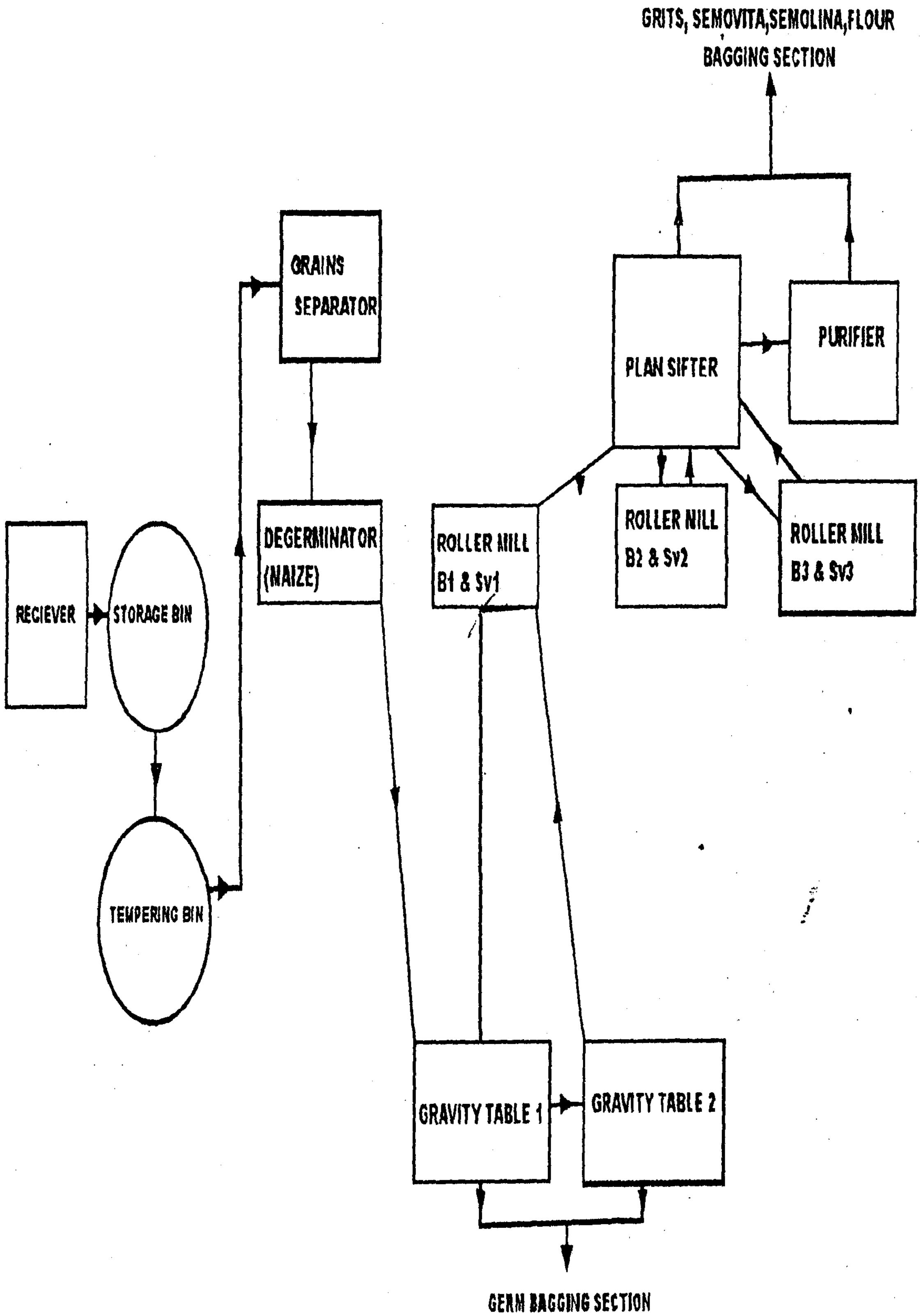


Fig 14 Plant Layout of Ideal Flour Mill LTD (IFM)

The maize is delivered into the worm conveyor at rate of 7.2 t/h. the conveyor deposits it into the bucket elevator which transfers it to a storage bin of 100 tonnes capacity.

The maize from the storage bin is passed to a second worm conveyor through a manual slide gate which transfers the maize to another bucket elevator. The bucket elevator transfer the maize to a worm conveyor where tempering takes place. Usually the moisture content of the maize before tempering 14.0 – 14.8 dry basis. The tempering involves pouring a calculated amount of hot water to the maize kernel in order to soften it. The capacity of the tempering bin is 160 tonnes and it delivers the maize to a collecting cone which passes it to a control scale. The control scale is a automatic. The 4th layer no 14 transfers its contents to 2nd gravity table, T2. The two gravity table now separates the germs from the other components of maize. The 5th layer transfers its components that are bigger than the sieve diameter into the 3rd receiver, T3 of SV2 roller mill prior to milling while those of less diameter are passed to DIV purifier.

The gravity table after separating the germs from the other components, transfers the germ to bagging section, where more germs from sv1 sifter joins the line. When the two ways values opens the germs are collected and stored in bags. The middle collector of the gravity tables collects some germs is still mixed up with the other components and sent them back to the 1st plan sifter again for more separation. Then the 3rd collector of the gravity table collects the other components excluding the germs for onward processing in B1 roller mill.

Milling section

In the milling section are standing machines, with 10 roller mill, which are in stands.

First machine

The proper milling starts in B1, B1 Sv1 roller mills which initiates the milling action immediately after degermining B1 roller mill reduces the sizes of the products to produce grits, meal and flour. The milled components are sent to plan sifter. The first chamber of plan sifter which receives milled kernel from B1 and Sv1 roller mills have 26 layers of micron sizes each, which is used in separation of the particles by sieving. Compartment no. 8 of B1 plan sifter contains 6 layers by 2970 micro sizes and the particles that didn't pass goes to SV1 roller mill for further size reduction. The 2nd compartment no. 18 passes the components that didn't pass to B2 roller mill. The 3rd compartment no . 3 transfer the components that didn't pass to S1 purifier. The no. 48 passes its product which is flour through the two way valve to flour bagging section while those components that didn't pass were sent to S4 purifier.

The Sv1 roller mill transfers its component to the plan sifter where the 1st compartment, no 7 sieves and those that didn't pass are sent to the meal bagging section. The 2nd sieve, no 29 transfer the components that didn't pass to SV2 roller mill. The 3rd sieve, no. 30 and 4th sieve, no. 60 transfers their components that did not pass to S1 to S4 purifier respectively and those that passed are sent to flour bagging section while other particles in form of that are bagged as animal meal.

Second machine

The second machine continues the milling process. The B2 roller mill transfers to the 2nd chamber of the plan sifter were sieving takes place in sieve, no. 12 and those that didn't pass are sent to Sv1 roller mill for subsequent milling. The 2nd sieve, no. 18 transfer size reduction. The 3rd sieve, no 30 transfers those that didn't pass to 32 purifier while those that passed goes into the first sieve ,no 60 where those that didn't pass are sent to either semolina bagging section or B3 roller mill depending on the quality of the produce and the rest are bagged at flour.

The components that were transferred from other operations are sent to SV2 roller mill for more size reduction, after which on reaching the first sieve,no 18 of the second chamber of the plain sifter ,those that didn't pass are sent to animal mill bagging section. The second sieve ,no 30 and third sieve ,no 60 transfers those that didn't pass to S3 and S4 purifiers respectively, while those that passed are bagged in floor bagging section.

Third Machine

The components of the milled maize do not get to the third machine most often ,in that before getting there a lot of them must have separated and graded .consequently B3 an SIZ roller mill perform less function when compared to the other two .The B3 roller mill on transferring its components to third chamber of the plain sifter ,the first sieve no 18 sends components that didn't pass back to SV2 roller mill while that pass continuous there journey till they get to sieve no 50 .The materials that didn't pass are transferred to S4 purifiers and those that pass are bagged in the flour bagging section.

The SIZ roller mill do not participate in the milling until the components must have passed through the sifter and purifying sections roller mill transfers its components to plain sifter for sieving and what is mainly left there is flour and animal mill which is equally bagged.

Purifying section

Purifying takes place after milling, but then, the various components of maize kernel must have passed through the plain sifter for appropriate separation. The purifier performs the following functions viz: sieving, calibration and grading. Calibration entails bringing products of the same micron sizes together and bagging them through proper setting.

In the purifying section, The 1st chamber of the purifier SI receives the milled components for B2 roller mill and after purification, the components that didn't pass the sieve is bagged as animal mill while the 2nd sieve transfer the remaining materials to SV2 roller mills .The 2nd chamber of the purifier ,S2 transfers its components that didn't pass through the first sieve to SV2 roller mill and those that pass to B3 roller mills. The third chamber transfer those that pass the 1st sieve to grits bagging section and the remainder to

SIZ roller mill while those that didn't pass are bagged as animal mill .The 4th chamber transfer those that pass to the first sieve to SIZ roller mill while the remainder is transferred to animal mill bagging section.

The DIV sifter within the purifying section does the final separation and grading of the flour and animal mill after receiving the materials from the first plan sifter and turbo sifter .The turbo sifter is a bran finisher which separates the semolina from the bran through the help of sieve before bagging.

3.4 Analysis of energy consumption in the mill and assumptions

Electricity is the main source of energy consumption in the mill. This lead to my singularly focused interest in the electrical energy consumption for the different operation. The main problem I encountered in the estimation of the energy consumption is that the processing of the maize in IDEAL FLOUR MILL is not by batch method, it is a continuous method therefore, I find it very difficult to collect the data required to estimate the energy consumption per unit operation. The data collection to that effect entails measuring the actual quantity of material passing through operation in hours and the power consumed by the machine in kilowatts, since it is not possible to dismantle the machine for this purpose.

This now, lead to my searching for the name plate of the electric motors, used to power the machines to enable me determine the power consumption of the motors. The following data was obtained from the name plate the power rating. The time of operation and quantity of material handled were equally obtained although I assumed that the rate of material is constant throughout the processing operation excluding the flow rate at the receiving section and therefore degermination.

The analysis of the energy consumption was done per unit operation. The aim was to determine the magnitude of energy consumed by a particular operation as well as to facilitate the easiness of the computation.

3.4.1 Electrical energy requirement in the mill

The estimation of energy consumption in the mill is as follows;

Receiving section

The receiving starts from 20 cells silos. A screw conveyor is responsible for conveying the maize kernel to the receiving hopper. As soon as the maize kernel is emptied into the receiving hopper, the following activities take place;

1. A worm conveyor, W.C delivers the maize to an elevator
2. The bucket elevator transfers the maize to the storage bin
3. The maize from the storage bin enters another worm conveyor.
4. The worm conveyor transfers the maize to another bucket elevator
5. The bucket elevator delivers the maize to a worm conveyor where water is added for tempering before proceeding to tempering bin.
6. The maize from the tempering bin through the help of control scale meter 100kg of maize to another worm conveyor.
7. The worm conveyor transfers the material to a grain separator via another bucket elevator.

In all, there are 6 worm conveyors and 2 bucket elevator the 6 W.C and 2 bucket elevator operate at rate of 7.2t/h while 1 worm conveyor and 1 bucket elevator operate at the rate of 6.8t/h.

Power output of the worm conveyor = 1.1kw

Power output of the bucket elevator = 4kw

Rate of flow of material = 7.2t/h

Number of the electric motor for worm conveyor = 6

Energy consumption of the electric motors can be estimated as follows;

For the first 3 worm conveyor (W.C) at 7.2t/h

= 1182.1 kj/h

Therefore the energy consumed in the receiving section Er,

= 3300 + 4000 + 591.0 + 2149.2 + 1182.1

= 11222.3 KJ/h

= 3.117 kwh/t

Cleaning section

The cleaning machine which is the grain separator, has only (2) two aspirator and three (3) fan high pressure fan with big two iron blade, when rotates anticlockwise it sucks to air cycles and airlocks are three (3).

Power output of aspirator = 0.12kw

Power output of fan = 15kw

Power output of airlock = 0.55kw

Number of electric motor of aspirator = 2

Number of electric motor of fan = 3

Number of electric motor of airlock = 3

Energy consumption of the electric motors can be estimated as follows.

For the two (2) aspirator at 6.7 t/h

= n x p x r

= 128.8 KJ/t

For the three (3) fan at 6.7 t/h

= n x p x r

= 24178.5 KJ/t

For the three (3) airlock at 6.7t/h

= n x p x r

= 886.5 KJ/t

$= n \times p \times r$ and $r = t/w$

where n = no of conveyors

p = power in kw

t = time in seconds

w = weight of material in tonnes

r = rate of processing of materials

$= n \times p \times r$

= 3300 KJ/t

For the first 2 bucket elevators

$= n \times p \times r$

= 4000KJ/t

When the flour rate has been decreased to 6.7 tonnes per hour. This implies that the control scale which tips 67kg of maize kernel per hour must have tipped 100 tonnes.

67kg x 100 = 6700kg

Divide by 1000 to convert to tonnes = $\frac{6700}{1000}$ = 6.7 t/h

For the 1 W.C at reduced rate of 6.7t/h

$= n \times p \times r$

= 591.0 KJ/t

for the next bucket elevator at reduced rate 6.7t/h

$= n \times p \times r$

= 2149.2 KJ/t

The control scale is also motorized; the motor helps in regulating the quantity of maize that passes at a time. The scale has one motor and the power output or 2.2kw

$= n \times p \times r$

Therefore total energy consumed for using operation Ec;

= 128.8 + 24178.5 + 886.5

= 25193.8 KJ/t = 6.99 kwh/t

Determination section

The maize enter inside the degerminator machine through gravitational fall. The degerminator has two (2) electric motor which supplies power to it. After tearing the maize apart to free the germs the degermination machine delivers the fragmented kernel to worm conveyors which transfer it to a bucket elevator. The elevator passes its component to anther worm conveyor through a two way gate. The worm conveyor now sends the material to the 1st plan sifter. The sifter distributes the material after sieving to different channels where subsequent actions will be taken. Still under the degermination section are gravity table that do the final germ separation. After which the other components are sucked and transferred into a container. The container passes it component to the fourth conveyor which finally transfers it to the roller mill for grinding. Then some component that still mixed up with germs are recycled to plan sifter for subsequent sieving through another worm conveyor.

Energy computations are as follows:

For degermination machine the power output = 90 kw

The rate of material flow = 6.7 t/h

The number of electric motor = 2

Energy consumption = n x p x r

= 96716.4 KJ/t

= 26.8 kwh/t

For the first plan sifter, power output = 4 kw

Processing rate = 6.7 t/h

Number of motor = 3

Energy consumption = n x p x r

= 6447.6 /t

for the bucket elevator power output = 4 kw

Processing rate = 6.7t/h

Number of motor = 1

Energy consumption = n x p x r

= 2149.2 KJ/t

For the gravity table power output = 8.5 kw

Processing rate = 6.7t/h

Number of motors = 2

Energy consumption = n x p x r

= 9134 KJ/t

For aspiration system used in degermination section, there are two cyclone that supplies air through fan for this operation

Power output = 30kw

Processing rate = 6.7t/h

Number of motor = 2

Energy consumption = n x p x t

= 32238 KJ/t

for water gauge for conditioning of the grain before milling

Power output = 0.33kw

Processing rate = 6.7 t/h

Number of motor = 2

Energy consumption = n x p x r

= 3554.6 KJ/t

The total energy consumed for degerminator, Ed;

Ed = 96716.4 + 6447.6 + 2149.2 + 9134 + 32238 + 354.6

= 147039.8 KJ/t

= 40.8 kwh/t

Milling section

The maize after degermination enters the milling section for proper grinding and size reduction by the roller. This implies that the germ free fragments are milled into flour and passed to the plan sifter for separation. The separation is based on the differences in particle size and aerodynamic characteristics of the components. The sequence of operation in the milling section is as follows.

1. First of all the material to be milled enters the B1 roller mill
2. B1 roller mill sends the milled maize into the first chamber of plan sifter
3. The plan sifter passes the component to B2 and Sv1 roller mills after sieving
4. SV1 roller mill, after more reduction in the sizes of the component transfer to the second chamber of the plan sifter.
5. The second chamber of the plan sifter transfer the component to Sv2 roller mill
6. B2 roller mill transfer the component to the third chamber of the plan sifter
7. The third chamber of the sifter transfer to B3 roller mill and subsequently to Sv1 roller mill again
8. SIZ roller mill collects material from purifier, after further size reduction then send to plan sifter.

The mill starts from B1 mill or 1st break rolls. Energy requirement for the mills are as follows;

There are ten (10) roller mills and 3 sifters working at the time of my visitation. Each and every one of the roller mill and the chamber has its electric motor.

Also, since the maize kernel consist of 1% tip cap, 5% bran, 12% germ and 82 endosperm (Asiedu J. J, 1989). I assumed that after removal o germ's the percentage of material passing must have been reduced by 12%

Rate of processing after degermination

$$6.7 \times \frac{88}{100} = 5.8 \text{ t/h}$$

For the roller mill, power output = 18.5kw

Rate of processing = 5.8 t/h

Number of electric motor = 10

Energy consumption = n x p x r

= 114827.5 KJ/t

For the plan sifter chamber, power output = 4kw

Rate of processing = 5.8 t/h

Number of electric motor = 3

Energy consumption = n x p x r

= 7447.2 KJ/t

The milling section aspiration system makes use of cyclones, the principle of operation of the cyclone is that the air, filled with maize particle enter or falls tangentially at the top into the cylindrical separator chamber. Thereafter, a rotating motion is formed in which the centrifugal force acts on the maize particle and forces them to the outside while the force of gravity tends to draw the particle downward. The particles move spirally downward under the influence of these forces into a collector while the air is discharged at the top.

There are two cyclones each having a fan and the fan are operated by electric motor.

Energy requirement for the cyclones is given by

Power of the fan = 90Kw

Rate of processing = 5.8t/hr

Number of motor = 2

Energy consumed = n * p * r

= 111708 KJ/t

Pneumatic aspirator

The pneumatic aspirator generates the air which is used throughout in transportation of the material from one section to the other. The movement of the air through the channels helps in separation of material as regards to aerodynamic characteristics.

I assumed that energy consumed by the pneumatic aspirator is part of energy consumption of the milling section of the aspirator since pneumatic aspirator is equally located in the milling section

Energy requirement for the pneumatic aspirator

= 111708 KJ/t

total energy consumed during the milling operation

Em = 114827.5 + 7447.2 + 111708 + 111708

= 345690.7 KJ/t

= 96.0 kwh/t

Purifying section

The purification is the final stage of the processing operation that most of the component must have reached sifting and purifier before getting to bagging section. In other to complete the computation of the energy requirements/assumed that the processing rate is still 5.8 t/h. the purifier have four chambers used for calibration and grading after receiving material from the plan sifter.

The other machines present in the purifying section are DIV sifter.

Energy computations for the purifying section are as follows;

For the purifier chamber power output = 0.75 kw

Processing rate = 5.8t/h

Number of motor = 4

Energy consumed = n x p x r

= 1861.8 kj/t

For the DIV sifter power output = 2.2kw

Processing rate = 5.8 t/h

Number of motor = 2

Energy consumed = n x p x r

= 2730.6 KJ/t

for the purifying section there is one cyclone which generates air for lifting of milled maize component.

Fan power output = 30kw

Processing rate = 5.8 t/h

Number of motor = 1

Energy consumed = n x p x r

=18618 kj/h

Total energy consumed for purifying, Ep,

Ep = 1861.8 + 2730.6 + 18618

= 23210.1 KJ/t

= 6.4 kwh/t

Bagging section

The energy used in bagging section uses 2 motor, as the components leaves milling/purifying section to bagging section. The bagging machine is motorized of 50kg per bag at 45 seconds. I assume the flow rate to be the same as 5.8 t/h because the same time of tip from the milling section

Power output of the motor = 0.55kw

Number of motor = 2

Energy consumption = n x p x r

Rate of flow = 5.8 t/h

= 715.6 kw/t

Stitching section

As the filled bags leaves the bagging machine by a conveyor to the stitching section. The stitching mechanism motor is motorize, stitched a bag per 45 seconds.

Power output of the motor = 0.55kw

Number of motor = 2

Energy consumption = n x p x r

Flow rate = 5.8 t/h

= 715.6kj/t

= 0.19kwh/t

assumed also the same flour rate because of the same flow continuous process.

The total electrical energy consumed in processing operation

Ee = Er + Ec + Ed + Em + Ep + Eb + Es

Ee = 3.11 + 6.99 + 40.8 + 96.0 + 6.4 + 0.19 + 0.19

Ee = 153.8 kwh/t

3.4.2 Human Energy Requirement in the processing operation

I assumed that one man-hour is one-tenth of a horse power i.e. 1/10 hp = 0.0746kw. Moreover, I assumed that the rate of doing work by man in plant (main) is the same as the flow rate of the material in the plant.

$p = 0.0746$

$n = 2$

$r = 5.8$ t/h

$= 92.5$kj/t

$= 0.03$kwh/t

total energy supplied by man; E_{man};

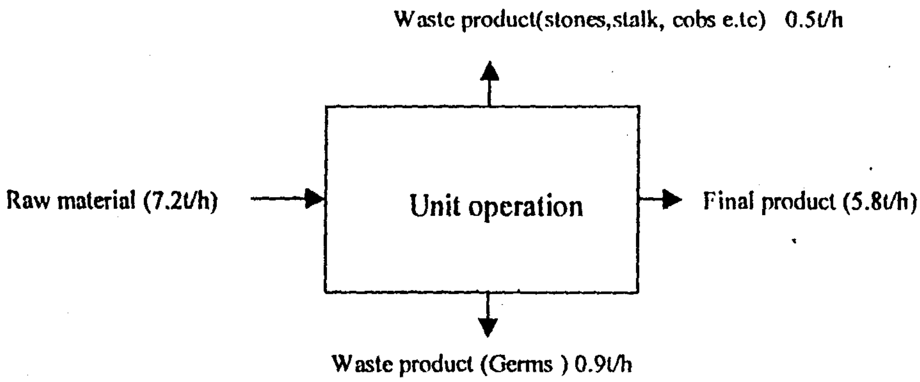
$E_{man} = Em_p + Em_b + Em_s$

$= 0.08$kwh/t + 0.03kwh/t + 0.3kwh/t

$= 0.14$kwh/t

$= 504$kj/t

3.4.3 Material and Energy balance

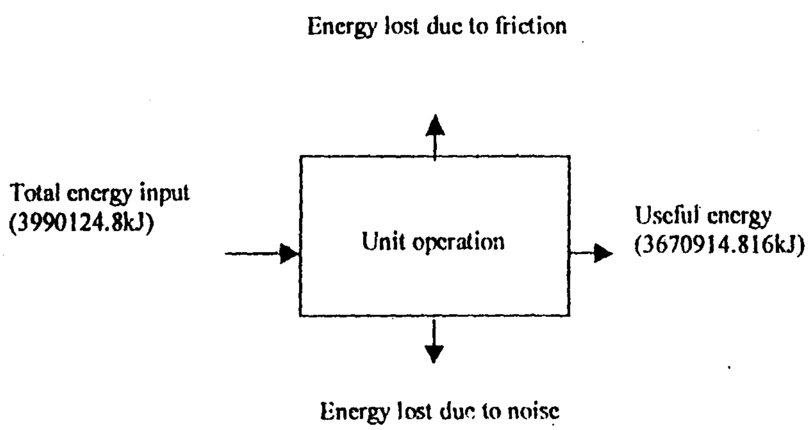


Total raw material $= \sum$ waste product + Final product

$= 0.5 + 0.9 + 5.8$

$= 7.2$t/h

Energy balance



Total energy mass =$\sum$energy lost + useful energy

3990124.8 = 3670914.8+energy lost

energy lost(kJ) = 3990124.8-3511309.824

=478814.976kJ

$$\text{Relative efficiency } \eta = \frac{\text{energy used}}{\text{Total energy input}} \times 100\%$$

= 88%

3.5 Problems encountered

Management problems

1. The major problem militating against smooth operation of the company is incessant power failure by NEPA
2. The procurement of raw material (maize) for production is epileptic, due to galloping increase in the price of the commodity.
3. Scarcity of raw material (maize) has done more harm than good compared to price increase, given the fact that maize is a seasonal crop as a result getting enough quantity to buy is a dilemma during planting season.
4. Provocative tax rate by government agents lead lower turnover.
5. The general country economy.

Milling section

i. Overloading of conveyor leads to machine breakdown and poor quality products.
ii. The incessant power failure can cause malfunctioning of the machine.
iii. The reaping of sieves which leads to mixing and improper separation of the production
iv. Improper setting of the machines of inadequate maintenance can lead to breakdown

Purifying section

i. Blocking of the sieves will lead to over loading of the system

ii. Improper cleaning of the brushes

iii. Improper functioning of the aspiration systems

iv. There is pressure differentials, if there is a leakage somewhere along the line

Weighing and bagging section

The weighing machine can loose sensitivity of accuracy if loaded

Problem I encountered while carrying out the project work

i. I have to travel to Kaduna each time to collect data because there was no accommodation for me there

ii. The initial problem of timing the processing operation, due to continuous process of the operation

iii. The initial problem of obtaining name plate, the power rating due to locations some are hid and some are located above my reach

iv. The initial problem of differentiating the motors that are in use because the plant is a very big electric motor due to economic situation the processing plant is not in full operation therefore not all the machine are in use.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

The study of the energy consumption at different stages of the unit operation involved in maize processing was conducted by collecting energy data in the factory and questionnaire. These data were analyzed to study the overall energy consumption in the mill as shown in the table. The table shows a summary of all the results obtained during the research to see equally showed the illustration of electrical energy consumption. It is possible to see that the highest energy (96.0kwh/t) was consumed during the milling section. The machine in milling section account for 62.4% of the total electrical energy.

The second highest energy consumer is the degermination section which consumes 4.5kwh/t of energy and it account 26.5% of the total electrical energy. The impact force of the degermination machine on the maize kernel requires a sufficient amount if energy to tear the kernels likewise the gravity tables.

Cleaning section consumer 6.9kwh/t of energy to be the third highest energy consumer and it account for 4.4% of the total electrical energy.

Purifying section consumes 6.4 kwh/t of energy to be the fourth highest energy consumer and it account for 4.16% of the total electrical energy. The operation that consumes the least energy is the bagging and stitching section which consumes 0.19kwh/t each and it account for 0.12% of the total electrical energy.

The human energy involvement in the processing operation given the fact that the processing operation is mechanized. It also shows no matter the level of mechanization still needs human assistance in the mill. The table shows that maximum energy (277.7kj/t) is required in the manning the plant. This is due to the number of persons involved in the operations. The bagging operation and stitching section consumed 92.5kj/t each the minimum energy requirement. This is due to the number of persons involved in the operations.

Electrical energy

The total amount of electrical energy consume in the mill is 153.8kwh/t. this result finds an explanation given that the total electrical energy requirement estimated might be higher than the actual amount consumed. This is as a result of the fact that the electrical motors might not be operating at its maximum rated power output. The main problem experienced in this mill is the issue of identifying power rating of the human energy.

The total amount of energy consumed in this section in the mill is 0.14kwh/t. this is 1.92% of the total energy consumed to produce a tonne of mill maize in the factory. Actually the amount of human energy when compared to other operation is small compared to electrical energy which consumed 99.9% of the total energy.

The number of man (worker) in bagging and stitching section is small because if the automatic weighing and stitching mechanism and immediately the scaled bags passes through the belt conveyor to the store.

Table Electrical energy Consumption of IFM LTD

UNIT OPERATION	ENERGY CONSUMED kWh/t
Receiving	3.1
Cleaning	6.9
Degermination	40.8
Milling	96.0
Purifying	6.4
Bagging	0.19
Stitching	0.19
Total	153.8

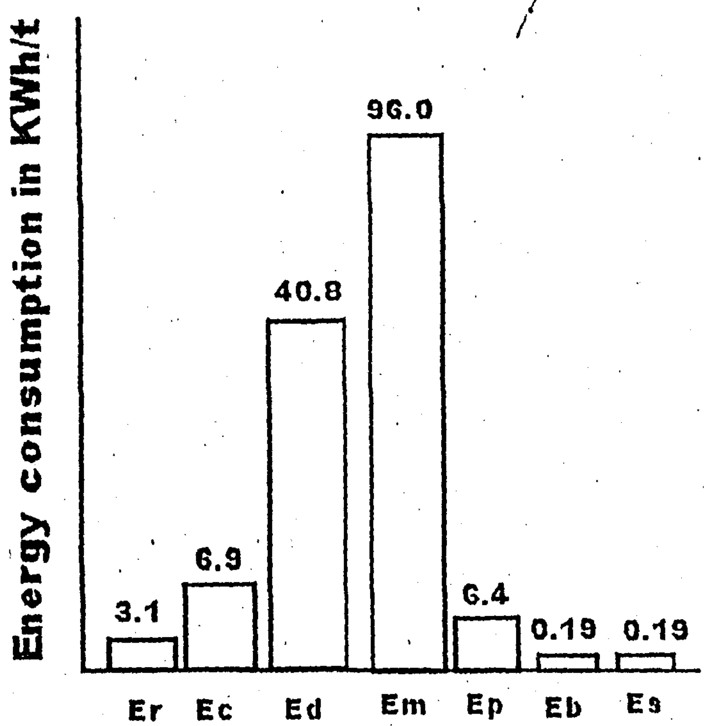
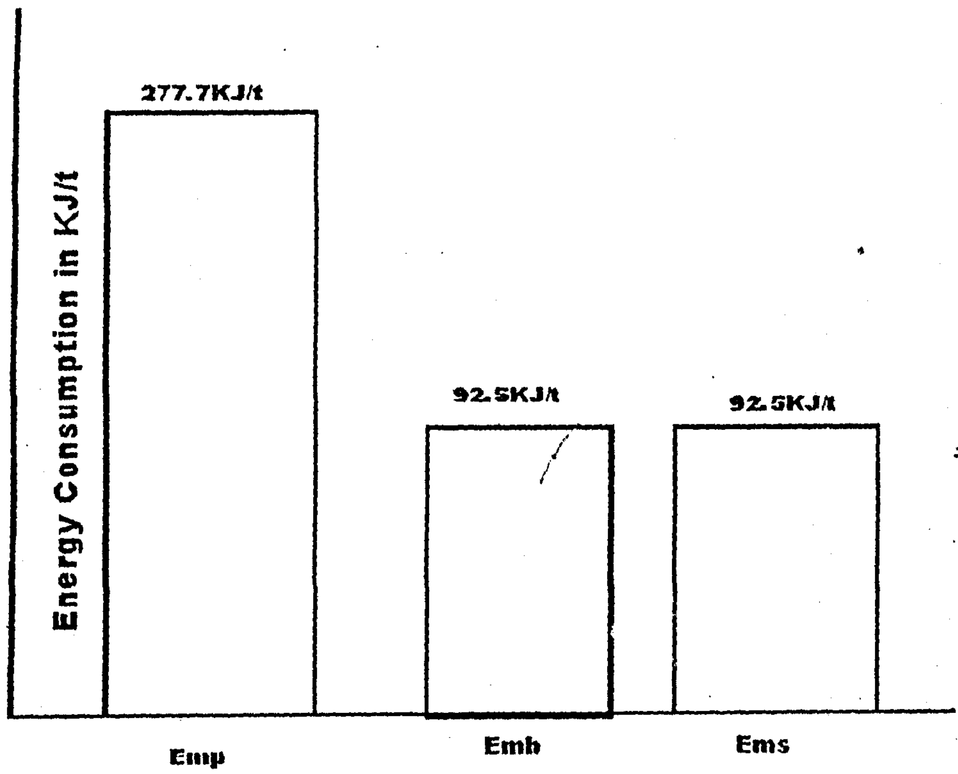


Table Human Energy Requirement in IFM ltd

Operation	ENERGY Consumed KJ/t
Manning of the plant	277.7
Bagging	92.5
Stitching	92.5
Total	504



CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The major achievement of this work are to point out areas of waste in energy consumption of the company .Moreover ways of conserving energy to improve out put was provided.

It was obvious from results that the quantity of energy consumed to produce one tonne of milled maize is 153.8Kwh/t, and human energy consumed 504KJ/t.

5.2 RECOMMENDATION

It is recommended that this project should be very vital for efficient and effective use of energy as pointed out in this work; it will help in solving energy problems which is pronounced, especially due to inadequate supply by NEPA.

The outcome of these project is vital in profit maximization of the firm ,.It will be of great help for the purpose of future expansion of the mill, likewise related mills all over the country .The result will equally be beneficial to the mill during budget planning in that , the company will be able to know the cost of energy consumed and how to improve on their energy efficiency.

The efficiency can be increased by reducing the cause of friction and noise.

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APPENDIX

QUESTIONAIRE ON IDEAL FLOUR MILL PLC KADUNA HARVEST PROCESSING OF MAIZE AND ENERGY REQUIREMENTS

A. PARTICULARS

1 Name and rank of respondents

2 Name of establishment

3. Business Address

4 Location of establishment

5 Ownership of Establishment

6 Date Establishment commenced operation

7. What is the plant capacity?

8. What actual quantity of maize is milled per day ?

9 What quantity of maize is milled per annum since inception

10 Major production activity.

11 How many departments do you have?

12. Which department is responsible for maize processing ?

13. How many staffs do you have in the production department

14. How many days in a week is the company in operation ?

15. How many hours per day does the production unit work ?

16. How does the company procure its raw materials ?

17. What other raw materials do you use outside maize ?

18. Do you operate on shift basis ? and if yes ,how many hours does a person work per shift.

19. What are the method used in production ?

20. What are the various types of energy used in production ?

21. What is the cost of implication of electrical energy per hour ?

B. PROCESSIN OPERATION

1. What are the various unit operations involved in maize processing ?
2. What quantity of maize is used per unit operation ?
3. What is the quantity of fuel used per unit operation ?

C. CLEANING

1. How do you receive the raw materials
2. How does the cleaning equipment operate/ achieve its cleaning function ?
3. What is the moisture content of maize before and after cleaning ?
4. How do you determine the quantity of maize?
5. How do you remove impurities such as cobs, chaff, stone etc .
6. How do the tempered means get to the processing section?
7. What storage facilities are used for holding maize before processing ?
8. How long does the maize stay after tempering prior to processing?
9. Is there any change in temperature of the tempered means before processing?

D. DEGERMINATION

1. What equipment is used for degermining?
2. Briefly describe the degerminig operation?
3. What are the major problems encountered in Degermining ?
4. How is the germs separated from other component maize ?

E. MILLING

1. What type of equipment is used for milling?
2. What is the capacity of the milling machine ?
3. How many machines are used for milling?
4. Briefly describe the milling operations

5. What are the problems encountered in milling operations?

F. PURIFICATION

1. What equipment is used for purification?
2. How does it carried out it purification function?
3. What problems are encountered during the exercise ?

G WEIGHING AND BAGGING

1. What weight is filled in each bag?
2. How do you weigh the bag?
3. How long does it take to fill a bag?
4. How are the bag sealed?
5. How long does it take to seal a bag?

H ELETRICAL ENERGY

1. What is the actual current drawn?
2. What is the voltage during operation?
3. What is the time taken for the operation?
4. What is the power of the motor?
5. What quantity of materials is process/ handle?

J MANUAL OPERATION (HUMAN ENERGY)

1 What is the direction of the operation?
2. What is the quantity of materials handle?
3. How many people are involved in the operation?