INVESTIGATION OF THE MACHINERY, LABOUR AND INFRASTRUCTURAL REQUIREMENTS FOR RICE FARMING (A case study of Maizube Farm)

BY

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN AGRICULTURAL & BIORESOURCE ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

FEBRUARY, 2010

DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

10-02-10

SALIHU MOHHAMMED BASHIR DATE

2004/18419EA

CERTIFICATION

This project entitled "Investigation of the Machinery, Labour and Infrastructural Requirements for Rice Farming (A Case Study of Maizube Farm)" by Salihu Mohammed Bashir, meets the regulations governing the award of the degree of Bachelor of engineering (B.Eng.) of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

18/02/10

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DEDICATION

This work is dedicated to Almighty God.

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ABSTRACT

The investigation of the machinery, labour and infrastructural requirements for rice farming case study of Maizube rice farm was carried out in this work. Parameters such as various stages of operation, types of implements used for each of the operations, the width of implements used, work output of implements, time of completion of individual operations were determined. The labour and infrastructural requirements were also determined based on what was available. Analysis show that the width of implement require for completion of ploughing, harrowing, planting and spraying were 1.06, 1.06, 0.91 and 6.37 meters respectively. However the width of available implements on the farm was found to be more than what was required, obtained by measurements. The time of completion for the measured implements were estimated and found to be 39.17, 33.94, 12.47 and 8 hours respectively. More so, the work outputs of the plough, harrow, planter and sprayer was also calculated and found to be 0.56, 0.65, 1.63 and 2.75 respectively. The labour use on the farm was also determined. Ploughing required 2 people per day, harrowing, planting and spraying also required two people per day. The harvesting stage was found to be more demanding in terms of labour use, this is because it was done manually (by hand). Some of the infrastructures on the farm were, an artificial lake for the provision of water for the irrigation, storage silo, transport equipments, implements shed and the sprinkler irrigation system.

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CHAPTER ONE

1.0 INTRODUCTION

Machinery, infrastructure and labour are some of the important inputs required for successful farm operation. Machinery is required for field work, infrastructure is required to provide storage and protection for machinery, and produce and labour is required to operate and manage the machinery and the infrastructures. The objectives of the project therefore are to determine the machinery, labour and infrastructural requirements in terms of capacity and quantity on a mixed farm and to ensure that there is no significant fluctuation in the weekly requirements of tractor and labour hours. Most small scale Nigerian farmers operate with cutlass and hoes even in some irrigated ecologies, resulting in high labour demand and exorbitant costs in peak periods. Irrigation facilities in some of these areas need to be improved to provide for efficient water usage and control. The machinery requirements was determined in terms of capacity and sizes, the labour was determined in terms of man hour and number of workers and category, the infrastructural requirement was also determined in terms of size and quantity.

The investigation of machinery, labour and infrastructural requirement will enhance proper planning needed to ensure smooth and successful operation in any farming enterprise. This research is intended to be carried out in a selected rice producing area in Niger state

1.1 Background of study

Farm mechanization plays a significant role in every nation's economy. However, it is often misconstrued to mean modernization, beneficial only to industrialized countries with highly mechanized agriculture. Developing countries often have to rely on a variety of imported farm machines, which are seldom appropriate for small farms.

In many parts of the African region, the most pressing need is to feed a growing human population. This requires sustaining food production, which can be realized by increasing land and labour efficiency in agriculture through farm mechanization. This international workshop challenged conventional notions by addressing issues concerning the development and utilization of small farm mechanization systems and technologies for the greater benefit of small-scale farmers. The activity provided a venue for the sharing of practical application of existing systems and technologies, as well as of strategies that will be most effective in tackling the very complex socioeconomic and environmental factors influencing the adoption and utilization of small farm machinery.

Rice is the most important food for about half of the human race. It ranks third after wheat and maize in terms of worldwide production. Oryza glaberrima is indigenous to Nigeria and has been cultivated for the past 3,500 years. The earliest cultivation of improved rice varieties (Oryza sativa) started in about 1890 with the introduction of upland varieties to the high forest zone in western Nigeria. consequently, by 1960 Oryza glaberima, which is now invited to some deep flooded plains of the Sokoto Rima River Basin and other isolated pockets of deep swangs all over the country. The production increase has however not been enough to meet the consumption demanded of the rapidly growing urban population (Imolehin, 1991).

\1.2 Statement of Problem

It has been observed that the general adoption and use of farm machinery is which reduces input of human labour on the farm has continued to be on low despite increasing awareness of agricultural mechanization, many small farms which individually contributes to the gross output of crops in the country still rely on hand tools for cultivation of their fields.

This work however is intended to provide basic information on the necessary farm machinery, labour and infrastructures for the cultivation of the rice crop, which can later be adopted for other crops.

1.3 Objectives of the Study

1. To investigate the machinery and implement required for each field operation.
2. Determine the width of the implements required.
3. Determine the work output the implements
4. Determine labour required during operations.
5. To determine the infrastructures available or required irrigation, material handling (transportation of harvested produce) and for storage of harvested products as well as for the machinery.

1.4 Justification

Because of the high cost of land development for rice, one way to ensure good returns from a hectare of irrigated land is by putting the Riceland to intensive agricultural use. Considering the limited geography of rice in this country, another way is to extend the acreage for rice in a rotation in addition to increasing the yield of rice through improved agronomy and superior varieties. Research on rotating rice with other crops has proved it possible to repeat rice cropping (up to four years) in the same field. Obtaining high and stable yields under such a system of cropping requires periodic incorporation into the soil of organic matter, optimum applications of fertilizer, good water management, sufficient treatment of the field with herbicides, and adequate agronomic practices. Rotational experiments conducted by the USSR

Rice Research Institute indicate that the yield and gross output of rice can be increased through using rotations, making better use of perennial grasses, increasing to more than three years the length of repeated cropping of rice after perennial grasses, and through growing catch-crops between rice croppings.

Most small scale Nigerian farmers operate with cutlass and hoes even in some irrigated ecologies, resulting in high labour demand and exorbitant costs in peak periods with farm holding reduced to the barest minimum. Irrigation facilities in some of these areas need to be improved to provide for efficient water usage and control. In some irrigated fields water inflow cannot be properly managed, hence some fields have excess water while others within the same scheme have inadequate water supply. These problems of poor crop and water management make the traditional low-yielding varieties more attractive to farmers than high-yielding, but high management-demanding semi-dwarf improved cultivars.

Investigation of machinery, labour and infrastructural requirement for rice farming will ensure determination of optimum resources input required for a successful or profitable farming and good management of the farm. It will ensure a timely and a well planned resources allocation and management.

1.5 Scope of work

This project is limited only to determination of width of implements, time of completion for each operation, work output of implement, determination of infrastructural provision required and the determination of labour required for all field operations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Rice cultivation in Nigeria

Rice cultivation in Nigeria dates back about three-and-a-half-centuries to a period when the indigenous red rice – Oryza glaberrima varieties – were the only cultivated rice species, as was the case for other parts of west Africa. Worldwide, only two of the over 20 known species of the genus Oryza are domesticated. Of these cultivated species, one is indigenous to Asia (o. sativa L), while the other is indigenous and endemic to West Africa, (O. glaberrima Steud). The latter is distributed mainly in the savannah along the southern fringes of the Sahara desert.

Oryza glaberrima was first grown as a crop in the central Niger Delta and sokoto Basin, among other places, but it later spread into the bush fallow upland farming systems of the western forest zones of Nigeria. O. glaberrima probably developed independently and was domesticated in the flood plains of the Niger River. Just half a century ago, O. glaberrima accounted for up to 60 percent of total rice production in Nigeria. The genetic diversity of the species is clears from the wide range of growing conditions that exist from north to south and in which these varieties have thrived for centuries. These conditions range from the floating/very deep to deep waters of the Sokoto-Rima Basin in the Northwest along the basins of the River Rima (an important tributary of the Niger River) and the Jere Bowl in the northeast to the lowlands and uplands of central and southern Nigeria. The floating/deepwater conditions in the flood plains were significantly reduced following the construction of the Bakolori Dam in the uppers ection of the river rima. Thus, while a number of varieties adapted to the floating/deepwater conditions, others grew well under drought-prone upland conditions. O.

glaberrima is still cultivated today in the Kebbi and Sokoto states of Nigeria along the Rima Valley flood plain, and as an upland crop in the Zuru area of Kebbi State. It can also be found in mixtures, and almost replaces the sativa cultivars in some farmer's fields, both in the shallow swamps of the flood plains of the Hadejia, Kano, Niger, Benue and other rivers, and in dryland rice crops in southern parts of the country. However, as a cultivated rice crop, O. glaberrima is fast being replaced by its Asian counterpart, O. sativa. That O. glaberrima still exists as both a crop and a volunteer, is probably due to high level of adaptability to African rice ecological conditions. Until the 1960's, the yield of O. glaberrima in Sokoto fadama was superior to that of available O. sativa floating cultivars. Two glaberrima varieties, Badande and Jatau, outyeilded some of the most successful sativa cultivars, such as FARO 6 and FARO 7, in Sokoto fadama in 1960. Similarly, a number of these varieties thrived well in the rainfed lowlands of the country (Hardcastle, 1959). On the basis of studies on genetic diversity in O. glaberrima, indicated that there were two major groups; floating and upland.

A number of these varieties can still be found in farmers' fields, particularly in the northern parts of the various rainfed rice ecologies. They are named in many ways, for example; after the cultivation location (Dan Zaria, Godongaji, Katsina Ala Shendam etc. – all of which are towns in Nigeria); or after the farm where or farmer from preserved in the short term by the Nation Cereals Research Institute (NCRI), Badeggi, and in the medium term at the West Africa Rice Development Association (WARDA), Bouaka. WARDA's working collection whom they are collected (Dogo, Baba Hawa). Some of these glaberrima varieties were collected and includes about 300 accessions of O. glaberrima collected between 1985 and 1990 in Nigeria. The gene bank of the international Institution of Tropical Agriculture (IITA). Ibadan, has a collection of over 2,000 entries of O. glaberrima from 22 African countries, and the International Rice

Institute (IRRI), Philippines, Keeps duplicates of all materials under long-term storage. At the same time, many of these varieties may have disappeared through the evolutionary processes.

These varieties are characterized mostly by short to medium, red grain types and they shatter very badly on ripening. Under farmers' conditions, grain yields are often very low but stable – probably as a result of the varieties' high adaptability to the ecology). O glaberrima varieties have very good early vegetative growth and ground cover and thus complete favourably with weeds, which are major constraints in rainfed rice production in Nigeria and West Africa generally. They also possess acceptable tolerance or resistance level to many of the prevalent adverse soil and environmental conditions (Diseases, pests and weather) in the country. They are considered more resistance to flooding due to their good elongation ability under flooded conditions..

2.2 Breeding methods, varieties and their impact on rice crop

There were initially no attempts to improve varieties, despite their possession of the above-mentioned desirable agronomical traits. At best, there may have been selection process farmers who tend to look for and plant materials most suited to their environment and tastes. As in other parts of the world, farers began crop varietal selection and were regarded as pioneer plant breeders. In Nigeria, as in other parts of Africa where O. glaberrima was the first rice crop, development of a wide range of O. glaberrima cultivars was practiced through farmer selection. The selection practice led to the vast diversity of cultivated African rice known today; floating varieties, photoperiod sensitive, photoperiod intensive, swamp and upland cultivars, short and long duration cultivars, materials with varying levels of pest and disease tolerance, and varieties with all kinds of grain characteristics. Unfortunately, these selection practices did not appreciably improve the yield potential of O. glaberrima. As a result, the introduced O. sativa varieties with superior grain yield were widely adopted and threatened the genetic base of the African rice. However, African rice survived the onslaught thanks to its wide adaptability.

There were attempts to improve O. glaberrima and produce hybrids or select cultivars for higher grain yield, adaptability to soil and other abiotic and biotic production constraints. Sativa/glaberrima crosses were mostly unsuccessful due to high sterility and continued segregation of progenies up to eight or more generation.

As a result, total national rice production remained low for many years, averaging only a few thousand tones and a low productivity rate of about 0.5 t/ha. Rice consumption before 1960 was restricted to the areas of production, and for many years rice in most households in Nigeria was used only for festival or other special occasions (Ola and Fredric, 2003). Rice was not the national staple it is today. Prices were higher than those of the main staple root, tuber, or of other cereal foods. Rice consumption was regarded as elitist – a special food only for well-to-do and urban consumers. On important occasions, it was a status symbol to serve a rice meal instead of the normal daily staple, such as yam/cassava fufu or a cereal dish. Rice was generally preferred by children, but it was rarely sufficient to satisfy their needs. At Independence in 1960 for example, Nigeria produced only 0.134 million tones Mt) of paddy from 0.156 (Mha) with an average yield of 0.8t/ha. Glaberrima rice accounted for 60 percent of total national rcie production at this time, despite the introduction several years earlier of white-grained O. sativa.

2.3 The arrival of Oryza Sativa

O. sativa is believed to have been introduced into Africa some 2.200 years ago. The route of O. sativa into Nigeria is not quite certain; however , Asian rice is known to have reached

Africa through Madagascar from Java. It is likely that many African countries, including Nigeria, received their rice via this route. Another possibility is that Asian rice was introduced into Senegal, Guinea Bissau and Sierra Loene by the Portuguese around 150AD, and Nigeria may also have received the Asian rice by the same route. It should be however be noted that Nigeria (like many other West African countries) established contact with the Arab traders and later Arab Islamic Missionaries through North Africa long before the arrival of the Europeans. The same Arabs were already in contact with Asia and could just as well have introduced Asian rice into the country. However, the most significant recorded introduction to Nigeria was in the 1920s when some form of research work stated on rice at Moor Plantation, Ibadan (Hardcastle, 1959). This period marked the beginning of rapid genetic erosion in the indigenous O. glaberrima. Over three-quarters of a century, the white-grained sativa varieties almost completely replaced the red rice. This rice of Asian origin had in turn adapted so well to rice-growing conditions that the country and the entire West Africa region became a new center of genetic diversity. However, the introduction of these varieties was largely uncoordinated with no significant progress made in rice production.

In many parts of Niger state, small farms remain at the center of agriculture and rural development. However, one of the main causes for the low agricultural productivity in most developing countries is the lack of appropriate machineries, infrastructures and labour that cater for or suit the requirements of small-farms. For this reason, many small farms are deemed as unproductive and inefficient.

Areas of interest includes status and directions of small farm mechanization in Niger state Region, factors influencing the successful development, adoption, and utilization of small farm mechanization systems and technologies; problems, issues, and constraints in developing and introducing small farm mechanization systems and technologies to the end users; and recommendations to enhance small farm mechanization development and adoption. (Ola and Fredric, 2003).

2.4 Land preparation

Tilling soil for rice is not much the same as tilling for other cereals and dryland crops. Its principal aim in rice production is to obtain high yields of rice through improving the rice soil and taking advantage of its potential productivity.

Flooding is very much essential for optimum grain yields, that is why the ideal soil types for rice production are those that conserve water. Most rice soils, often referred to as heavy soils because of their high clay and silt content, present special soil management problem that are overcome through soil cultivation practices intended also to help make the best use of the natural soil potential. These measures include tillage and seedbed preparation, maintenance of organic matter and soil texture, drainage for successful mechanized rice operations, cultivation of other crops in rotation with rice, fertilizer application, use of green manures, and weed control.

Soil tillage practices vary from place to place depending on soil type, climatic conditions, crop that preceedes rice in rotation, physical condition of the soil, character and degree of field infestation, herbicides used and other factors. Tillage in rice production pursues many purposes, which are generally aimed at:

(1) Forming a sufficiently deep and biologically active ploughline layer by working the field several times over with various types of plow;

(2) Creating conditions in the plow-line that help immobilize soil nutrients i.e. regulate oxidation and reduction through loosening, drying and aerating of soil;

(3) Wetting the rice fields that are to be sown at early dates and to a greater depth so as to establish the moisture content sufficient to bring about emergence of rice seedlings without additional flush-irrigation;

(4) Preparing the riceland with a soil structure that will ensure a uniform coverage and germination of seeds; good stand establishment and further development of the plant during growing season;

(5) Controlling weeds, pests and diseases of rice and other rotational crops by plowing in the fall one time over with a chisel and a second time in the spring with a mouldboard;

(6) Precise levelling of the field surface (to within ± 5 cm from the median plane of the rice check surface) to maintain desired depth of flood water in the field and to drain as rapidly as required;

(7) Covering organic and mineral fertilizers at desired depths;

(8) Preparing a suitable seedbed for rice.

2.5 Machinery requirements

Selection of machinery with the proper size and type to meet production needs must include an evaluation of timeliness requirement and efficiency of the machine working in the field (Jacobs and Harrell, 1982). Information such as performance data and operation features of all equipment are analyzed.

The capacity and efficiency of a machine are primary factors in selecting farm machines, machine capacity is based on quantity – time relationship rather than length number factors. The importance of timeliness in crop production makes the use of machinery of proper size, a critical factor according to Stone and Gulvin (1977).

The size of tractor chosen is based on power requirement, it may be p.t.o power, or drawbar power, the highest value of power is normally used to select the tractor size.

According to Crossley and Kilgour (1983).

$$Drawbar\ power = drawbar\ pull \times speed\ (M/s)$$

$$Kw \qquad\qquad KN \times m/s$$

$$p.t.o\ power = torque\ (KNM) \times speed\ (m/s).$$

Power per cultivated hectare can be used as indicators of existing mechanization and as a basis for mechanization planning (Crossley and Kilgour, 1983). They also stated further that tractor can approximately pull half their weight and that the penalties are high, provision of high power, high output even though expensive forms of mechanization could be justified. They stated that the work output of an implement may be calculated using the formula below.

$$ha/h = \frac{Width \times Speed \times n \times 3{,}600}{10{,}000}$$

$Where\ ha/h = hectare\ per\ hour.$

$$n = efficiency, speed\ in\ m/s, width\ in\ meters.$$

They also stated that the size of equipments with respect to its width can be determined using the formula

$$W = \frac{Area \times 10{,}000}{Time \times Speed \times n \times 3.6}$$

$Where, n = field\ efficiency$

$W = Implement\ width$

$Time\ is\ in\ hours$

$Area\ is\ in\ hectares$

$Speed\ is\ in\ meters\ per\ seconds$

Based on this, one can determine the size of machinery required for each operation or the time it will take the machinery if the size and other factors in the formula are known..

There are various type of machinery available for each of the operations performed on the farm. Machines which are used to perform primary tillage are classified into the three major groups, namely;

i) Ploughs

ii) Listers and bedders

iii) Rotary tillers (Jacobs and Harell, 1982).

Various implements used to carry out primary tillage are the mould plough, disc plough and rotary plough (Crossley and Kilgour, 1983). There are also various implements used for secondary tillage, disc harrows, cultivators, rotary cultivator and non powered rotary cultivators (Crossley and Kilgour, 1983), they gave the list as disc harrows. Cultivators, row crop cultivators, field cultivators, rotary hoe and rotary tillers.

Various equipments are also available for planting and seeding. There are row crop planters and grain drills (Jacobs and Harell, 1982). The various type of planter, given by Stone and Gulvin (1977) are regular drill planters, check row planters, trailing planters and mounted planters.

Other types of machinery that comes next after planting and sowing machinery include wed insect and soil fertility control equipment. The various types stated by Jacobs and Harrell 1982 are:

1. Liquid application equipment under which there are low pressure sprayer, high pressure sprayer, mist applicators, recalculating sprayers, rope applicators.
2. Dry chemical applicators.

The equipment used for weed had insect controls stated by Stone and Gulvin (1977) are sweep, shovel, spiker, knives and hoes, furowet, disks, weeder mulchers, mist sprayer, low pressure and high pressure sprayers.

The various types of machines are spinning disc, oscillating spot machine, trailed machine, pneumatic machine plate and flocker machine and rotary manure spreader. Other types of machines are those required for harvesting and handling stated by Jacobs and Harrell (1982). These include combine harvesters for grains, silage and hay harvester, windrower and tedding equipments. There are field mowers, rakes windrowers and crop conditioner, balers, forage harvester, combine harvester (Stone and Gulvin, 1977).

Handling equipment includes grain threshers, shellers and cleaners, grading machines, (Crossley and Kilgour, 1983).

After harvesting and handling comes processing, the various processing machines are roller mill, plate mill rotating mortar and pestle (Crossley and Kilgour, 1983). They gave grain dryers, grinding mills, hammer mills, mixers as grain dryer, processing equipments. Including, pumps, fans, conveyors, belts, augers, loaders and trailers for handling.

2.6 Labour requirements

Labour requirements for the cultivation and harvest of rice have been seriously under estimated in the past. The first detailed investigation has revealed surprisingly high human energy inputs for the crop.

On the farm, the actual working day varies according to the demand and type of operation. Thus, labour may work as 6 – 8 hour/day at busy times such as at planting and harvesting, but only 2 – 4 hours/day at other times. Moreover, during land preparation, the working hours are mainly determined by the stamina of the draught animals. (Catling, 1992).

The total labour inputs for a single crop of rice varies from 128 to 210 labour – day/hectare and average 150 labour – day/ha.

The main reason for such high inputs is the lack of mechanization and intense weeding operation. The highest input was for hand weeding (44%), followed by harvesting and threshing (29%) and land preparation (24%). The total labour requirements increased by about a third to a mean of 210 labour – day/ha. This was mainly due to the harvesting of the extra mixed cropping or time wasting.

Although the labour for each of the main operation is spread over several months (maximum ploughing is greater than 6 months, sowing and weeding 5 months, harvesting 4 months), the timing of each is usually critical for the individual farmer.

Farm labour is employed to the fullest extent possible for all operations; an average of 3 family labours/ha is available for rice. Family labour is usually sufficient for land preparation, sowing and weeding since these are spread 7 weeks, but labour is often hired, that hired labour amounted to a mean of 70 labourers – day/ha for row stands and 100 labour – day/ha for mixed stands, which is about a half of the total labour input, Culpin, (1975).

Culpin, (1975) stated that to facilitate the study of peak periods of labour requirement on a farm a method called "Analysis of Gang work Days" can be used. This involves dividing the year into a number of seasonal periods and estimates based on the average weather, number of daylight hours, the number of working days available are determined work free days per season will have to be considered on this case. The other factor is the period during which the work should be carried out. With these, it is possible to list the operations to be done, the number of hours needed and the minimum gang size for the various essential jobs and to study how these can best be fitted into the number of days available for the work and the work is facilitated by the use of special prepare dlabour distribution charts consisting of roler sheets to assist the drawing of simple histograms depicting the allocation of work days to a particular job (Culpin, 1975).

Culpin, (1975) stated that the average tractor requirement can be calculated on a basis of standard tractor hours and it can be used to check tractor usage. He defined work study as the study of work in a systematic manner with a view to improving the effectiveness with which the job is done and it embraces method study, time study and may also include a detailed study of the movement employed in doing a particular job.

In general, Labour is hired in return for cash payment plus meals, by contract for individual task such as harvesting where the payment may be in rice, or as an exchange of labour with another farmer (Catling, 1992).

2.7 Infastructural requirements

The infrastructural requirement of rice crop is basically irrigation, drainage and storage facilities. But since there are various varieties of rice and different ways which rice can be grown, which dryland, paddy and floating rice is as discussed, it requires substantial amount of irrigation and drainage construction.

To protect crops properly after harvesting, producers need to understand how to store and treat crops to preserve quality and know the storage conditions under which the crop can lose quality.

Storage of crops after harvest whether commercially or on the farm is critical. The correct storage condition i.e. temperature and humidity are two conditions that need to be considered while pest such as insects, must be controlled.

Infrastructural requirement for crops include silos for crops storage, containers like jute bags and ventilated structures.

The different types of silos, are air tight silos, unsealed silos, flexible sealed silos (Culpin, 1975).

2.8 Irrigated rice study

The sector is characterized by a wide array of irrigated rice-based production systems in different parts of the country, from systems with complete water control found in the Sahel and Sudan Savannah zones in Northern Nigeria to systems with partial water control found in some parts of the savannah and equatorial zones in the Middle Belt and Southeastern parts of the country. Irrigation schemes in the north of the country are generally much larger than those in other regions. In addition to problems with maintenance and operation of schemes, there is widespread underutilization of irrigation infrastructure at all schemes visited in the north. This observation has important implications for increasing irrigated rice productivity and production in the country. Significant production gains can be achieved by better utilization of existing infrastructure. Irrigation development policy should focus on improving the performance and efficiency of existing irrigation infrastructure, rather than investment in new schemes.

There is wide diversity of land and resource endowment, ranging from small farmers with access to less than one hectare of irrigated rice land to large-scale producers cultivating more than one hundred hectares. There is a strong relationship between extent of water control and levels of investment in external inputs like fertilizers and herbicides. In general, the input rates or dosages are much higher in systems with greater water control. Although farm level decision-making continues to be dominated by men, female farmers continue to play important roles in the irrigated rice sector. Women are actively involved in various production and post harvest operations.

In general, yields are much higher in the Sahel and Sudan savanna zones than in irrigated rice systems in the other agro-ecological zones in the country. In most sites however, there have been significant declines in irrigated rice yields over the last decade. Actual yields are also much lower than potential yields. Yields obtained by farmers in Northern Nigeria are much lower than those obtained by farmers in similar environments in the Sahel. Yields and profits obtained by small-scale farmers in the study sample are generally higher than those obtained by medium scale and large scale farmers. Similarly, benefit:cost ratios are higher among small-scale producers.

Research and extension support for irrigated rice-based systems in the Sahel and Sudan savannah zones are highly inadequate. The scope of adaptive on-farm research and development is very limited. Farmers make little, if any, contribution to the debate on the major constraints and priority research and extension themes.

In general, extension staff is not adequately trained and lack access to relevant training materials and other resources.

Major constraints identified in the study sites are:

-High input costs and limited access to farm credit.

- Use of inappropriate crop and resource management practices, due to general lack of knowledge of improved technologies.

- Limited access to improved varieties (duration and yield), and persistent use of poor quality seed.

-Lack of appropriate small farm machinery for harvest and post-harvest operations.

- Inadequate Research and Extension Support, especially in the Sahel and Sudan Savannah zones.

-Localized problems of soil degradation.

Recommendations for research and development interventions:

- Development and adaptation of small farm machinery for harvest and post harvest operations (Thresher-cleaner, reaper-harvester).

-On-farm evaluation and adaptation of improved irrigated rice varieties.

-Site specific adaptation of improved integrated crop management technologies.

- Limited number of key sites (one or two) for participatory on-farm research and development (R&D) activities. (Ola and Lancon, 2003).

2.9 Agronomy

As with Asian rice, African rice is grown in three major ways, dryland, upland and floating.

i) Dryland: The dryland rice form thrieves in light soils where there is a rainy season of at least 4 months and minimum rainfall of 760mm. It is often inter planted with millet, maize, sorghum, beniseed, reselle, cowpea, cassava or cotton. Today varieties mature in 90-170 days yield. Average 450-900kg pet hectare but can go as high as 1,680kg hectares.

ii) Upland Paddy: this type of rice can be grown by seeding into dump soil or transported to field under water. This type matures in 140-220days. The yield ranges 1,000-3000kg per hectare.

iii) Floating: In floating, varieties can utilize deeply in undated basin, where nothing else can be raised. They are often harvested from canoes. They mature in 180-250days, yields ranges from 1,000-3000kg per hectare. Depending on the amount of rainfall in early growing season and on the eventual depth of the subsequent flood.

2.9.1 Cultivation of rice

For the 3 ways of grown rice to be successful, all of the following are required;

i) Soil requirement – wide variety with high fertility but slightly acidic.

ii) Method of propagation - Seed are planted in nursery, rice seedling to be transplanted to the field or direct sowing.

iii) Spacing – (25 to 30) cm between rows and 325 – 30cm between plants depending on variety of rice.

iv) Seed to rate (number of seeds per hectare 4.8 x 105

v) Number of seeds per hole 3 to 4 (or a pinch)

vi) Planting depth – 2cm

vii) Maturity period = 4 to 7 months.

viii) Method of harvesting – inflorescence stalk cut with a knife or sickle combine harvester s used on large scale farms.

ix) Storage – dry dehusked rice grains are stored in bags or insect free container.

x) Marketing – Rice is sold locally in Nigeria.

Environmental Requirement of rice

Daylength – varieties from neutral to strongly sensitive, depending on variety. However, most dryland types now in use are sensitive to photo period. They flower with the advent of dry season. On the other hand most floating types show little sensitivity to day length.

Rainfall: some upland variety can produce adequate with precipitate as low as about 700mm.

Altitude – From sea level to 700m.

Low temperature: average temperature below about 25 degrees, these effects are pronounced.

High Temperature – Africa rice does well at temperature above 30 degrees. Above about 35 degrees however, spikelet fertility drops off noticeably.

Soil type – Some cultivators apparently can perform rice on alkaline site as well as on phosphorous deficient site. Not unexpectedly, however, the crop performs best on alluvial soils.

Harvesting

After the tiller branch is fully developed then it is being by harvesting which can be done locally and mechanically (Spencer, 1981).

Local method

In most places animal powered cultivation takes place, but the soil is still worked on manually in the developing countries. Very few rural families in Nigeria are landless. In the inland deltas i.e the Niger area of Nigeria land holdings are relatively large (4-9 ha) and so are families (10 – 12 members) uses locally made cutlasses, hoes and sickle harvesting (Nyanteng et. Al., 1986)

The situation could vary from place in the rice producing area. This could be due to related cultural practices that is been employed. The practice of shifting cultivation will also affect the term size. In the valley swamp the landholding varies 0.6 to 0.7 hectares and family size is 6 – 8 people (Spencer, 1981)

CHAPTER THREE

3.0 MATERIALS AND METHODS

Maizube farm is a 500ha large farm, though only about 240ha of the said area is arable, the rice farm that was the case study is about 22ha, and is located inside the farm. The cultivation of the land is achieved by both manual and mechanical means.

3.1 Materials

The stipulated time of completion of the various activities all together is one month. The planting will be done on clay soil. The following are series of operations required.

1. Ploughing - Disk Plough is selected for use
2. Harrowing - Disk harrow is selected for use
3. Planting – 6-row planter is used
4. Weeding/spraying – Boom sprayer is selected
5. Harvesting – This is done by human labour

The first four operations will be completed within one month as stated earlier, using eight hours a day and six days a week, a total of 8 x 6 x 4 = 192hours will be available for the operations.

3.2 Methods

According to crossley and kilgour (1983), the width of machinery

$$W = \frac{Area \times 10{,}000}{Time \times Speed \times n \times 3{,}600}$$

$Where, n = field\ efficiency$

$W = Implement\ width$

$Time\ is\ in\ hours$

$Area\ is\ in\ hectares$

$Speed\ is\ in\ meters\ per\ seconds$

The time available for the operations is 192 hours, it is assumed that each will have 192/4hours i.e. 48 hours each.

3.2.1 Determination of width of Plough required

Due to the nature of the soil on the farm, a disc plough is selected for use. Since,

$Area = 22ha$

$Time = 48hours$

$Speed = 2m/s\ (Crossley\ and\ Kilgour, 1983)$

$n = 60\% = 0.6\ (kaul\ and\ Egbo, 1985)$

$$W = \frac{22 \times 10{,}000}{48 \times 2 \times 0.6 \times 3{,}600}$$

$W = 1.06m$

But the width of the available plough was measured to be 1.3m, therefore the total time for ploughing using the available plough is found by simply making time the subject in the expression given in 3.2 above thus,

$$Time = \frac{Area \times 10{,}000}{Width \times Speed \times n \times 3{,}600}$$

$$Time = \frac{22 \times 10{,}000}{1.3 \times 2 \times 0.6 \times 3{,}600}$$

$$Time = 39.17hours$$

3.2.2 Determination of width of Harrow required

$$Area = 22ha$$

$$Time = 48hours$$

$$Speed = 2m/s\ (Crossley\ and\ Kilgour, 1983)$$

$$n = 60\% = 0.6\ (Kaul\ and\ Egbo, 1985)$$

$$W = \frac{22 \times 10{,}000}{48 \times 2 \times 0.6 \times 3{,}600}$$

$$W = 1.06m$$

The measured width of harrow was found to be 1.5m, therefore the estimated time of completion of harrowing will be;

$$Time = \frac{Area \times 10{,}000}{Width \times Speed \times n \times 3{,}600}$$

$$Time = \frac{22 \times 10{,}000}{1.5 \times 2 \times 0.6 \times 3{,}600}$$

$$Time = 33.94hours$$

3.2.3 Determination of the width of Planter required

$Area = 22ha$

$Time = 48hours$

$Speed = 1.85m/s\ (Crossley\ and\ Kilgour, 1983)$

$n = 70\% = 0.7\ (Kaul\ and\ Egbo, 1985)$

$$W = \frac{22 \times 10{,}000}{48 \times 2 \times 0.7 \times 3{,}600}$$

$W = 0.91m$

The measured width of the 6 row seed planter is 3.5m, obtaining the new time therefore will be;

$$Time = \frac{22 \times 10{,}000}{3.5 \times 2 \times 0.7 \times 3{,}600}$$

$Time = 12.47hours$

3.2.4 Determination of the width of sprayer required

Spraying (a form of weed control) weeding considering the large area of land involved, chemical control of weed is suggested using boom sprayer. From some manufacturers manual (Ransomes and M. F. Manual) boom sprayers having up to 15m spray width are available.

It is always ensured that spraying is started and completed the same day, this is because it is most likely that spraying or weeding will take place in the rainy season so having appropriate sunlight hours required may not be easy. On days having bright weather, the spraying can then be accomplished within a short time.

$$Available\ time\ for\ spraying\ is\ =\ 8hours$$

$$Area\ =\ 22ha$$

$$n\ =\ 0.6\ (Kaul\ and\ Egbo, 1985)$$

$$Speed\ =\ 2m/s\ (Crossley\ and\ Kilgour, 1983)$$

$$W = \frac{22 \times 10{,}000}{8 \times 2 \times 0.6 \times 3{,}600}$$

$$W\ =\ 6.37m$$

The boom sprayer has a 15m spray width available, considering the area of land to be sprayed 1 boom sprayer will efficiently spray the area. The obvious advantage of the boom sprayer is that it can also be used to spray chemicals for the control of pests and diseases.

3.3 Determination of work output

Power per cultivated hectare can be used as indicators of existing mechanization and as a basis for mechanization planning (Crossley and Kilgour, 1983). They also stated further that tractor can approximately pull half their weight and that the penalties are high, provision of high power, high output even though expensive forms of mechanization could be justified. They stated that the work output of an implement may be calculated using the formula below;

$$ha/h = \frac{Width \times Speed \times n \times 3{,}600}{10{,}000}$$

$Where\ ha/h\ =\ hectare\ per\ hour.$

$n\ =\ efficiency, speed\ in\ m/s, width\ in\ meters.$

3.3.1 Plough work output

$Width\ of\ plough\ =\ 1.3m$

$Speed\ =\ 2m/s\ (Crossley\ and\ Kilgour, 1983)$

$n\ =\ 60\%\ =\ 0.6\ (kaul\ and\ Egbo, 1985)$

$$ha/h = \frac{1.3 \times 2 \times 0.6 \times 3{,}600}{10{,}000}$$

$ha/h\ =\ 0.56$

$Work\ output\ =\ 0.56ha/h$

3.3.2 Harrow work output

$Width\ of\ harrow\ =\ 1.5m$

$Speed\ =\ 2m/s\ (Crossley\ and\ Kilgour, 1983)$

$n\ =\ 60\%\ =\ 0.6\ (Kaul\ and\ Ebgo)$

$$ha/h = \frac{1.5 \times 2 \times 0.6 \times 3{,}600}{10{,}000}$$

$ha/h\ =\ 0.65$

$Work\ output\ =\ 0.65ha/h$

3.3.3 Planter work output

$Width\ of\ planter\ =\ 3.5m$

$Speed\ =\ 1.85m/s\ (Crossley\ and\ Kilgour, 1983)$

$n\ =\ 70\%\ =\ 0.7\ (Kaul\ and\ Egbo)$

$$ha/h = \frac{3.5 \times 1.85 \times 0.7 \times 3{,}600}{10{,}000}$$

$ha/\ h\ =\ 1.63$

$Work\ output\ =\ 1.63ha/h$

3.3.4 Sprayer work output

$Width\ of\ sprayer\ =\ 6.37m$

$Speed\ =\ 2m/s\ (Crossley\ and\ Kilgour, 1983)$

$n\ =\ 60\%\ =\ 0.6\ (Kaul\ and\ Ebgo, 1985)$

$$ha/h = \frac{6.37 \times 2 \times 0.6 \times 3{,}600}{10{,}000}$$

$ha/h\ =\ 2.75$

$Work\ output\ =\ 2.75ha/h$

3.4 Determination of labour requirements

During the field operations, it is required to have four different tractors for the four operations to be carried out, this means that four tractor operators may be required for this, however during harvest; it was observed that there was a lack of machinery input and this lead to produce being harvested by manual means. It was strictly noted that it took about 30 people to harvest using cutlasses and sickle an estimated 0.5ha per day (8hours working per day). A summary of the labour input is given in table 4.2

3.5 Determination of infrastructures

Rice production yield is put at 1.6 tonnes per hectares in Nigeria. Based on a total land area of 22ha, total yield expected is

1.6ton/ha x 22ha = 35.2tonnes = 35,200kg of rice.

This implies that;

- A 40tonnes storage structure is required.
- It is recommended that a 40tonnes storage silo with facilities for self loading and unloading as well as drying be provided.
- Transport equipments for the transportation of harvested produce to storage ground.
- Implement shed to accommodate or house all the machinery.
- Source of water for irrigation and other uses.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Presentation of results

Results obtained from calculations made are tabulated in the table 4.1.

Table 4.1 Results of calculations

S/No.	Implements	Width of implement Required (m)	width of implement Available (m)	Estimated time of completion (hr)	Work output (ha/h)
1	Plough	1.06	1.3	39.17	0.56
2	Harrow	1.06	1.5	33.94	0.65
3	Planter	0.91	3.5	12.47	1.63
4	Sprayer	6.37	15	8	2.75

Table 4.2 Results of manual labour employed

Operations	No. of manual labour required(per day)
Ploughing	**2**
Harrowing	**2**
Planting	**2**
Spraying	**2**
Harvesting and threshing	**30**

4.2 Discussion of results

From the results shown in the table 1.1 shown above, it can be deduced that width of plough required was less than that of the available plough and as such more work would be done by the available plough, the estimated time of completion of ploughing using the width of the available plough was estimated, also a corresponding decrease in time was noticed, this means that as a result of the increase in the size of the implement that was available for the work, more work has been done in a shorter time. The work output of the plough was found to be 0.56ha/h, this means that in a day for instance, using a 8hour working daily rate, 0.56 x 8 = 4.48ha will be ploughed.

The width of harrow required was found to be 1.06m, but the width of available harrow was measured at 1.5m, the time of completion of the available harrow was found to be lower than the projected time of completion, since the area of the land remains the same, it can be concluded that the harrow used for operation is efficient and has done more work in a shorter time. The work output of the harrow was found to be 0.65ha/h.

The width of the six row seed planter was found to be 3.5m which is far more than 0.91m that was required and such the time of completion of the planting was found to be 12.47hours, compared to 48hour initially projected. The work output of the planter was found to be 1.63ha/h.

The boom sprayer which was used for weed control has an available spray width of 15m, but the required width was found to be less, also the spraying is expected to be done in one day, the work output was determined as 2.75ha/h.

From the values obtained in the various analyses and calculated it is clear that implements with a wider width will complete the various operations faster than the required with. Work output also increases as the width of implements increases.

Also, from values shown in table 4.2, it is deduced that ploughing requires a total of two people, tracor operator and assistant for miscellaneous duties per day. The same is required for harrowing , planting and spraying.

However, because harvesting is done manually with the use of hand tools like sickle and cutlasses, more human effort is required to sufficiently cover the area of farm size involved. A total of 30 people were found to be sufficient to completely harvest and thresh 0.5ha in eight hours.

4.3 General equipment use and considerations

4.3.1 Disk plough

The plough is generally used for primary tillage, various types exist for this purpose, but because of the nature of the soil a disk plough is selected for use. The objectives of the disk plough generally is to obtain require tilt of 10-15cm depth, open soil for drying, to uproot stubbles and weeds, to burry trash under soil and to kill weeds. However;

1. Power requirements are of the order of 14-26 k W/m at 7.2 km/hr
2. Stabilizer chains should be relatively loose.
3. Plough should be level in two planes (front to back, side to side)
4. If the tractor is "Pulling" to one side, then the plough is not properly adjusted.
5. Depth of cut should be uniform – results if plough is level.
6. Field should be as level as possible after ploughing (no ridges)

4.3.2 Disk harrow

The harrow is an implements used for secondary tillage, the disk harrow was selected for use because of the nature of the soil.

- The secondary tillage, consists of two operations by disc harrow completes the puddling of one ha in 12 to 15 hours.
- In well soaked soil disc harrow can be used for puddling without initial opening and in such case 4 to 5 operations are generally required.
- Disc harrow for puddling should be provided with scrapers for keeping the disc clean from mud and weeds.

- A light type of tandem disc harrow (weight 40 kg) with 8 discs spaced at 13 cm each having a working width of 110cm in two gangs is very suitable for puddling operation.
- The draft (97-122 kgs) of such a disc - harrow was less than that of wooden plough (136-160 kgs).
- The yield of paddy crop from the field puddled by disc harrow was the highest in the field experiments, conducted on use of different type of bullocks – drawn implements.
- Tandem disc – Two sets of gangs front and rear in the shape of an "X".
- Front discs face out ward (and throw soil outward) – back discs face inward. Offset disc – Single front gang with single rear gang. Concave face of gang discs face opposite directions.

After a successful primary and secondary tillage has been carried out and the land has been properly prepared, planting, spraying of herbicides or weeding and harvesting follows. Two other important equipments used are the;

(i) Seed planter

(ii) Chemical sprayer (Boom sprayer)

4.3.3 Seed planter

The seed planter available for operation is a six row planter. Availability is made for the control of the quantity of to be planted. It consists of two hoppers; one of it carries the seed while the other carries the fertilizer. The planter is mounted like other implements like the plough and the harrow, it obtains it power via rotary shafts directly from the tractor.

4.3.4 Boom sprayer

The boom sprayer is 400 liters capacity equipment and carries 18nozzles, it is also a mounted implement and used for spraying of herbicides or chemicals on the farm land before planting in other to kill weeds or pests.

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Plate 1: Disk Plough

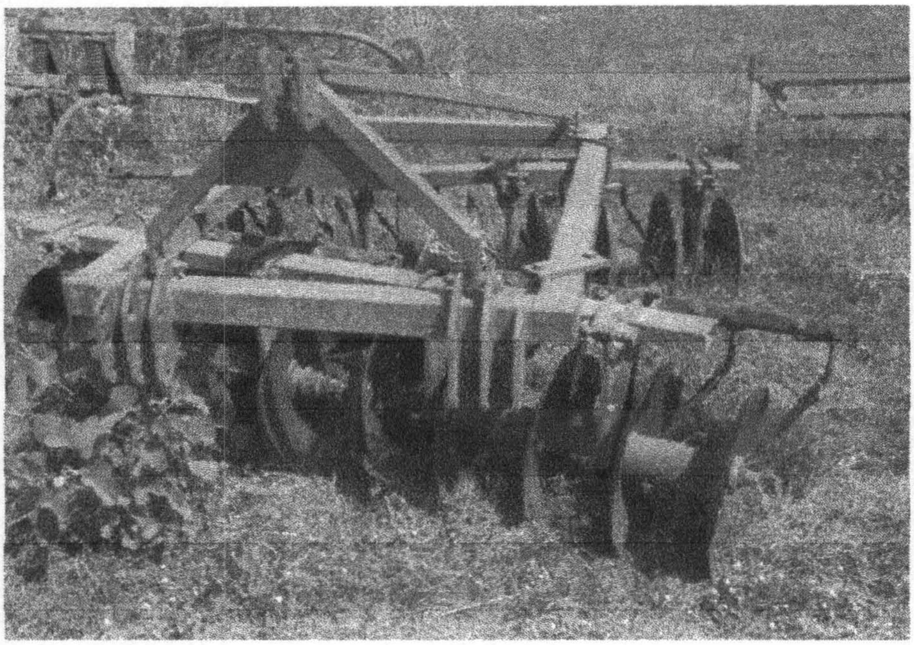

Plate 2: Disk Harrow

Plate 3: Seed Planter (Side one)

Plate 3 Seed planter (side two)

Plate 4: Boom Sprayer

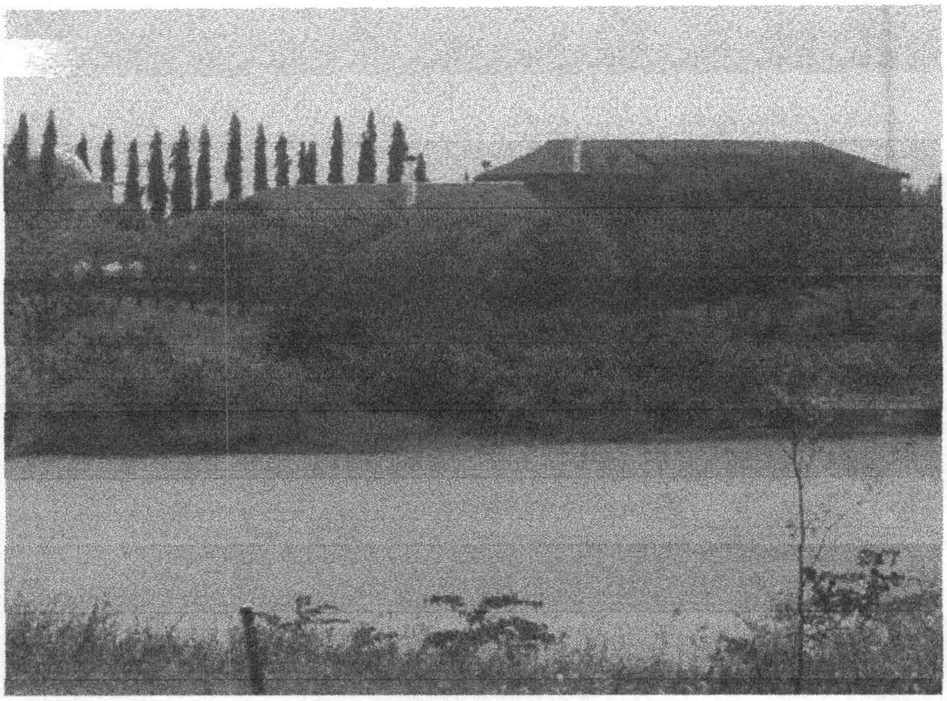

Plate 6: Artificial lake

Plate 7: Implements shed

4.4 Determination of infrastructure

Some of the infrastructures available for on the farm were;

1. Artificial lake for the provision of irrigation water for the crop, the water is conveyed to the farm by means of underground pipes under very high pressure. The method of irrigation used on the farm is the sprinkler system, where the underground pipes are net worked with the sprinkler head, the resultant pressure of the water is then transformed to a gradual rotary motion of the sprinkler thereby enabling it to rotate 360degrees. A careful arrangement of the sprinklers where adequate spacing is made between sprinklers can adequately irrigate the rice land.

2. Implement shed which is provided in other to provide protection and shade for all machinery and implements. The nature and size of implement is dependent on the on the overall size of all equipments.

4.5 Determination of labour

Harvesting of produce is the only field operation that employed the highest number of human effort, however, it was discovered that using a eight (8) hours working per day, 30 people (mostly women) were engaged in the harvesting and threshing of about half a hectare per day.

Averagely, it takes 30 people to harvest and thresh 0.5ha per day, this implies that harvesting would be completed in 44 days using a 8 hour working daily rate.

The average yield of the harvested produce is estimated at 1.5 tonnes per hectares, which is equivalent to 1500kg of rice, this volume of harvested produce is however transported via trailers mounted directly on the tractor and deposited in the storage for house where the final disposal can or may be made.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This work has been a source of very rich experience with which has been enlightening on how to determine the machinery, labour and infrastructural requirements for crop production in general and rice crop farming in particular.

The results obtained in the course of this project work shows types, sizes, capacities of machines and implements, required infrastructures and labour. These can serve as a guide for the development of a standardized a more generalized model for the cultivation of any commercial crop.

5.2 Recommendations

From observation made during the course this project work, there is very low adoption of mechanical means of cultivation of the rice crop, although it is an established fact that the cost agricultural implements is on the high and as such unaffordable to the local or rural farmers, therefore it is recommended that the government of the day should ensure the provision and availability of these machines or equipments and infrastructures in order to not only to boost agricultural production in the metropolis, but also to reduce fatigue and improve the health and living standards of the rural framers.

It is also recommended that a more generalized model of this project work should be developed in order to boost the production of commercial crops in and around the country.

In the design of farm layout for any crop at all, determination of the type of machines or implements to be used, sizes that would be required, expected time of completion of the field operations, capacity of the implements and equipments, methods to be used should be determined before the start of operation.

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