SURVEY OF COMPONENT DEFECTS OF AGRICULTURAL MACHINES IN NIGER STATE

BY

UMAR MUHAMMADU AMINU
PGD/AGRIC. ENG'G/2001/2002/155

THIS PROJECT IS SUBMITTED TO

THE FEDERAL UNIVERSITY OF TECHNOLOGY,

DEPARTMENT OF AGRICULTURAL ENGINEERING,

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE

AWARD OF POST GRADUATE DIPLOMA IN

AGRICULTURAL ENGINEERING

(FARM POWER AND MACHINERY OPTION)

MAY, 2004

SURVEY OF COMPONENT DEFECTS OF AGRICULTURAL MACHINES IN NIGER STATE

BY

UMAR MUHAMMADU AMINU

PGD/AGRIC. ENG'G/2001/2002/155

DEPARTMENT OF AGRIC ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY

MINNA, NIGER STATE

MAY, 2004

DECLARATION

I hereby declare that this project has been conducted solely by me under the supervision of my project supervisor Dr. Adgidzi D. Head of Department of the Department of Agricultural Engineering, Federal University of Technology, Minna.

UMAR MUHAMMADU AMINU
STUDENT'S NAME

SIGNATURE

DATE: MAY, 2004

CERTIFICATE OF SUBMISSION

This is to certify that this project is an original work undertaken by UMAR MUHAMMADU AMINU, Reg. No. PGD/AGRIC. ENG'G/2001/2002/155, and has been prepared in accordance with the regulations governing the preparation and presentation of projects in the Federal University of Technology, Minna.

Dr. Adgidzi D.
(Project Supervisor)

Dr. Adgidzi D.
(Head of Department)

May, 2004

DEDICATION

Dedicated to Almighty Allah the creator of all the creatures for all His bountiful blessings and mercy on mankind.

AKNOWLEDGEMENT

I whole heartedly expressed my profound gratitude to Allah for making all things easy and possible during this project work.

I reckoned seriously with joy with the able leadership of my Project Supervisor, Head of Department of the Department of Agricultural Engineering, Federal University of Technology Minna in the person of Sir, Dr. Adgidzi D. for all the support and courage given me to ensure the success of this project.

Similarly, I extend same acknowledgment to the Department Course Coordinator, Dr. Z. D. Osunde for the effective role she performed, Dr. N. A. Egharevba for putting all the necessary clues before me, all the members of academic staff of the department for imparting this level of knowledge on me, and above all the Dean of SEET for his efficient role for a smooth academic pursuit in the School under a free atmosphere. I also acknowledged the contributions from Engineer Christian O. of Niger State ADP, Engineer Suleiman of FMRD (former NALDA), The Director Engineering Services, of the Ministry of Agriculture, Engineer Abubakar B. Enagi for his total support and Engineer Danjuma Matthew (Officer-in-charge of Heavy Duty Machines and land clearing) of ministry of agriculture for amiably accommodating all my approaches to him on different matters relating to this project.

Niger State Ministry of Agriculture and Ministry of Establishment and Training for their approval to undertake the programme.

ABSTRACT

On the average, about 50% of agricultural machines in Niger State are not functional. Most of these machines broke down prematurely, well before their rated useful life. The reasons for the premature failure are identified to include macro-economic environment (currency devaluation, privatization and Commerçialization of government ventures, tax and import duty, removal of subsidies), ecological and environmental factors (soil conditions, vegetation and climate), system of machinery use (private, joint and government ownership), technical factors (mismatching of equipment, ease of adjustment, ergonomics, wrong installation, bad selection and maintenance) and socio- cultural and management problems (poor supervision, inadequate workshops, lack of records). Sustainable strategies for prevention of premature failure include informed purchase and installation, preventive maintenance, and proper management and supervision of operators and mechanics. Based on these, simple tips are given for prolonging the life of agricultural machines.

TABLE OF CONTENT

LIST OF TABLES AND FIGURE(S)

CHAPTER ONE

1.0 INTRODUCTION

Most efforts at agricultural production and development can be divided into three parts namely; biochemical approach, management approach and engineering approach. The biochemical approach includes the development of improved animal and plant species, plants and animal nutrients (fertilizer and feeds) and plant and animal production protection (veterinary drugs, pesticides and herbicides). The management approach includes financial packages and management programme, extension services and marketing strategies. The Engineering approach deals with the provision of appropriate agricultural machines, tools and equipment for production and post harvest systems, storage and farm structures, erosion control measures, water resources development as well as irrigation drainage structures (Odigboh and Omwualu, 1994).

The advantages of Engineering approach which is synonymous with agricultural mechanization have been discussed by many, to include reduction in drudgery, increased land under cultivation, increase returns to the farmers among others (Anazoda, 1982). For these advantages to be realized, the introduction of use of machines must be done in a judicious manner by taking sustainability into consideration. Some efforts have been made at introduction and use of machine in agriculture, through government projects and donor agencies as well as private individuals. However, a large number of machines lie idle, rusting away because one or more things are wrong with them, (that is defefect,) the focal point of this project, even worse are situation where machines breakdown before there useful life is reached, or before it is used for a productive venture in the first place.

With high cost of spare parts and other equipment required for servicing and repairs (Adekoya and Otona, 1990) under the distressed economy of Nigeria, any efforts towards the prevention of premature failure of agricultural machines are urgently needed. It has been estimated that up to 30% of investment required in agriculture in development countries (including Nigeria) by the end of the century would be on machinery, (FAO, 1990). If these machines are allowed to fail prematurely, the loss would be enormous. It is therefore important to guard against premature components defects from the time of planning for machines purchase to procurement, use and storage. This can be done by following not just a strategy but a sustainable one which can be use on a continous basis to reduce the risk of premature components defect or break down.

1.1 OBJECTIVES

This project study was carried out to identify:

I. The most severe conditions which are indicative to component defects to agricultural machines, and to measure the level of attainment in agricultural technology.

II. The ecological and environmental impact on agricultural machines and components relatively to the system of machinery use.

III. Socio-economic factors and level of maintenance culture in the state, and

IV. How small and medium scale (SMS) industries and local Blacksmith can fabricate some machine elements to make parts available.

1.2 SCOPE AND LIMITATION OF THE PROJECT

The project studied the nature of defects and their causes, types and models of machine affected, and components in particular. The project also observed the period at which defects occurred, and duration between purchase and period of occurrence.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CONDITION OF AGRICULTURAL MACHINE IN NIGER STATE

The landscape of agricultural establishment and farmers in Niger State are polluted by abandoned and broken down agricultural tractors, and machines. The field production machinery such as tractors are more visible because they are usually outside. In many privately operated processing establishment, broken down machines occupy greater parts of buildings and stores. One of the national survey studies was conducted for the FDA by Anazodo et al. (1982). In another study, a nation-wide survey was conducted to assess the condition of agricultural machines with a view to initiating a rehabilitation programme (EZEIKE et al; 1982).

Some of the results from the studies are quite scaring. In a particular local government, in Niger State, only 26% of available tractors were operational. The state average was 58%. A situation where almost half of the tractors in the state are under some state of disrepair is very serious. With the introduction of SAP and its associated macro economic interventions the percentage of tractors that were operational had decrease to 45%. The situation is progressively getting worse as the economy continous in its slumber.

In that survey, the frequency of the breakdown were high. It is revealed that for standard four-wheel tractors, the electrical system is the

In that survey, the frequency of the breakdown were high. It is revealed that for standard four-wheel tractors, the electrical system is the highest, while braking system (control) is the least. Machines are breaking down very frequently and with the high cost of maintenance, no repairs are effected easily. Thus many of the machines rust away in the open. What makes the situation even worse is the fact that most of the establishments cannot even dispose of the machines by cannibalizing and selling the parts because of government. Bureaucracy. Thus even essential spare parts that could be retrieved for maintenance and repairs of more functional equipment are left to rot away. Thus state of affairs is even more costly for a private farmer who has to operate with a margin of profit.

The unfortunate fact about agricultural machine breakdown in Niger State is that most of them become mal-functional after one or two years of purchase. Since the mechanization level of Niger State is low, the annual use of most of the equipment are also low. Thus a tractor may be used for only 50 hours effectively in a whole year. Therefore, some of the broken down agricultural machineries got to their intended users without all the functional parts intact.

Depending on the situational parts may not have been fully supplied by the manufacturer or they may have been vandalized between the factory and the user. Thus the machine even fail before they are put to use.

In other to bring back these machines to active life, the serviceable ones have to be serviced while the unserviceable ones have to be replaced or rehabilitated. Whatever the decision, since neither the new equipment nor the spare parts for rehabilitation are available, therefore, the best solution under the circumstances is to prevent components defects or breakdown in the first place. To do this, it is relevant to understand the possible reasons for premature failure of agricultural machine.

2.2.0 REASONS FOR COMPONENTS DEFECT OF AGRICULTURAL MACHINES

The reasons for components defect are many but can be grouped as macro-economic environment, ecological and environmental, systems of machinery use, technical management and socio-cultural factors.

2.2.1 MACRO – ECONOMIC ENVIRONMENT

Since the introduction of the Structural Adjustment Programme (SAP) in Nigeria, in 1986, a number of economic policies have been implemented mostly based on the recommendation of the World Bank and International Monetary Fund (IMF). The two bodies believed that over-valued exchange rate, tos many controls on the economy, in effective tax policy formulation and implementation, unwarranted over protection of local manufacturing enterprises by import tariffs and deregulation of financial industry. Subsequently, intervention policies that have been implemented through SAP have included currency devaluation, removal of price controls, privatization and commercialization of government owned companies, commercialization of public utilities, tax and import duty reforms, Civil Service reforms, reform of the financial system and trade liberalization (CBN/NISER, 1991; FMI, 1993 Adeboye, et al; 1995). Initially, government was not willing to implement a full currency devaluation policy for fear of political problems. However, between 1986 and now, the Naira has been devalued several times from its over valued exchange rate of 0.8 Naira to US$ to the current exchange rate of 8u2 Naira to US$. This discouraged imports and encouraged exports, a great increase in cost of products since most manufacturing outfits in Nigeria are mere assembly lines. This business as the demand for their products dropped. However, the situation has encouraged the offshoot of many new small and medium scale (SMS) industries using local raw materials.

The deregulation of financial system in Nigeria initially resulted in the establishment of a large number of private banks of different forms, unfortunately, the gains from this exercise was short lived as many of the banks became distressed since 1995, making it difficult for investors to have good access to funds. Many industrial enterprises have been commercialized or privatized resulting in general increase in cost of services.

Another macro-economic intervention is removal of subsidies. The most outstanding is that of petroleum products such as petrol whose pump price has increased from 0.3 Naira to 40 Naira per litre. Since every aspect of economy depends on petroleum, there has a proportionate increases in the cost of every thing.

In general SAP another interventions have been affecting the economy in different ways. On one hand lead to growth, which on the other led to losses and low capacity utilization in industrial sector.

Agricultural Machinery industry is one that depends greatly on importation, with the devaluation of the Naira the cost of required spare parts and petroleum products for maintaining equipment has been skyrocketing. Most agricultural enterprises hitherto depend on subsidies and assistance from government. With government withdrawal, many establishments are starved of funds, leading to poor maintenance culture as machineries are frequently used without preventive maintenance. These indirectly lead to premature failure and complete component breakdown.

2.2.2 Ecological and Environmental Factors

These factors that may cause premature failure include soil physical and mechanical properties, vegetation climate (rainfall, temperature and humidity) and topography.

Most field agricultural machine work on or through the soil, resulting in soil plant-machine interaction. The interaction can be detrimental to the machine depending on the state of the soil as shown by its properties. Soil physical properties of interest include moisture content, particle size distribution, bulk density, while the mechanical properties include shear strength, bearing capacity and penetration resistance. The following soil conditions can result in premature components failure or defect of agric machines: too low soil moisture contact, soil texture with a large percent of gravel, high dry density, high shear and bearing strength, and high resistance to penetration.

The use of agricultural machines in a farm that was initially poorly cleared can result to premature failure.

The climate determines rainfall, temperature and humidity. Most agricultural machines were designed and built abroad, under temperate environment. Nigeria, being in tropics, is characterised by extremes of heat, rainfall and dust. The effect of these on agriculture machine can occur either when the machines are in use, or when parked. When in use, it is usually during the rainy season and the humidity can be high, leading to oxidation or roosting of machine parts. When the machines are parked for off-season storage, they are subjected to extremely to high or low humidity and temperature. These could lead to failure of components especially electrical ones. When machines are used in areas of bad topography, accidents can occur such as over turning of tractors. This does not happen, some parts can be subjected to abnormally high stresses while other parts are not. Such unforeseen circumstances can lead to premature failure of machine components.

2.2.3 System of Machinery Use

System of machines use can be classified as private, joint and government ownership. In such situations, government ministries and parastatals purchase machines and make them available either as machines subsidies to groups of farmers or give them out on hires to basis. Experience has shown that most government managed machines outfit are characterised by premature failures, due mostly to inadequate attention paid to routine and preventive maintenance (Anazodo, 1982C) on the other hand, most privately owned machines operating either as a joint venture or by contract work are more efficiently run and so prevent premature failure.

2.2.4 Management and Socio-cultural factors

Management factors that can cause premature failure of agricultural machines include lack of effective supervision of operators, bad workshop and repair facilities and inadequate keeping of records. When operators are not properly supervised they can use machines wrongly. These would includes improper adjustments, over working or overloading machine and lack of cleaning and proper storage after use. When repairs are needed, a good maintenance workshop should be readily available. Some studies have revealed that workshop facilities are a serious problems that need urgent attention (Agigun and Oni, 2002). If workshops are not adequately equipped, simple maintenance cannot be done, leading to premature failure. Record keeping is a very important aspect of machinery management. When records are properly kept it is easy to see when a particular machine output or performance is declining. This inadequate records can cause premature component failure as it will be impossible to keep track of the machine's performance.

2.2.5 Technical Factors

The technical factors which can cause premature failure of agricultural machines include adaptability to farming system, incorrectly used machine, poor matching of implement to power source, badly maintained machine, poor quality fuel and lubricants, non availability of spare parts, ease of adjustment, manenverability of equipment, operator's skill and mechanical aptitude and ergonomics.

2.3.0 DEFECTS IN COMPONENT PRODUCTION

Several types of defects may occur during casting, considerably reducing the total output of casting besides increasing the cost of their production. Understanding these defects are essential for possible elimination.

Casting defect may be define as those characteristics that create a deficiency or imperfection contrary to the quality specifications imposed by the design and the service requirement.

2.3.1 CLASSIFICATION OF PRODUCTION DEFECTS

2.3.1.1Major defects which cannot be rectified, resulting in rejection of the casting total loss.

2.3.1.2 Defects that can be remedied but whose cost of repair may not justify the salvage attempts.

2.3.1.3 Minor defect, which may clearly allow he casting to be economically salvage and therefore leave a reasonable margin for profit.

2.3.2 The defects most commonly occur in production are further classified under four groups.

2.3.2.1Surface defects; which are visible imperfections on the surface of casting such as incorrect shape and mass laps, flashes and so on.

2.3.2.2 Internal defect and discontinuities of material such as hot and cold cracks, blowholes and others.

2.3.2.3 Incorrect chemical composition and defective structure of casting may arise from an incorrect proportioning of charge materials, blending of various kinds of metals and poor melting practice. It is only possible to remedy the condition by properly checking the quality of casting material, striking the sequences of weighing and charging the material, and exercising strict control over furnaces run.

2.3.2.4 Unsatisfactory mechanical properties of casting commonly arise from an inadequate chemical composition and structure of metal being poured.

2.3.3 TYPES AND CAUSES OF DEFECTS AND REMEDY

2.3.3.1Shifts. This is an external defect in a casting due to core misplacement or mismatching of top and bottom parts of the casting usually at parting line. Misalignment of the flasks is another likely causes of shift.

Remedy: - This defect can be prevented by ensuring proper alignment of the pattern or die part, moulding boxes, correct mounting of patterns or pattern plates, and checking of flasks, locating pins etc before use.

2.3.3.2 Warpage. Warpage is unintentional and undiserable deformation in a casting that occur during or after solidification. Due to different rates of solidification in different sections of a casting, stress are set up in adjoins walls resulting in warpage in these areas large or flat section or intersecting section such as ribs are particularly prone to warpage.

Remedy: - This is to 'produce large area with wavy corrugated construction to provide equal cooling rates in all areas, proper casting design can go along way in reducing the warpage of casting.

2.3.3.3 Fins. A thin projection of the metal, not intended as a part of the casting, is called fins. Fin usually occurs at the parting of the moulds or core section. Moulds and core incorrectly assembled will cause fins. Insufficient weighing the moulds, or improper clamping of flaks may again produce the fin.

Remedy: - The remedy lies on the use of sufficient weight in top part of the mould so that two parts fit tightly together and correct assembly of the moulds and cores used for the casting.

2.3.3.4 Swell: - This is an enlargement of a mould cavity lay metal pressure, resulting in localised or defective ramming of the mould.

Remedy: - The sand should be evenly and properly rammed.

2.3.3.5 Blowholes: - These are smooth, round holes appearing in jthe form of clusters of a large number of small holes below the surface of casting. These are entrapped bubbles of gases with small walls. Blowholes are caused by excessive moisture in the sand or when permeability of sand is low, sand grains are too fine, sand is rammed too hard or when venting is insufficient.

Remedy: - The moisture content in the sand most be well adjusted, sand of proper size should be used, ramming should not be too hard, and an adequate venting system or device should be provided.

2.3.3.6 Shrinkage Cavity. This is a void or depression in the casting caused mainly by controlled and haphazard solidification of metal. These may also be produced if the pouring temperature is too low.

Remedy: - This defect can be eliminated by applying principle of directional solidification in the mould design and by judicious use of chills, padding etc.

2.4.0 WEAR

It is the main cause of failure in power source. It could render machine inoperable. It is a process of destruction and separation of materials from the part surface due to friction. This lead to change in dimension, shape and surface condition of the parts. This process occurs in all operating mechanisms. Part wear depend on the material construction and machine operations. When threaded joint get loose, their strength decreases and impact load rises which eventually leads to destruction of valuable parts.

Considerable alternating load deform the frame members, cause cracks and fracture and loss of resilience of protective devise spring disrupting the operation of the drive.

2.4.1 WEAR RESISTENCE

This refers to the ability of a part to resist superficial destruction in friction, which could eventually distort the original geometry and surface condition of a part.

The wear on machine components can be reduced by making them have an optional surface roughness through suitable machining operations and ensuring their further operations in liquid friction conditions. Lubrication allows the wear of components to be reduced.

In the absence of lubrication (dry friction) coefficient ranges between 0.5 and 1.0, but where lubrication is present it is reduced to 0.01 – 0.0001. The service life of machine components can be prolonged by improving their wear resistance, for example, by increasing the hardness of their rubbing surface through heat or chemical treatment or surface impregnation (carbonising, hardening, chrome platting or chroming, etc) or by using polymer. (Richew, 1976).

2.4.2 CLASSIFICATION OF TYPES OF WEARS

Wear may be define as the unwanted removal of the surface of a metal through the action of friction. Like automobile, agricultural machines consist of individual components parts forming certain joints. The performance of a joint is characterised by its operational factors, which in this case is the fit of the parts forming the joint, determine by the design. Wear occurring in component parts are classified in to two groups – natural and accidental (Prof. V.I Kazan of USSR).

Natural wear result from friction and action of high temperature and loads occurring under normal service conditions.

Accidental wear is the result of bad servicing. In some instances, it may be caused by manufacturing defects, poor materials, and design errors. This type of wear is characterised by a rapid progress and is accompanied by residual deformation, breakage of component parts and other defect preventing the further operation of the automobile.

The natural wear of a movable joint depends on many factors and particularly on the type of friction, the relative velocity of the mating parts, the initial condition (surface roughness, work hardening), lubrication method and the amount and quality of lubrication, and the presence of abrasive. What is common to all movable joint is that the degree of wear increases with operating time.

2.4.2.0 <u>WEAR TYPES</u>

2.4.2.1 Seizure wear. This is define as the transfer of contact lumps with or without the resistance of lubricants between members in sliding contact. The contact lumps leave groove on the surface of the softer parts, or scour the softer surface, this failure is known as scouring.

2.4.2.2 Oxidation wear. This is a process of gradual destruction of the surface of robbing parts under the action of oxygen on the metallic surfaces subjected to deformation. Oxidative wear is typical of crank shaft journals and pins, pistons and rings, and other components operating under similar condition.

2.4.2.3 Thermal wear. This result from the action of high specific pressure and sliding velocities on robbing surfaces. The heat generated in the process of friction soften the metals of the surface and cause their intensive destruction due to fusion, smearing, and transfer of small volumes of the fusion, smearing, and transfer of small volumes of the metal between them. Thermal wear occurs on cams, value push rod end places, cylinder faces and so on.

2.4.2.4 Abrasive wear. This occur as a result of abrasive particles, wear products included, on rubbing surfaces. As the surfaces slides over each other, these particles cut the microscopic volumes of metals off them. This type of wear inevitably accompany all the other types, accepts for pitting. It is especially widespread where machine components operate in abrasive media.

2.4.2.5 Mechanical wear. This wear result from various mechanical processes, such as the cutting off and plastic deformation of surface irregularities when making parts more with respect to one another. Abrasive and fatigue cracking also cause mechanical wear.

2.4.2.6 Mechano – chemical wear. Is the kind of wear in which are corrosion products and protective film of oxides are removed by a mechanical action. Corrosion is pronounced in machines serving outdoor. This wear mechanism also cover fretting or chaffing corrosion which is defined as: surface damage usually in an air environment between two surfaces, one or both of which are metals, in close contact under pressure and subject to a slight relative motion.

2.4.2.7 Pitting: Is characterised by flaking, sapling and other similar phenomena on rolling friction surfaces. This types of wear manifest itself most vividly on the surface of all bearings and gear teeth.

2.5.0 METHODS OF RECONDITIONING WORN OUT COMPONENTS OF MACHINE

A worn component part is restored to have either the nominal or repair size. It is imparted to the true geometrical shape and the necessary surface properties, and its various mechanical damages and sometimes accidental defects are eliminated.

For this purpose, use is made up of the following methods.

- Restoration of the original fit of components by using their repair size counterparts.
- Restoration of the original fit of component by making use of additional repair parts

- Restoration of the original fit of component by making them have their nominal sizes through building up, metallization, electrolytic and chemical plating, coating with polymer materials.
- Elimination of various mechanical damage.

2.5.1 The Restoration of the original fit component by using their repair size counterpart: Consist in that the more costly and critical of two making parts is machined to a repair size, while it counterpart is replaced by a new one of suitable size. For instance when repairing a crankshaft, the journals and pins are machined to have nearest repair size and blaring selected to fit them with the necessary clearing selected to fit them with the necessary clearance. Thus, a repair size is one nearest to the nominal size of a given part, which ensures the necessary shape and surface roughness of the part machines to this size.

A distortion is drawn between standard, specified and free repair size. Standard repair sizes are used for piston, piston rings and pins, valve push rods, and thin wall bearing inserts. These parts are manufactured in standard repair sizes. Their making parts (cylinder block and crankshaft etc) are reconditioned by matching them to the standard repair sizes of the above listed components. Specification covering the repair of number of components, such as cram shaft journals and bushing, valves and valve guides, and king pins.

Standard and specified repair size are disadvantageous in that, in the process of reconditioning a given surface layer, but also to machined it further until its nearest standard or specified repair size is reached. On the other hand, an important advantage of these sizes is that they allow one to have handy ready-made repair parts and make repair by the partial interchange ability methods.

Free repair size provide for the matching of parts under repair until their true geometrical shape and the necessary surface roughness are obtained. Thus, similar parts may emerge from the norminal size of shaft and hole respectively.

2.5.2 <u>The Restoration of the original fit of component by making them have their norminal sizes.</u>

Irrespective of the extent of wear, this can be done by various techniques, provided that the strength of the component is high enough and the method find application in repair practice; building-up, metalisation, electrolytic planting, plastic working and coat with polymer material. Plasma-jet hard faring, friction welding, liquid metal surfacing, and tro-physical welding techniques, now at the stage of experimental taxing.

2.5.2.1Building-up: This has found wide application in restoring the bearing surface of rotating parts, various slides and guides, spines, gear teeth, etc where use is made of high quality adding material, the service life of the parts being restored is substantially increased. The application of cast hard alloys gives wear resistence built-up surface requiring no thermal treatment.

2.5.2.2 Mettalization: a process of applying a metal coating on to the surface of part by spraying with a liquid metal by means of a jet compressed air or inert gas. The process uses special apparatus metal spraying guns.

Metallization can help to recondition flat, external and internal cylindrical surface, to seal cracks in base (structural) members to spray coat with aluminium the surface of a component with a view to improving its heat resistence to obtained pseudo-alloy processing good antifriction properties, to apply decorative coating and soon.

2.5.2.3 Electrolytic plating: the following metals are used for plating worn surface by the electrolytic methods; chromium, iron, nickel and copper. Electrolytic plating is based on the phenomenon of electrolysis which is chemical process occurring when an electric current flows through an electrolyte.

The electrolyte plating process involves (3) groups of operations and machining of the platted coating. The preparation of the worn surface include matchining, degreasing, electing and dipping. Various metal can be used for plating, and it is these metals that gives names to each particular plating process and ensure the necessary properties of the reconditioned surface.

2.5.3 <u>Reconditioning of parts by plastic working</u>

This method is based on the use of plastic properties of metals. Plasticity is the ability of metals and alloys to change shape under pressure and retain their initial shape after the pressure is being removed.

The following varieties of this method find the widest application in auto repair practice: up setting, straightening, expansion and reduction in diameter. These can be done both with and without heating of the work pieces.

2.5.4 Reconditioning of parts with polymer materials

Polymer – materials are finding increasing application in auto repair practice. The essence of the process consists, in that the thin plastic coating are applied auto worn metal surface with a view to reconditioning them. To casting, are applied by spraying. Most frequently used techniques are flame spraying and eddy or vibration spraying. The material are polymer which are divided into (3) groups: plastic, elastomers and fibres.

Plastic are used most extensively in auto machines practices. These materials are classified into thermoplastic and thermosetting plastic, mainly polyamidamoplastic (polymides). These are hard thermoplastic polymer, melting at a very high temperature. They surpass all the other types of plastic in mechanical strength and wear resistence.

2.5.5 Application of Adhesive composition

Adehesive bending of components find extensive application in auto – machines repair practice. In a number of instances, this repair techniques compare favourably with other methods such as welding, soldering and riveting, because it is easily applied and required no complex equipment. Adhesive can be use to bond components made of similar and non – similar materials, and also those of complex shape and varying size. They find application in repairing of auto mobile bodies in commenting friction linings on brakes shoes, and clutch drive discs, in applying protection coating and so on.

Machines, and mostly automotive components are required using various adhesive compositions containing resins, platicizers, hardners, accelerators, solvents, fillers, and other additions.

2.5.6 Reconditioning of parts by welding

Welding is applied in a very wide scale in automobile / machines repair, welding help to remedy many defective or damaged components all sorts of cracks, breakage, holes, stripped and worm threads, etc. welding is a process of uniting pieces of metal by heating until molten and fused, or until soft enough to hammer or press together. Metal is heated with a gas flame or electric arch. Since components are manufactured from different metals (sceel, gray and malleable cast iron, non ferrous metals and alloys) they require different techniques.

2.5.7 Reconditioning of parts by electric resistence machining

This techniques is used to finish cylindrical flat, and other surfaces, and also to restored slightly wormed components. It provides for simultaneous improvement of the mechanical properties of the surface metal layer of the work pieces.

The service test of the components restored by this method have proved to be effective.

The tests were run of the steering knuckles of the truck and machines (control system), whose bearing surface were restored by various method. New other control system components were tested simultaneously. The tests have shown that if the coefficient of wear resistence of new steering knuckle is taken to be unity, it is equal to 1.35 for knuckle restored by electric resistence machining, 1.2 for those reconditioned by chrome plating, 0.73 for steel plated knuckles and 0.74 for metalijzed ones.

The essence of the techniques consists in that a heavy current (400 – 2000 A) through the contact between the tool and the components being machined. As a result, the surface metal layer of the work pieces is extensively heated and is deformed, smoothed down and compacted under the pressure exerted by the tool. The process can be conducted using the lathes, milling and drilling machines, and other machine tools. Borov skikkh (1989).

CHAPTER THREE

3.1 PROCEDURE AND MATERIALS

This project was carried out through collection of data after having physical contact with different people, and visual observations on agricultural machines at different locations. In areas where physical contact could not reached, questionnaires were prepared and distributed to the officers in-charge for filling and to be returned after filling.

During the survey, journeys were made to some selected local government areas and other places such as:

1. Zonal and Area Offices of the Ministry of Agriculture
2. Zonal and Area offices of Agric. Development Project
3. Institute of Agric Research Station in Mokwa
4. Institute of International Tropical for Agric (IITA)
5. National Cereals Research Institute (NCRI – Baddegi)
6. Private Agric enterprises, such as:

   Maizube Farms

   North Cott Farms

   Nasko Farms

   Wushishi Farms

   Maimasa Farms, and a few
7. Individual tractor owners

8. Federal Ministry of Agriculture and Rural Development.

The format of questionnaire used and the selected local government areas visited shown in the Niger State map, are all at the appendix pages of the project book.

3.2 STATE OF 4 WHEELS TRACTOR IN NIGER STATE L.G.A

S/N	L/GOVT AREA	NO OF BREAKDOWN TRACTORS	TYPE OF TRACTOR				
			MF	STYRE	FORD	FIAT	JOHN DEERE
1.	CHANCHAGA	8	3	1	-	2	2
2.	AGAIE	5	1	-	2	-	2
3.	LAPAI	7	4	-	2	-	1
4.	MOKWA	4	2	-	1	-	1
5.	KONTAGORA	6	2	1	-	1	2
6.	KAGARA	6	3	-	-	1	2
7.	BIDA	9	4	1	2	-	2
8.	KUTIGI	4	2	1	-	-	1
9.	RIJAU	4	1	1	-	1	1
10.	NEW BUSSA	3	1	-	-	-	2
11.	PAIKO	4	2	-	-	1	1
12.	SULEJA	6	3	-	-	1	2
		66	**28**	**5**	**7**	**7**	**19**

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 COLLECTION OF DATA

Statistics depends on the fair collection of data. Data have been collected of various types and models of agricultural machines from different locations with simple tables and diagram to display this data in a fair form of statistical analysis.

4.2 PRESENTATION OF DATA

Data of a total number of 92 defective machines were collected from different areas out of which 26 were taken for sampling.

TABLE 4.2.1

S/N	AREA	NO OF MACHINE	TYPE OF MACHINE					
			MF	STYRE	PORD	FIAT	JOHN DEERE	CRAWLER
1.	MIN. OF AGRIC	8	5	-	-	-	-	3
2.	AGRIC DEV. PRJ	8	-	-	-	5	5	3
3.	FDRD	3	1	2	-	-	-	-
4.	NCRI	7	-	2	1	-	-	2
5.	12 LGC	66	28	5	7	19	19	-
		92	**34**	**9**	**8**	**24**	**24**	**8**
			From this sample data 455 defective components were recorded as shown in tables 4.2.2 – 4.2.5, and an analysis of cumulative total defective components is illustrated in table 4.2.6 below					

STATISTICAL ANALYSIS OF DEFECTIVE COMPONENTS OF AGRIC M/C FROM NIGER STATE NALDA (FDRD)

TABLE 4.2.2

S/NO	DEFECTIVE COMPONENTS	NO. OF DEFECTS & RELATIVE FREQUENCY
1.	PISTONS & RINGS	8 = 4x2 & 3x2 = 6, Σ =14
2.	METAL & MAIN SEARINGS	8x2 = 16 & 6x2 = 12, Σ =28
3.	RADIATOR	1x2 = 2
4.	WHEELS	4x4 = 16
5.	HYDRAULIC PUMP	1 from 2 Styre tractors
6.	INJECTOR PUMP	1
7.	OIL PUMP (BALANCER)	1
		From 1 MF Tractor Total defective components = 63 Average $\frac{63}{7}$ = 9 * MF has 2 defective components * Styre has 61 defective components * Component with mode value is the wheel

STATISTICAL ANALYSIS OF DEFECTIVE COMPONENTS OF AGRIC M/C FROM NIGER STATE ADP

TABLE 4.2.3

S/NO	DEFECTIVE COMPONENTS	NO. OF DEFECTS & RELATIVE FREQUENCY
1.	PISTONS & RINGS	4x2 = & 3x3= 9 Σ =21
2.	WHEELS	4x5 = 20
3.	OIL PUMP (BÅLANCER)	1x3 = 3
4.	OIL SEALS (C/SHAFT)	2x5 = 10
5.	SLEEVES	4X2 = 8
6.	VALVES & SPRINGS	8 X 3 =24
7.	INJECTOR PUMP	2
		* 3 Bulldozer of Caterpillar brand * 5 John Deere wheel tractors * total defects 88 * Average $\frac{88}{7}$ = 12.6 * Component with mode value are: wheels and crank shaft oil seals. 21 defects from bulldozer (Cat) 67 defects from John Deere tractor

STATISTICAL ANALYSIS OF DEFECTIVE COMPONENTS OF AGRIC M/C FROM NCRI BADDEGI, NIGER STATE

TABLE 4.2.4

S/NO	DEFECTIVE COMPONENTS	NO. OF DEFECTS & RELATIVE FREQUENCY
1.	PISTONS & RINGS	4x2 = 16 / 3x4= 12 Σ =28
2.	SLEEVES	4x4 = 16
3.	VALVES & SPRINGS	8x4 = 32 / 8 X 3 = 32, Σ =64
4.	CYL. HEAD GASKET	5
5.	HYDRAOLIC RAM	1
6.	WHEELS	4 X 5 =20
		2 Bulldozer (Cat tractor)
		2 Ford tractors
		1 Fiat wheel tractor
		2 Strye wheel tractor
		* Total defects = 134 * Average = 26.8 * Mode Value = 20 (wheel) * Ford has 64 defects * Strye has 64 defects * Fiat has 5 defects * Crawler has 1 defect

STATISTICAL ANALYSIS OF DEFECTIVE COMPONENT OF AGRIC MACHINES FROM THE MINISTRY OF AGRICULTURE

TABLE 4.2.5

S/NO	DEFECTIVE COMPONENT	NO. OF COMPONENTS DEFECT & RELATIVE FREQUENCY
1.	STEERING PUMP	4 = 1 x 4
2.	STEERING UNIT	4 = 1 x 4
3.	HYDRAULIC PUMP	2 = 1 x 2
4.	INJECTOR ROTOR HEAD	3 = 1 x 3
5.	WHEEL	20 = 4 x 5
6.	LEVELLING BOX	10 = 2 x 5
7.	PISTONS & RINGS	16 = 4 x 4 / 3x4 = 12, $\underline{\Sigma = 28}$
8.	SLEEVE	16 = 4 x 4
9.	GASKET	4 = 1x 4
10.	BALANCER	2 = 1 x 2
11.	RAM CYLINDER	1
12.	METAL & MAIN BEARINGS	8 x 3 = 24 / 6 x 3 = 18, $\underline{\Sigma = 42}$
13.	LOWER LINK	2 x 4 = 8
14.	WHEEL BOLTS & NUTS	16 x 1
15.	CRANKSHAFT SEALS	4 = 2 x 2
16.	TOP LINK	1
17.	THROUST WASHER	2
18.	INJECTOR PUMP	1
19.	GEAR BO	components 1 – 17 from 5 MF tractors

20	TURBO - CHARGER	1 1 component 18 – 20 from Crawler Tractor * Total defective components 170 * 3 Bulldozers (Cat) * 5 MF tractors * 3 defects from Bulldozer * 167 defects from 5 MF * Average $\frac{170}{20} = 8.5$ * Defective component with mode value is wheel of lower links (20 and 8).

ANALYSIS OF CUMMULATIVE TOTAL DEFECTIVE COMPONENTS OF AGRIC MACHINES

TABLE 4.2.6

S/NO	DEFECTIVE COMPONENT	NO. OF DEFECTIVE COMPONENTS	PERCENT (%)
1.	STEERING PUMP	4	0.88%
2.	STEERING UNIT	4	0.88%
3.	HYDRAULIC PUMP	3	0.66%
4.	INJECTOR ROTOR HEAD	3	0.66%
5.	WHEEL	76	16.7%
6.	LEVELLING BOX	10	2.2
7.	PISTONS & RINGS	91	20
8.	SLEEVE	40	8.8
9.	GASKET (CYL. HEAD)	9	2.0
10.	OIL PUMP (BALANCER)	4	0.88
11.	RAM CYLINDER	2	0.44
12.	METAL & MAIN BEARINGS	70	15.4
13.	LOWER LINK	8	1.76
14.	WHEEL BOLTS & NUTS	16	3.52
15.	CRANKSHAFT SEALS	14	3.1
16.	TOP LINK	1	0.22
17.	THROUST WASHER	2	0.44
18.	INJECTOR PUMP	4	0.88
19.	GEAR BOX	1	0.22
20.	TURBO-CHARGER	1	0.22
21.	VALUES & SPRINGS	88	19.34
22.	RADIATOR	2	0.44
		455 * Average $\frac{455}{22}$ = 20.7 * The highest number of defective component is valves & springs, 88	

TABLE 4.2.7

This table below shows the types of machines surveyed and the number of defective component recorded against each and every one of them.

S/NO	Type of Machine	No of Components Defective
1.	FIAT	5
2.	CRAWLER	25
3.	FORD	64
4.	JOHN DEERE	67
5.	STYRE	125
6.	MASSEY-FURGUSSON (MF)	169
		455

This information could further be represented using a Pie-chart (a circular diagram) to show what faction of the total defective components on each type of machine. In this, the angle at the centre of the circle is proportional to the quantity the sector represents.

Since the total defective components are 455;

1. Fiat is represented by a sector angle of 5/455 x360^0 i.e 4^0
2. Crawler by a sector angle 25/455x360 i.e 19.8^0
3. Ford represented by a sector angle of 64/455x360 i.e 51^0.
4. John Deere is represented by a sector angle 67/455 x 360 i.e 53^0
5. Styre is represented by a sector angle of 125/455 x 360 i.e 99^0
6. Massey-fergusson (MF) is represented by a sector angle of 169/455 x 360 i.e 134^0

PIE – CHART
(CIRCULAR DIAGRAM)

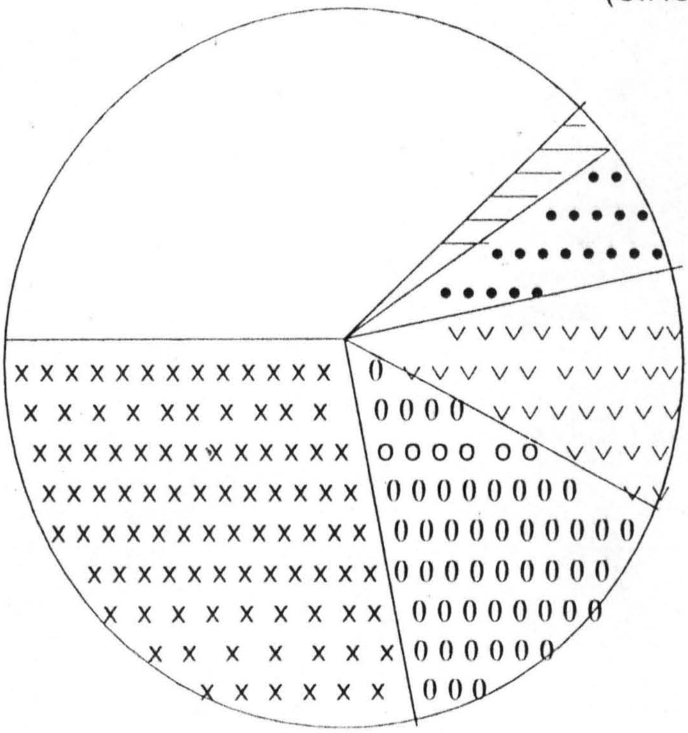
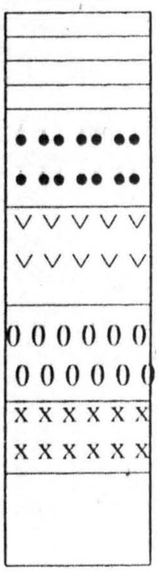


FIG 4.2.8

KEY



FIAT

CRAWLER

FORD

JOHN DEERE

STYRE

MF

4.3.0 CLASSIFICATION OF COMPONENTS DEFECT INTO SYSTEMS

The component defect are classify into the various tractor systems so as to identify the system that has the highest percentage of defects, gravity of defects on the machines and their economic implications. This illustrated in the table below:

TABLE 4.3.0

S/NO	SYSTEM	COMPONENTS	NO. OF DEFECT	PERCENTAGE OF TOTAL
1.	Transmission	i) Wheels ii) Wheel bolts & Nuts iii) Gear	76 16 1	$\frac{93}{455} \times 100$ = 20.41%
2.	Hydraulic	i) Hydraulic pump ii) Levelling box iii) Ram cylinder iv) Lower link v) Top link	3 10 2 8 1	5.3%
3.	Cooling	i) Oil pump ii) Radiator	4 2	1.32%
4.	Lubrication	i) Oil pump	4	0.88%
5.	Control	i) Steering pump ii) Steering unit	4 4	1.73%
6.	Fuel system	i) Injector Rotor head ii) Injector pump	3 4	1.54%
7.	Engine unit and intake / Exhaust	i) Pistons & Rings ii) Sleeves iii) Cyl. Head gasket iv) Balancer v) Min bearings vi) Crankshaft seals vii) Thrust washer viii) Valves & springs	91 40 9 4 70 14 2 88	70%

The table shows the engine unit with the highest percentage relative frequency of component defect while the fuel system has the least. The engine unit has a total number of 318 defective components out of the grand total of 455. The piston and rings have the highest value of 91, while valves and springs, metal and main bearings have 88 and 70 defects respectively.

Thus:

S/No.	System	Percentage defect frequency (%)
1	Transmission	20.4
2	Hydraulic	5.3
3	Cooling	1.32
4	Lubrication	0.88
5	Control	1.73
6	Fuel	1.5
7	Engine	70

4.3.1 COMPONENTS WITH THE HIGHEST FREQUENCY OF OCCURRENCE IN DEFECT

The wheel component has the mode value of defects among all the defective components. From the analysis tables 4.22 – 4.25, the frequency of occurrence of wheel defect is almost in all the machines sampled from the four areas. From the data a total number of 76 defects are recorded against wheel component out of 455 grand total.

4.3.2 PERCULIARITIES OF PROBLEMS

MASSEY – FERGUSSON (MF)

MF model 260 is classified as the inferior model while models 165, 185, and 290 are rated better. The major component defect with a frequent occurrence in this type of machine are:

(i) hydraulic pump: lever hooking

(ii) steering box: breakage

(iii) steering unit: valve weakness

FIAT

Models 8066 and 640 are predominant with 640 rated better. It major components problems are:

(i) Torsion bar seals: leakage

(ii) Stiffness in steering.

STYRE

The major component defect associated with this machine is the steering pump seals that easily gets ruptured and therefore, drain oil from the engine to the back axle.

FORD

The major component defect on this machine is the constant breakage of front wheel bearing. It also have the problem of non – availability of spare parts.

JOHN DEERE

Model 26y50 of this machine is common on the field with a high efficiency of performance. The major problem peculiar to this machine is the brake fluid failure due to suction of air along the line.

4.3.3 REPAIRS AND COMPONENT COST ANALYSIS

Agricultural farm equipment constitutes a vital and relatively costly input in agricultural production, but the introduction of a machine for any farm operation usually results in an overall cost reduction, in addition to the relief from drudgery that it provides. This necessitates the proper management of machines in order to maximise returns.

Survey on component cost revealed the costs of engine components to be very much higher than the costs of components in other system during this project work. From the classification of components defect into tractor's system, the individual cost of component from table 4.3.3 shows a total sum of defective component within the engine unit at over two hundred thousand Naira (N200,000.00), followed by control system at a sum of one hundred and fifty thousand Naira, while the fuel system total cost of component defective has the least cost of sixty thousand Naira (N60,000). The highest gravity of defects and economic implication is on the engine unit. Similarly, it is understood from this survey that the defects are within the repairable limit. This is because the overall total cost of repair of a single tractor is less than 75% of the cost of a new machine. The cost of a single new tractor (N3m) can be use to rehabilitate about three (3) breakdown tractors effectively.

TABLE 4.3.3 COMPONENT COST ANALYSIS

S/NO	SYSTEM	COMPONENT / UNIT COST	TOTAL COST
1.	CONTROL	I. STEERING PUMP: ₦45,000 II. STEERING UNIT: ₦40,000 III. RAM CYLINDER: ₦65,000	₦150,000
2.	ENGINE	I. COMPLETE OVERHAULING: ₦120,000 II. PISTONS, RINGS, SLEEVES: ₦ 21,000 III. CRANKSHAFT SEAL: ₦1,500 IV. METAL & MAIN BEARING: ₦3,500 V. THRUST WASHER: ₦2,000	₦148,000
3.	HYDRAULIC	I. HYDROLIC PUMP: ₦ 85,000 II. LEVELLING BOX: ₦14,000 III. LOWER & TOP LINK: ₦14,000 & ₦500	₦113,500
4.	FUEL	I. INJ. PUMP ROTOR: ₦ 12,000 II. INJ. NOZELE: ₦ 6,000 III. INJ. PUMP: ₦ 40,000 IV. FUEL PUMP: ₦2,500	₦ 60,500
5.	TRANSMISSION	I. CLUTCH PLATE (DRIVING): ₦ 6,000 II. RELEASE BEARING: ₦ 3,000 III. REAR TUBES & TYRES: ₦80,000 IV. FRONT TUBES & TYRES: ₦13,000	₦102,000
6.	LUBRICATION	I. BALANCER: ₦60,000	₦ 60,000
7.	ELECTRICAL	I. STARTER MOTOR: ₦ 27,000 II. ALTERNATOR: ₦ 18,000 III. BATTERY (150 AMPS): ₦5,000	₦ 50,000

4.3.4 PERIOD AT WHEN DEFECT OCCURRED AND IT CAUSE

This survey identified that 70% of component breakdown occurred during field operations as a result of improper handling, matching, size selection, in competence of operator, and incorrect materials and spare parts use. Fuels, oils, lubricants and coolant are diluted and often contained abrasive, while improper grade of fluids used contributed in quality distortion thereby increasing wearing rate which consequently causes untimely component failure.

Similarly, poor storage facilities during and after field and season's operation exposed the machines to an excessive atmospheric hazardous weather resulting in rust and corrosion on the parts. This seriously shorten the life-span of parts, and eventually a premature failure.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Agricultural machines are complementary in agricultural production, it is necessary for training programme to cover all areas of Agricultural technology. It is a paramount importance in realising a tremendous reduction in premature failure or defects in machine components. Many encountered troubles can be avoided if a programme on maintenance culture is well formulated at adhered to strictly. Often it is carelessness in delaying a particular recommended services that creates problems for the future.

Care, maintenance and repair facilities, sufficient in quality and capacity are a pre-requisite for sustaining agricultural machines life span. Regular repairs and maintenance throughout their economic life influences the frequency and duration of breakdown.

The CEO / MD or Commissioner in his office uses a biro of ten Naira in discharging his duty, while the machine operator uses a machine worth of hundreds to a few millions of Naira to perform his duty on the field. It is of utmost importance to train these operators, failure to do this result to Kobo wise Naira foolish on the part of the owners of the machines.

Adigun and Oni (1995) identified factokrs responsible for short useful life of agricultural machines to include:

(i) inadequate maintenance personnel,

(ii) ill-equiped repair and maintenance facilities

(iii) lack of spare parts.

However, an efficient management system requires time, money and efforts to ensure maintainability of agricultural machines. The table below illustrate the diagnostic features of typical agricultural tractors in use in Niger State in the first 5 years and 10 years, respectively.

TABLE 5.1.2 Repair and maintenance schedule for typical tractor in use in Niger State

ACTOR TYPE	First 5 years of Use	5 – 10 years of use
MASSEY-PERGUSSON	i) regular servicing ii) changing of fuel filters and engine oil. iii) clean air pre-cleaner bowl and oil bath. iv) flushing the hydraulic and transmission system v) servicing the hydraulic and transmission system vi) servicing injector pump and nozzles vii) changing clutch plate and leather viii) changing of tyres as required ix) changing of pistons and rings only by the 5th year x) servicing steering system xi) changing of oil seal at (5th year)	i) complete over hauling of engine ii) servicing of transmission system iii) servicing of cooling system iv) servicing the hydraulic and electrical system v) changing of brake pad as required.

5.2 RECOMMENDATIONS

5.2.1 MACHINERY MANUALS

Manufacturers and dealers of agricultural machine in Niger State that transact business in this area should be made to accompanied their products with operator, service and spare parts ordering manuals. This will ensure local capability to correctly operate, maintain and service such machines.

The standard Organisation of Nigeria (SON), the Nigeria Society of Agricultural Engineers (NSAE) in conjunction with the National Centre for Agricultural Mechanization (NCAM) should intensify efforts to complete dealers to adhere to this provision.

5.2.2 CETIFICATION AND SPECIFICATION

SON, NSAE and NCAM must be further strengthened to test and certify and specify requirement for agro-machine and components on sale in the state. Machine that cannot be maintain in agriculture and is allowed to be used is like a patient with a disease before a doctor who is ignorant of the disease, the patient will probably die.

Specifications in terms of accompanying spare parts and protection of component parts, weight in relation to soil bearing capacity need to be spelt out.

5.2.3 TRAINING OF PERSONNEL

Periodic upgrading of the skill of operators and maintenance crew of agriculture machine must be encouraged. Careful handling of equipment is cheaper than having to go for corrective maintenance due to poor handling.

5.2.4 BUDGETING FOR REPAIR AND MAINTENANCE

Machines owners must make proper budget provision for repair and maintenance for service personnel, retainer ship of consulting engineer and stocking of spare parts, beside emergency fund on hold.

5.2.5 REPAIR AND MAINTENANCE SHOP

Adequate provisions should be made for qualified personnel, machines and tools and gauges in the repair shop.

5.2.6 INDIGENOUS MANUFACTURING CAPABILITIES

The Federal Government should consider it a matter of urgency, not only for Nigeria's industrial growth and food and fibre production in agriculture, but for security (Food), develop the steel, aluminium, petrochemical and allied industries to pave way for the manufacture of agricultural machineries and machine elements in Nigeria.

REFERENCES

Borovskikh Y; Klennikov V; Nikiforov V; Sabinin A. (1989). Automobile maintenance and repairs. Moscow, Mr. publisher

Richard H. W. (1996). Principle of metal casting, New York; MC - Graw Hill book Company, Pp 218-222

Castro R. J. (1990). Welding metallurgy of stainless and heat resisting steels, Garden City, New York.

Onwualu A. P (1996). Welding strategies for prevention of premature failure of Agricultural machinery in a distressed economy. Paper presented at the National Workshop on Agricultural Mechanization sub-programme of FGN/UNDP NIR/A1 Pp. 222 - 234

Onwualu A. P (1998) Strategies for Rehabilitation and maintenance of unserviceable Agricultural Tractors in Nigeria. Presentation at the National Train the Trainers Programme for Agricultural Mechanics and operators, out-board engine mechanics and Relevant Institutes.

Stuttman H.S (1992). The new illustrated science and invention encyelopadia volume 4, West port; connecticut 66889, Inc. Publisher.

Kepner R. A; Bainer R. and Barger E.L (1989). Principle of Farm Machinery, 3rd Edition E.L.BS and Granada London.

Adigun, Y. J. and Oni, K. C. (1995). Evaluation of problems and maintenance of Agricultural Machinery in Kwara State. Presented at the 17th Annual comferencxe of the NSAE, Akure.

Adeboye, T.O, Bagachwa, M.S.O., and Bamiro, D. A. (1995). Effects of Reforms on technological cakpability in Sub-Sahara Africa. Concept paper. African Technology Policy Studies Network, IDRC Office, Kenya.

Odigboh, E.U and Onwualu A.P (1994). Mechanization of Agriculture in Nigeria. A critical appraisal. J. Agric Tech. NSTE, Kaduna, 2 (2) Pp 1 - 58.

Anazodo, U.G.N. (1982). Mechanization of Farms in Nigeria. A quantitative analysis of problems and prospects. Agric. Mech. In Asia, Africa and Latin America (AMA), Vol. XII (3) Pp 59 - 63.

Ezeike, G.O.I; Odigboh, E.U., Anazodo, U. G. N. Idike, F. I. (1992). National Survey of farm Machinery rehabilitation programme in Nigeria. Zone 4: Akwa Ibom, Anambra, Imo, Rivers. Report submitted to FDA Abuja

Adekoye, L.O and Otona, P.A. (1990). Tractor maintenance costs in Nigeria. Tropical Agriculture (Trinidad) 67 (2) Pp 119 - 122

Kudu, A. M (2001) Reconditioning of worn out components of machine. Project Book presented to FUT, Agric Engineering Department; Minna. Pp 25 - 36.

APPENDIX A

QUESTIONNAIRE

S/NO	MACHINE : TYPE MODEL		NO OF NON-FUNCTIONAL	DEFECTIVE COMPONENT	CAUSES	UNIT/SYSTEM	SYSTEM CODE
							A– ENGINE B–LUBRICATION SYTEM C-COOLING SYSTEM D – FUEL SYSTEM E – HYDRAULIC SYSTEM F – CONTROL SYSTEM G-IN TAKE AND EXHAUST SYSTEM H-TRANSMISSION SYSTEM