DESIGN AND FABRICATION OF MOTORCYCLE POWERED BOOM SPRAYER

BY

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NOVEMBER 2008

DECLARATION

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 Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

18-11-2008

Alhassan Mahmud

2003/14778EA

Date

CERTIFICATION

This is to certify that this research work "Design and Fabrication of Motorcycle Powered Boom Sprayer" carried out by Alhassan Mahmud of the Department of Agricultural and Bio-Resources Engineering, Federal University of Technology, Minna, Niger State, meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.), and it is approved for its contribution to scientific knowledge and literary presentation.

____________________ ____________________

Engr. Prof. E.S.A. Ajisegiri Date

(Project Supervisor)

25/11/2008

Dr. (mrs) Z.D OSUNDE Date

(H.O.D)

19-11-08

External Examiner Date

DEDICATION

This project is dedicated to my beloved parents Alhaji Alhassan Abdulkareem, Mrs Hawau Alhassan and my brother Alhassan Iliasu whose financial support ensured me in achieving the present standard of education.

Also to my beloved friends Salihu Jubril, Umaru Zakare, Issa Mariam, Issa Rukayat, Isaac Dalbuto, Abdullazeez (Kadosky), Abdullahi Yakubu and Ndama Mohammed.

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ABSTRACT

The machine was designed and fabricated with locally available materials with adequate considerations of some design parameters such as strength, durability, and rigidity. The design of various components of the applicator was made for proper functioning of the equipment as a whole. The machine eliminates the time and energy wastage encountered during the manual methods in compression and hand lever operated knapsack sprayers. The machine is majorly powered by a motorcycle through the hitch points carefully mounted at the passenger's seta of the motorcycle. The tyres engage ratio is 1:4 between the motorcycle rear wheel and that of the compressor, which gives the pump the required revolution for appropriate pressure during operation although the value depends on the speed of operation.

CHAPTER ONE

1.0 INTRODUCTION

We are living in a world of energy saving. It is easy predict that energy saving will be of interest shortly as on the one hand energy and time saving will rise again on medium term basis and, on the other hand, it seems convenient to lower both the primary energy consumption and the energy demand for reasons of human effort preservation and environmental protection.

It is shown that there is large technical potential especially on the improvement of future boom sprayer. The technical and economic comparison between the tractors mounted boom sprayer and that of the motorcycle powered boom sprayer. Has shown that the latter powered by motorcycle is of economic and technical advantage, over which African peasant farmers willing to go on farm mechanization would rely upon.

1.1 Definition of Sprayers

MC Graw – Hill dictionary of scientific and technical terms fourth edition, defines sprayer as a mechanical device that produces a diversion of liquid into a gas stream.

Oxford advanced learners dictionary current English define sprayer as an apparatus that sent liquid through an atomizer in tiny droplet.

But in Agricultural terms, sprayer can be define as a device that convent mostly mechanical energy to hydraulic energy in order to atomize liquid chemicals into a spray fog for either pest, disease, insects or weed control on a given of land.

1.2 Historical Development of Boom Sprayers

Horse – drawn crop sprayers where used in the 1930s to apply long since banned chemical including Copper Sulphate and dilute sulphuric acid to control weeds in arable crops. They were little more than a wooden barrel on wheels with a pair of shaft, an adjustable spray bar and a pump driven from the main axle.

In 1940s the Ransomes Agro atomizer spray was originally developed because it was feared that Colorado beetle might be dropped on the British potato crop during the second world war. It gives low application rates by introducing small amount of chemical into an air blast from a high capacity fan.

Allman, Dorman, Evers and Well Ferguson, Fisons pest contro, the four Oaks spraying company and vigzol among others made hydraulic nozzle sprayers in the late 1940s. by 1990 standards they were very basic machines with a round or rectangular section steel tank, power take – off driven pump, filter, control lever, pressure zange, spray bar and nozzles.

In early 1950s Dorman and Fisons pest control were two companies making trailed sprayers. A 50 – 100 zallons low volume trailed sprayer were introduced. The tank contents were constantly mixed by a mechanical agitator driven by the pump shaft.

During the 1980s new names including Alleys, Berthond, Evrard, Lewly and Tecnoma invented a raise of polythene tank sprayers with stailess steel, spray lines and quick fit plastic jets with non drip diagram valves.

Also in 1998 a completely new concept in spraying technology was introduced to British farmers by Ferrag Design in Israel, The Deganin sleeve boom sprayer has a large PVC sleeves above the spray back.

The present day tractor mounted boom sprayers where just the modifications of the previous inventions.

1.3 Problems Associated With Existing Sprayers

Amsden has used the baltin formula to consider various factor ranging from the time needed to refill the sprayer to the length of the field require treatment.

For example, a 5.5m boom traveling at 1.79 m/s could apply 220 liters/ha to 1.74 ha/h. Refilling the 364 liters tank at the nearest water supply, situated on average of 200 meters or more from the field, took so long that less than half the available time would actually be used for spraying.

Wider booms can only be used if the land is sufficiently flat. An increase in tank capacity has very little effect on spraying efficiency and is more likely to cause soil compaction and also injury to the crawling crops. Also, larger track roots (tramline) has to be left out for easier passage of the tractor which automatically reduced the farm size.

In knapsack hand carried sprayers. Manually operated pumps are tiring to use regardless of whether you pump continuously with lever operated knapsack or intermittently with compression sprayers. The labor input in this sprayers is proportionally high especially when water has to be carried over a long distance. Three to four man hours/ha spent spraying weeds contrast with the drudgery involved with having weeds for days.

Unavailability of spare parts and high cost of maintenance of the existing sprayers in the remote areas hampers their seasonal operation. Most spare parts in tractor mounted boom sprayers and in some motorized sprayers are not what can be acquired easily; the order goes to the company follows by transportation expenses and time waste in farm operation.

1.4 Modifications on the Existing Sprayers

- The motorcycle powered boom sprayer is fabricated to reduce soil compaction caused by tractor weight. That is weight control.
- Two wheels machine to reduce the tramlines caused by tractor tracks.
- Construction of easy pulley system to replace the power take-off shaft in tractors.
- Provisions for the tank carriage to eliminate content carriage on human back, as in the compression and knapsack sprayers.

1.5 Ecological Advantage of the Modified Sprayer

In farm operations care should be taken not to cause damage to the ecosystem. With the present use of heavy machineries such as tractors causes great impact into our ecosystem. The repeated track line (tramlines) during spray kills most of our soil micro organisms that recycles the soil nutrient and also fixed nitrogen into the soil for proper plant growth.

Also the heavy weight of the tractor causes soil compaction along the tracks which either enhance soil erosion or desertification.

With the invention of the motorcycle powered boom spray such situation is bound to be eliminated as the machine is more lighter, little tramlines and little stamped on crawling crops. All this poses less or no danger to the soil micro organism and also check desertification and soil erosion control has the tramlines can easily be changed.

1.6. Justification

In African countries, where labour is readily available the manoeuverability and low initial costs of small equipment is an advantage over large tractor or animal – drawn equipment.

Indeed, under difficult African conditions, where road access to farm mostly is foot tracks and tractors where beyond the reach of the farmer, a motorcycle powered boom sprayer would be the most suitable means of spraying insecticides, herbicides and pesticides on large acreage of farm lands.

It would give the farmer all the required comfort ranging from equipment transportation to it final farm operation.

1.7 Objectives

The main objective of this project is to design and fabricate a motorized sprayer with available local material that would be affordable, environmental friendly, easy to comprehend and of low cost.

1.8 Scope

An air compressor with tank placed at the passenger seat of a motorcycle and the same time powered by the rear wheel of that same motorcycle. It is used in order to provide the needed air compression to force out the chemical through the nozzle as fine droplets in a spray fog.

CHAPTER TWO

2.0 LITERATURE REVIEW

Every farmer project is to grow crops and harvest the crops with out any external hindrance, But the probability of no external obstruction of crop growth to the period of harvest is zero. The crops where naturally meant to compete with weeds and also thrive in the presence of insect pest and diseases.

In order to control method the destruction of the crops by these hazardous agents, the farmers apply various techniques. Among the method/techniques adopted are as follows:

2.1 Mechanical Control Method of Weeds and Crop Diseases

This involves the use of mechanical removal or destruction of insects and pest or removal of seeds by physical energies. These however are unimportant in most countries owing to the high cost and time wastage involved. This method was probably on of the earliest method of pest and weeds control and is still a method use in most of the underdeveloped world.

2.2 Biological Control Method of Weeds and Crop Diseases

This is defined as the control or suppression of weeds or pest by the action of one or more organisms accomplished either naturally or by manipulations of the weed or pest control organism on environment.

Other involves the use of other plants or organisms in this regard specific control methods applicable in the humid and sub-humid tropic are fallowing, live much use of low-growing crops to smoother weeds, use of ducks to fight aphids, grasshoppers and locust and also manipulation of plant and canopy.

2.3 Chemical control method of crop diseases and weeds

This term refers to all weeds and insect pest control practices in which toxic chemicals known as herbicide, and pesticides are used to kill, suppressed, sterilize or modify weed growth and insect pests multiplication in such a way as to prevent interference with crop establishment, growth and production of economic yield. Chemical control method of weeds and pest has within the last four decades, become the most widely used in developed countries of the world. Although the use of herbicides, fungicides, pesticides and nematocides in the tropic is still limited to a few plantation crops and large scale farms, there are indications that it will increase as more farmers become aware of the advantages of chemical method of weed and pest control in increasing crop yields.

In fact, the most important method of crop protection appears to be directed on the use of chemical that may be applied in one of the following forms.

- As a solid (either as a dusting powder or granules)
- As a liquid (either as droplets of different size or in a spray fogs.).

Crop Spraying Techniques

These are the necessary method use in spraying the herbicides or insecticides in the field for effective management and control. Among the techniques this includes:

i. **Drift spraying technique:** In this method the wind direction is noted so that the spray operator can walk progressively upwind across the field through untreated crops. Smoke pellets can be used to assess wind direction. Alternatively, a piece of thread can be attached to a wire fixed to the spray head. Spraying commences 1 or 2m inside the downwind edge of the field. The drift system gives the operator some sense of belonging for the farmer to determine the direction of wind flow, and avoid chemical contamination to himself.

The spinning disc is normally held about 1m above the crop. It may be necessary to hold it lower while spraying the first swath along the leeward side of a field to reduce the amount of chemical which may drift outside the treated area. Similarly the nozzle may be held lower during the final swath on the wind ward side of a field, to cover the edge of the field. Nozzle height can be lowered if necessary when the wind velocity increases, but if the area being treated is sufficiently large; a wider swath can be used to take advantage of the wind.

ii. **Placement spraying:** When spraying herb the disc is held only a few centimetres above the weeds so that downwind displacement of the spray is negligible. The disc or nozzles are held behind the operator at 60^0 from the ground to avoid the hollow – cone pattern from a horizontal disc. The operator does not walk over treated surfaces with this method but if greater control of the position of the swath is needed the less poisonous chemical can be applied with the disc tilted slightly away and in front of the operator. A spray with a single shrouded disc is being developed to control swath width as well as droplet size.

iii. **Boom spraying:** Much of the spraying work was on herbicide application and pesticides at volume less than 50 l/ha. Initially stacked 'Herbi' discs were mounted on a vertical shaft and shrouded to attempt to provide spray distribution equivalent to a fan – jet nozzle and with adjustable swath. The spray pattern from a horizontal disc is a hollow cone, so to obtain the fan type distribution; the top four of the five discs were shrouded. Half the spray was collected on shroud in two 90^0 segment and drained to the disc immediately below it. Spray recovery on the ground 30cm under the boom when 15 litres/ha was applied with 150, 250 and 350μm droplets was equivalent to 8.7, 9.7 and 12.7 litres/ ha, respectively, when the swath was displaced by a 1.8m/s wind, with winds up to 5.4m/s the swath was displaced by up to 3m down wind.

Air - assisted spraying:

It projects the changed spray into crop canopies using an air stream. This spraying method is useful when spraying large targets, such as trees.

The air stream may be used to breakup liquid into droplet, so twin – fluid nozzles are often required to form an essential part of the spraying machine. In this set up an axial fan with blades of 'aerofoil' shape similar to an airplane wing accelerating in the same direction as its moves, discharged at 90^0 to its entry enhance the up movement of the liquid droplet to the target. This factor is particularly important when projecting spray vertically upward into a crop canopy; gravity affects the trajectory of the large droplets, increasing fall out which result in considerable wastage of pesticide on the ground as well as increasing the risk of operator contamination.

Exhaust nozzle spraying:

In this type of spraying, vehicle exhaust gases are used to pressurizing the spray tanks and also to shear the spray liquid into droplet. This technique was developed specifically for the control of locust hoppers. The latest unit has twin 50-litre tanks and sits on the back of a suitable vehicle (Jeep) so that the controls can be operated through the rear of the cab. Exhaust gases are directed through a flexible hose to the spray tank and the nozzle the orifice size of which is selected to suit the particular vehicle and engine.

The sprayer, is operated so that a wind across the line of travel takes the 70-90μm vmd droplet down winds away from the vehicle to the target. Swath width will vary with wind speeds, but can be up to 100m with 10-15 km/h winds. At 1.2 litres/min. out put and vehicle speed of 10km/h, the application rate is 0.3 litre/ha over a 240m swath. Twin tanks are provided so that two different insecticides can be applied if necessary, thus a persistent chemical can be applied in remote areas of bush, but a less persistent and safe insecticide is needed if hoppers are feeding on food crops or near village.

Metered spraying:

Uniform application with this equipment depends on a constant tractor speed and constant pressure a variation in speed from 0 to 80 km/h must be considered when herbicides are applied to railway tracks – some systems incorporate a metering pump which is linked to the PTO or sprayer wheel and a proportion of spray may or may not be returned to the tank. The main disadvantage in this type of spraying is that the power required needed to supply 500liters /ha through a 12m boom be kept in separate tanks each with a pump unit. The chemical pump operating at a higher pressure would inject the chemical into the diluents at the nozzle in population to the forward speed and is controlled electronically. This type of spraying system has been used on one orchard sprayer, but has been confined mostly to spray trains.

CROP SPRAYING MACHINERIES

Considering the type and rate of growth of Agricultural practices, different types of sprayers are employed for crop protection. Some of them include the following:

a) Lever operated knapsack sprayer: these were used through out Africa and are especially successful in treating small acreages. These sprayers work on the principle of hydraulic energy. Here the pressure may be produced by a pump that convents mechanical energy to hydraulic energy. Knapsack sprayers usually have 10 -15 litres container with a hand – operated pump attached some sprayers have a small piston or diaphragm pump actuated by a handle which the operator pumps continuously to maintain pressure. The spray liquid passed from the container into a compression cylinder so that the spray is continuous and even. Knapsack sprayers are fitted with straps and can be carried comfortably on the back. However, their chief disadvantage is that both hands are required for operation and their use over long period is therefore tiring.

Limitations of the knapsack sprayer:

i. Bulk carriage: The whole of the tank including it contents (chemical) has to be carried on the farmer's back; which at the end gives him back ache, shoulder pains causes by the straps and postponement of next farm operation due to fatigue.

ii. Continuous pumping using the lever: This poses serious trouble during operation. The up and down movement of the operators arm may not be uniform through out the spray, which in turn causes under dose and overdoes of some areas in the field.
Also the frequent rest of arm during operation cause delay on farm operation, as half of the operational period is required to give the operator's arm to gather more momentum for the next strokes.

iii. Chemical hazards: There may be a chemical hazard if the operator falls or slip on the ground, has the whole of the content may burst and splash the hazardous liquid on his body. This may cause serious bumt or total blindness.

iv. Lack of easier mobility: The operator treks on his foot during the operation. This delays the work and also causes fatigue.

Design replacement

The motorcycle powered boom is fabricated to over come all these limitations in order to:

i. Provide the means of carrying the whole content or mixture on a mobile structure (motorcycle) so as to eliminate the incessant complains of backache, shoulder pains and reduce work fatigue by the farmers.

ii. Provide pulley operation system to replace the hand lever in knapsack sprayers. These pulleys were set in such a way to transmit the mechanical energy derived from the motorcycle via a pulley belt to an air compressive which provides the required pressure necessary for spraying.

iii. Eliminate chemical hazards as the whole of the content is trap on a metal frame mounted on motorcycle to avoid direct contact with the farmer in case of fall over.

iv. Provide means of mobility: The motorcycle as a whole serves as means of transporting the chemical mixture during the farm operation, instead of trekking the whole length and breadth of the farm with the content trap on his back.

Compression sprayers: Is a pressurized small sprayer suitable for farmers with a very small area of crops some are very small with a capacity of less than 5 litres and are usually hand – carried. While many of these were fabricated from metal, they consist of a tank with an air pump usually felted through the filler hole of the trigger valve, lance and nozzle.

When using these sprayers, the spray liquid is purred into the tank, making sure that the maximum filling capacity is not exceeded usually about 75 percent of the total capacity of the container.

In this type of sprayer the operator does not need to keep pumping while spraying but may need to repressurize the tank by more pumping to discharge all the spray liquid from the tank. The air pressure is used to force the liquid along a delivery hose to the lance, trigger valve and nozzle. Initially the pressure is high but as liquid is sprayed, the pressure falls affecting the performance of the nozzles. Experience with these is that they are relatively expensive so seldom are fitted as standard and if supplied, they are frequently adjusted incorrectly.

Some compression sprayers are fitted with a pump which is separate from the lid. These were developed primarily for vector control and have been used to spray surface on which mosquitoes may rest. They are suitable for agricultural use, but tend to be heavier and more expensive.

Other pressure - retaining types, which are still used in few tropical countries, for example in Colombia to treat coffee, are pre-pressurized with air and then the spray liquid is pumped into the tank. Due to the much higher pressure used with these sprayers the tank is much heavier and a pressure control valve is essential. Their use should be phased out as the pressures used are no longer acceptable and the weight is also considered excessive for manually carried equipment.

Limitations of the compression sprayers

i. **Standardized fitted parts:** most of the parts in compressive spray are standardized and if supplied, they are frequently adjusted incorrectly. The farmer who uses these sprayers find it difficult to adjust the spray pattern in order to suit his purpose in the field.

ii. **Expensive:** The compression sprayer is too expensive to the African farmers, ranging from procurement of parts to it maintenance. And also a special container is used to withstand the excessive pressure and corrosions.

iii. **Excessive pressure:** To prevent repressurization of tank, an excessive pressure is put into the container to prolong the spray time which may cause explosion when the environmental temperature rises; and death or serious consequence would be the end result.

iv. **Pressure variation:** Initially when the spray started the pressure is very high but as liquid is sprayed, the pressure falls, affecting the performance of the nozzle.

Design Corrections

i. Most of the parts of the motorcycle powered boom spray are adjustable to meet the desire of the farmers during field operation, ranging from spray height adjustment, speed of spray and spray swath.

ii. The motorcycle powered boom is not cost effective compare to the compression sprayers. The materials used are cheap and locally available and the maintenance is so simple that every farmer can comprehend with little explanations.

iii. The fabricated boom is safe to use as there is not excessive pressure build up, which the farmer may have fear of explosion. Hence, there is no need of any special container for pressure build up and alas safe cost.

iv. The spray pressure in this boom is designed in such a way that pressure is maintained through out the spray though the provision of pre-compressed chamber.

Motorized knapsack mist blower

Conventional hydraulic sprayers can only project spray droplets generally over a short distance from the nozzle. Thus to project spray upwards into trees or across several rows of crops; it is necessary to add an air stream to carry droplets towards the target. The manually carried sprayer with a fan to create the air stream is generally known as a motorized knapsack mist bellower. They are designed to produce a very fine spray and apply lower volumes than convention knapsack sprayers.

These sprayers consist of a 35-70cc two-stroke engine which drives a centrifugal fan. The larger size engine required to drive a fan withy a fan with a greater out air volume. These heavier sprayers are needed to spray taller trees as the greater volume of air emitted can project droplet higher than the small mist bellower. It is rarely possible to project droplets higher than 10m vertically ever with the larger motorized knapsack.

Limitations of motorized knapsack mist blower.

i. These engines need specialist maintenance, so their large - scale use has been restricted to areas with qualified mechanic who are able to service the equipment. And beside the machines are not common in Africa due to scales spare parts.

ii. The spray chemical may go off-target if there is nay high current of wind in the atmosphere, and the end results are chemical hazard to farm animals and contamination of drinking water. Also the spray chemical may travel a far distance there by causing havoc to other unrelated crops.

Corrections

i. Almost 75 percent of Nigerians have or can afford to buy a motorcycle. This makes it popular among the populace through the use as "going" or "Archaba". The specialists are found almost every nock and cranny of each community. Thereby making it maintenance cheaper and easier.

ii. Less vibration effect, as the machine trolls on the ground with shock absorber supported to the operator's seat to eliminate vibration and galloping effects encounter during field operation.

iii. Targeted spray is maintained as the spray figs were thicker and heavier than in motorized knapsack mist blower. Therefore, there is no fear of isolation damage with the use of motorcycle powered boom sprayer.

Spinning disc sprayer:

Hand-carried battery operated spinning disc sprayers are generally of two types: Sprayers intended for insecticide and fungicide application with small droplets (<150μm), which will move down wind from their point of release and others that produce large droplets (>200 μm) suitable for placement, particularly herbicides application. The latter being equipped with a governed motor or an equivalent system to provide a disc speed of no faster than 2000rpm.

Each type of sprayer consists of a small plastic rotated by a DC electric motor, powered by batteries. One manufacture has used a spinning brush. The speeds of rotation of the supply so disc speed sows down as the batteries are used. A container of pesticide is attached so that liquid will be feed by gravity through a restrictor to the surface of the disc.

Electrostatic sprayers:

Improved deposition of a sprayer on exposed foliage be obtained if the droplets are electrically changed. The effect of a cloud of changed droplets is to induce an opposite change on the nearest earthed surfaces that assist in deposition, even on the under surface of leaves. However, this improved deposition does require sufficient airspace around plants for the charged spray. In practice when plants are close together along a row, and when branches of adjacent rows grow across the inter-row, the charged spray may not penetrate down through a crop canopy, so the improved coverage would then be confirmed to the upper parts of the plants.

Several systems of changing spray droplet have been examined, but only one method has been used commercially on small - scale farmers in some areas of Africa and South America. This is known as the 'Electrodyn' sprayer. In this system, an insecticide such as synthetic pyrethroid, specially formulated in oil, was sold in a container, the "Bozzle, with an annular nozzle fitted in the opening, which is screwed into one end of a long tubular handle. Four 'D' size 1.5 volt batteries in the handle provi-power to a high voltage generator which then connect 25,000 volts to the nozzle. A counter electrode ring around the nozzle is connected through the tube to a trailing earth wine. Liquid is fed by gravity through the nozzle and becomes charged. When it is emitted around the annulus, with a strong divergent electrical field between the nozzle and earth counter electrode, the charged liquid separates into ligament that then break up into the charged droplets.

Limitations for both spinning disc and Electrostatic sprayers.

i. They both contain dry cells as an external source of power, which may affect the application make as the voltage in the cells runs down.

ii. Frequent refill of the bozzle due to low tank capacity usually between 1.2.5 litres.

Corrections

The motorcycle powered boom tend, to correct the trend of incessant refilling by provision of larger tank up to 50 litres and also regular voltage drop of the dry cells which may litter the farm land with used dry cell batteries and in turn causes soil and water pollution.

(vi) Tractor – mounted operated sprayer.

These are used for spraying field crops. A large tank or container of up to 500 litres is mounted at the near of the tractor which provides power for the pump. Large tanks are usually carried on trailers. The tank is connected to a horizontal pipe with outlet nozzles situated at interval along it lengths. The equipment should have sufficient ground clearance to pass over the crops with causing appreciable damage with such equipment large acreage can be easily treated. Tractor mounted sprayers are really not very relevant for use in Africa, though some one used with special boom on coffee in East Africa and a few on some large number estates.

Limitations

i. It is cost effective to own a tractor due to it maintenance cost and that of the spare parts. That is for those who can afford one.

ii. Formation of hard pans on it tracks: The sub-soil in the farm got harden along the tramlines, which seriously hamper the development of root crops and also cause soil erosion as the velocity of the running water increases tremendously along the tracks.

iii.The tramlines reduce the farm size due to the fact that a root path has to be left along the length for the easy passage of the tractors. Assuming a farmer has a ($100x50m^2$) farm land needed to be spray by a tractor with 5m boom length. And the width of the tractor is 2m. From simple mathematics we have the following reduction on the farm land.

Original farm Area A_o = 100x50 = 5000m^2

Boom length B_l = 5m

Tractor width = 2m

:. Total travel lines will be 100m/5m = 20 travel lines (tracks)

:. But each track takes 2m

:. Total length use for tracks will be 2m x 20 = 40m

:. The total reduction in farm size area will be

Ad = 40m x 50m = 2,000m^2

:. Total reduction is 2/5 of the farm land.

Remedies on the fabricated motorcycle powered boom sprayer

i. Provision of inline two wheel drive to avoid the unnecessary wastage of farm land. The width of the motorcycle including it content is not more than 70cm (0.7m). And there is no need of any clearance during track of less width to that of the tractor.

ii. The light weight of the motorcycle and the whole content reduces the level of hand pan formation below the soil surface. And avoid any unnecessary formation of splash or sheet erosion caused by surface sun off.

iii. Almost 80% of the Nigerian farms can afford and maintain a motorcycle, and the parts can easily be found within the community. Unlike that of the tractor that is expensive and beyond the reach of a common man. The principle of it operation can easily be understand by the farmers.

Aerial Spraying:

These are specially design aircraft that are operated by specialized agencies to spray pesticide over large acres. For the first time air craft for insect control in India was used in 1951 when about 3,120 acres of land where sprayed with Aldrin in order to control the spread of desert locust.

In this spraying system, a well trained pilot with a fortified Air field is required for appropriate spraying and safety landing of the plane. The purchase of air craft is far beyond the reach of Nigerian farms, due to it high cost and the technology involve.

Also, a well equipped meteorological centre is required to monitor the visibility effect of the pilot on board. The maintenance of this air craft is too cost, because the air craft has to be flown abroad for either repairs or servicing.

In view of all these above mention problem with the existing spraying machines. The motorcycle powered boom sprayer was fabricated so as to solve some of this problem if not all. The operation of the fabricated boom is simple, easily maintained and at the same time environmental friendly.

CHAPTER THREE

3.0 MATERIAL AND METHOD

These are the design consideration and material selection in order to make use of the best and at the same time the cheapest engineering materials available within.

These design materials were selected due to the enormous Physical properties, ranging from strength, light weight, to corrosive resistance in terms of the rubber Jerri can and the hose.

The two side pulley connecting rods are made of steel in order to withstand the extension and compressions force obtained during the pulley drivers.

3.1 AIR COMPRESURE

This is the vital unit of the crop spraying machinery also known as the heart of the sprayer in conventional terms. It is situated at the tail end of the motorcycle carriage so as to create room for proper wheel to wheel mesh rotation which in turns drives the pulley system. There were two opening on the Air compression one known has the intake opening and the other the compression outlet. The principle behind it operation is that the compressive consist of a cylinder in which a piston moves in a reciprocating motion. When the piston moves down, the inlet valves opens by the effect of suction and the air enters into the cylinder through the intake opening. During the upward movement of the piston the inlet valves closes and the outlet valves opens by the air pressure. The air is then siphon by the use of rubber hose to a pre-compressed chamber for pressure regulation using valves.

3.2 HYDRAULIC NOZZLES

For good spraying result, the fluid must be ever distributed over crop or the filed. It is therefore necessary the fluid is change into droplet at the nozzle. The fluid is ejected with high velocity in the shape of thin film.

The nozzle tip is usually held in a nozzle body by a cap. The body can be an integral part of the end of a lance or a separate component screwed to the lance or a boom. The body and the cap is designed to fit any of the manufacture's own nozzles is supplied, but this should be discourage so that users can fit the most appropriate nozzle tips for a particular application. The body incorporates a diaphragm check valve that acts as a anti-drip device.

The pressure properties of the liquid such as surface tension, density and viscosity and ambient air condition, all influence the development of the sheet spray. The minimum pressure for most nozzles is at least 1 bar but usually 2.3 bars is required.

Most hydraulic nozzles wee manufactured from brass which is un affected by a wide range of chemicals and can be readily machined. However, brass is easily abraded by particles. Alternative nozzle tips are made in harden stainless steel, ceramics and certain plastics such as Derlin. Plastic tips are some time more resistant to abrasion than metal tips because molded tips has a smoother finish. The surface of metal tips has microscopic grooves as a result of machining and drilling the orifice.

The following were at of selected nozzles use for spraying.

3.2.1 DEFLECTOR NOZZLE

The deflector nozzle, sometimes called an impactanvil- or flooding nozzle, has around opening through which liquid passes before hitting a flat surface that deflects the fan-shaped spray towards the target surface Most liquid is at the edges of the sheet, so the spray pattern of most deflector nozzle is not as uniform as with other fan nozzles, however, the circular orifice is less likely to block.

The deflector nozzle is ideal for spraying path ways with herbicides, such as in tea, coffee, oil palm and rubber estates. Some have a wide angle so that the full width of the pathway can be covered in one swath.

3.2.2 STANDARD FAN NOZZLES.

The most widely used fan nozzle has elliptical orifice, that results in more spray being emitted through the centre of the nozzle and less at the edges. These spray pattern of adjacent nozzles can be easily over lapped to provide a uniform distribution of spray so they could be used along a boom, particularly on motorcycle powered boom and other mechanized sprayers. They are used for applying pesticides to relatively flat surfaces, such as soil surface treatment. They are also extensively to treat closely spaced cereal crops and are sometimes set at an angle to increase deposition on the upper foliage.

3.2.3 LOW – PRESSURE FAN NOZZLE

These nozzles are similar to the standard fan but were designed specifically for herbicides applied at 1 bar pressure. Flow rate are specified for 1 bar rather than 3 bars. They are used where there is concern that drift can occur.

3.2.4 PRE-ORIFICE FAN NOZZLES

With increasing concern about spray droplets drift away the target surface there has been an increasing interest in reducing the proportion of small droplets produced by a hydraulic nozzle. The presence of an orifice before the final elliptical orifice results in a drop in pressure and an average the droplet size is larger than if a standard fan nozzle is used. These nozzles are marketed to produce less drift but fewer small droplets can be a disadvantage for some pesticides.

3.2.5 EVEN – SPRAY FAN NOZZLE

When the whole area does not require treatment but the spray has to be uniformly sprayed across a band, the even - spray droplets are smaller than if a standard fan is used at the same pressure and output. They are particularly used where a band treatment of herbicides along the crop row can be can also be used for a band treatment across the inter-row between crop rows.

3.3 FILTERS

Careful filtration of the spray liquid is essential to prevent nozzle blockage during spraying. Apart from a filter in the tank inlet, the pump must be protected by a filter or line strainer, on it input side and each individual nozzle should have a filter. At the line strainer should have a large area, ideally of the same mesh or slightly coarser than that used in the nozzle filter, to cope with the capacity of the pump The line strainer should be position to collect debris on the outside of the mesh at the bottom of the filter so that blockage is unlikely to occur, even if debris has collected. All filters should be regularly inspected and cleaned.

3.4 SPRAY BOOM

Most booms are mounted at the rear of the spray tank, although some are in front, particular for band applications of herbicides so that the farmer can see the position of the nozzles in relation to the rows. Booms are generally designed in three or more section so that the outer section can be folded for transportation and storage. Ideally the boom is constructed as rigid as possible over it length and mounted centrally in such a way that as little as possible of the motorcycle is transmitted to the boom. For most booms the width is fixed. A suitable boom width for the fields can be calculated from.

$$Boomwidth = \frac{arearequiringtreatment}{Timeavailablexmotorcyclespeed}(m)$$

Thus if a farmer has 100ha field which needs treatment in 3days (6 hours actual spray per – day) at speed of 8km/h: the minimum boom width required would be

$$Boomwidth = \frac{100ha}{(6x3)hx8km/h} =$$

The pump out put in litres /min is given by

$$\text{Pump out put} = \frac{\text{swath (m) x application rate l/ha x velocity km/h}}{600}$$

3.5 CONTROL VALVES

Flow of spray liquid from the tank to the nozzle is controlled by the valves, so that the operator controls the spray and the pressure in the pre-compressed and compressed chamber for adequate dose application.

There are two types of control valves employed in the fabrication of this motorcycle powered boom sprayer the valves are as follows:

i. Hand lever control valve: This is a valve that controls the spray of the boom nozzles by opening and closing at a required time. The lever is situated beside the operator's seat, so that he can easily control the spray at the nozzles.

ii. One way valve: This is valve that allows the flow of liquid or air in only one direction. This prevents the flow of liquid into the Air compressure and also prevents the incessant return of liquid to the tank due to air pressure.

3.6 AUXILLIAY (DRIVEN) WHEEL

This serves has the rotational linkage between the air compressor and the motorcycle rear wheel. The auxiliary wheel is chosen in such a way that the diameter of the motorcycle wheel twice that of the auxiliary, which in terms of rotation gives ratio 1 to 2 (1:2) and in turn transmits this revolution to the air compressor via the pulley belt. The pulley head on the air compressive is also 1:2 in terms of rotation therefore the total rotational ratio between motorcycle rear wheel and that of the pulley head on the air compressor is 1:4 which means that when the motorcycle rear wheel make one revolution, the drive on the air compressive is 4 times the formed.

Thus, if a motorcycle with 80cm wheel diameter is operating at a speed of 4kn/h, turns a pulley head on an air compressor of diameter 20cm. turn speed of the air compressor would be:

From calculation

Diameterof motorcycle Dxspeedofm otorcycleV = Diameterof pulleyxspe edofpulley S

:. DV = DS

But D = 80cm

V = 4km/h

D = 20cm

S =?

:. 80cm x 4km/h = 20cm x 5

$$:.\ S = \frac{80cm \times 4km/h}{20cm}$$

S = **16km/h**

3.7 THE PULLEY SYSTEM

The V – groove pulley system is been used in this fabrication due to the fact that a large quantity of frictional energy is required to drive the pulley. To avoid slagging of driven belt an adjustable steel linkage were provided to support in positioning and straighten of the belt in order to given an effective rotation on the pulley.

3.8 THE TANK

The tank may be of plastic, steel either galvanized or otherwise protected from the corrosive effect of the chemical used for spraying. Even galvanized coating is not entirely imperious to some of the stronger chemical used. A recent development is the introduction of plastic and glass fibre as a tank material and this has proved satisfactory for most spray substance.

Other common features of the sprayer tank are a large filler cap, fine mesh strainer (filter) and a drain plug to facilitate drainage and flushing of the tank after spraying operation. The shape of the tank is usually cylindrical or cuboidal.

The tank capacity depends upon the type and nature of the soil working upon; but the maximum should be 50 litres.

3.9 THE MOTORCYCLE

This is the external source of power required to operate the boom. The boom sprayer is attached to the motorcycle on the passenger seat while the operator sit on his seat for it application.

The grids on the two mesh tyres enhance friction between the engaging tyres in order to avoid slip over.

BELT AND PULLEY SELECTION

A pulley consists of a block; it is a lever of the first or second class. There are several different application of pulley depending on their arrangements.

A belt of flexible material forming a band about two or more pulleys is a simple method of transmitting power in farm equipment. Belt can be used in many intricate patterns over several pulleys, on parallel shafts. The pulleys and belts may be either flat or V-shaped.

The V – shaped pulley and belt were selected for this design. The trapezoid shaped or V belt are so named because the sides of the belts are bevelled to fit into the slot of a pulley. The frictional contact between the sides of the belt results in less belt slippage with less tension than flat belts.

(i) SLIP OF THE BELT

Sometimes the frictional grip between the belt and the drives some time looses. This may cause some forward motion of the driver without carrying the belt with it. This may also cause some forward motion of the belt without carrying the driven pulley with it. The process described above can generally be expressed as a percentage.

The result of the belt slipping is to reduces the velocity ratio of the system.

Let $S_1\%$ = Slip between the driver and the belt

$S_2\%$ = slip between the belt and the follower.

Now velocity of the belt, passing over the driver per minute, V

$V = \pi d_1 N_1 - \pi d_1 N_1 \times S_1/100$

Where d_1 = diameter of the driver

N_1 = speed of the driver in rpm

d_2 = diameter of the follower

N_2 = speed of the follower.

∴ V = velocity of the belt

$V = \pi d_1 N_1 (1 - S/100)$ ------------ (1)

Similarly

$\pi d_2 N_2 = V - V \times S_2/100$

$= V(1 - S_2/100)$

Substituting the value of V from equation ---(1)

$\pi d_2 N_2 = \pi d_1 N_1 (1 - S_1/100) \times (1 - S_2/100)$

or

$$\frac{N_2}{N_1} = \frac{d_1}{d_2}\left(1 - \frac{S_1}{100} - \frac{S_2}{100}\right)$$

Neglecting $\left(\frac{S_1 + S_2}{100x100}\right)$

$$\therefore \frac{N_2}{N_1} = {}^{d_1}\!\!/_{d_2}\left[1 - \left(\frac{S_1 + S_2}{100}\right)\right] = {}^{d_1}\!\!/_{d_2}\left(1 - {}^{S}\!/_{100}\right)$$

Where $S = S_1 + S_2$ (Total percentage of slips)

If thickness of the belt is considered, then we have

$$\frac{N_2}{N_1} = \frac{d_1 + t}{d_2 + t}\left(1 - {}^{S}\!/_{100}\right)$$

Where t = thickness of the belt

LENGTH OF THE BELT

This means the total length of the belt, required to connect a driver and a follower.

Let O_1 and O_2 = centre of the two pulleys r_1 and r_2 = Radii of the large and smaller pulley

L = Distance between O_1 and O_2

Let the belt leave the larger pulley at E and G, and the smaller pulley at F and H as shown in fig a above, through O_2 draw O_2M parallel to EF. From geometry of the figure we find that O_2 M will be perpendicular to O, E

:. $\text{Sin } \alpha = \frac{r_2 - r_1}{l}$ (α = angle MO_2O_1 in radian)

Since the angle α is very small

:. $\text{Sin } \alpha = \alpha = \frac{r_2 - r_1}{l}$ -------------- (1)

Length of the arc JE = $r_1 \left(\frac{\lambda}{2} + \alpha\right)$ ---------------- (2)

Similarly length of arc FK

$= r_2\left(\frac{\lambda}{2} - \alpha\right)$ ------------------------- (3)

And

$EF = MO_2 = \sqrt{\ell^2} - (r_1 - r_2)^2$

$= \ell\sqrt{1 - \left(\frac{r_1 - r_2}{\ell}\right)}$

Expanding using binomial theorem

$$EF = \ell\left[1 - 1/2\left(\frac{r_1 - r_2}{\ell}\right)^2 + - - - - - - - - -\right]$$

$$= \ell - \frac{(r_1 - r_2)^2}{2l} - - - - - - - - - - - - (4)$$

But we know that length of the belt L

L = length of arc GJE + EF =length of Arc FKH + HG

= 2(length of arc JE + EF + Length of Arc fk)

Substituting the value of length of arc JE from equation (2), length of arc FK from equation (3) and EF from equation (4) we have:

$$L = 2\left[r_1\left(\frac{\lambda}{2} + \alpha\right) + \ell - \left(\frac{r_1 - r_2}{2\ell}\right)^2 + r_2\left(\frac{\lambda}{2} - \alpha\right)\right]$$

$$= 2\left[r_1 \frac{\lambda}{2} + r_1\alpha + \ell - \frac{(r_1 - r_2)^2}{2l} + r_2 \frac{\lambda}{2} - r_2\alpha \right]$$

$$= 2\left[\frac{\lambda}{2}(r_1 + r_2) + \alpha(r_1 - r_2) + l - \frac{(r_1 - r_2)^2}{2l} \right]$$

Substituting the value of $\alpha = \frac{r_1 - r_2}{l}$ from equation (1)

$$\therefore L = \lambda(r_1 - r_2) + 2x\left(\frac{r_1 - r_2}{l}\right)(r_1 - r_2) + 2l - \frac{(r_1 - r_2)^2}{l}$$

$$= \lambda(r_1 - r) + \frac{2(r_1 - r_2)}{l} + 2l - \frac{(r_1 - r_2)^2}{l}$$

$$L = \lambda(r_1 + r_2) + 2l + \frac{(r_1 - r_2)^2}{l}$$

TENSIONS ON THE BELT

Consider the follower pulley rotating in the clockwise direction as shown below.

Let T_1 = Tension in the belt on the tight side

T_2 = Tension in the belt on the slack side

Θ = angle of contact in radians

Taking a small portion of the belt PQ, subtending an angle δΘ at the centre of the pulley as shown in fig C. the belt PQ is in equilibrium under the following forces.

1) Tension T in the belt at P

2) Tension T +δT in the belt at Q

3) Normal reaction R

4) Frictional force, F = μ x R

When μ = coefficient of friction between pulley and belt.

Resolving all the force horizontally and equating the same.

$$R = (T + \int T)\sin\frac{\int\theta}{2} + T\sin\frac{\int\theta}{2} - - - - - - - - (1)$$

Sin δθ is very small

Substitute $\sin\left(\frac{\int\theta}{2}\right) = \frac{\int\theta}{2}$

$$R = (T + \int T)\frac{\int\theta}{2} + T\frac{\int\theta}{2}$$

$$R = T\frac{\int\theta}{2} + \frac{\int T\int\theta}{2} + \frac{T\int\theta}{2} = T\int\theta - - - - - - - - - - - - (2)$$

Resolving the forces vertically,

$$\mu R = (T + \int T)Cos\frac{\int\theta}{2} - T\cos\left(\frac{\int\theta}{2}\right) \text{-------------(3)}$$

Sin δθ is very small

Substituting Cos $\left(\frac{\int\theta}{2}\right) = 1$

$$\mu R = T + \int T - T = \int T$$

$$\therefore R = {\int T}/{\mu} \text{---------------(4)}$$

Equating the value of R in equation (2) and (4)

$$T\int\theta = {\int T}/{\mu}$$

Or

$${\int T}/{T} = \mu\int\theta$$

Integrating both sides from A to B,

$$_{T_2}\int^{T_1}\frac{\int T}{T} = \mu_o\int^{\theta}\int\theta$$

$$\text{Log}\left(e\,{\pi}/{T_2}\right) = \mu\theta$$

$$\therefore \frac{T_1}{T_2} = e^{\mu\theta} \text{------------(5)}$$

$$\text{Or } 2.3\log\left({\pi}/{T_2}\right) = \mu\theta$$

In the above expression (θ) is the angle of contact at the smaller pulley.

$\Theta = (180^0 - 2\alpha)$

MAXIMUM TENSION IN THE BELT ——

Consider a belt transmitting power from the driver to the power.

Let δ = maximum safe stress in the belt.

B = width of the belt in (mm)

t = thickness of belt in (mm).

Maximum tension in the belt T

T = maximum stress x cross sectional area of the belt. = δbt when centrifugal tension is neglected.

T = T_1 considering centrifugal tension.

$T = T_1 + Tc$

CENTRIFUGAL TENSION

At lower speeds, the centrifugal tension is very small and may be neglected. But at higher speeds, its effect is considerably high and this should be taken into account.

Considering a small portion AB of the belt as shown in fig d below

Let = m = mass of the belt per unit length

V = Linear velocity of the belt.

r = radius of the pulley over which the belt runs.

Tc = centrifugal tension acting at P and Q dΘ = angle subtended by the belt AB at the centre of the pulley.

:. Length of belt AB = rdΘ

Total mass of the belt M = mrdΘ

Centrifugal force of belt AB

$$Pc. = \frac{MV^2}{2} = \left(\frac{Mrd\theta}{r}\right)V^2$$

$Pc = md\theta V^2$

Now resolving the force – (i.e. centrifugal force and centrifugal tension) horizontally and equating the same.

$$2Tc \ \text{Sin}\left(\frac{d\theta}{2}\right) = md\theta V^2$$

$\text{Sin}\frac{d\theta}{2}$ in the equation

$$2Tc\left(\frac{d\theta}{2}\right) = md\theta V^2 or Tc = mV^2$$

CHAPTER FOUR

4.0 The result obtained from this fabrication has all the quality and efficiency when compared with other sprayers. Also the cost of construction of this sprayer is quite affordable to almost all the Nigeria farmers if not Africa as a whole.

A situation where farmers find it difficult to buy a tractor of about ₦6 million or too costly to maintain one, that is for those who are able to buy one for their used could easily be substituted with the motorcycle powered boom in terms of crop spray and related operation.

The need for the motorcycle powered boom sprayer can not be over emphasized due to it low maintenance cost, simple mechanical system and easier operational principles that can be comprehended by Nigerian farmers.

4.1 Hitching the Spray Boom on the Motorcycle

Hitching is the way and manner or the procedure through which the whole of spray boom is been mounted on the motorcycle as it sources of power. The procedures are as follows:

i. Attaching the air compressive and the water on the iron frame at the appropriate position provided for each. That the water pump below the tank and the air compressive at the extreme end of the motorcycle.

ii. The vertical side supporting bars are bolted on the flown iron bar that runs through the compressive attached face, towards the boom lance, with the other end swings bellow.

iii. The auxiliary wheel is then attached at the swing ends of the vertical support bars. With the V-grooved belt already position on both pulley head. The adjusting knob is set in place for adjustment, in order to give the belt, the proper tension required for it drive without unnecessary slippage.

iv. Horizontal side support bars were also attached at the lower end of the vertical support bars. (That is beside the auxiliary wheel) with the other end gripping the shock absorbers at it lower point. An adjuster is also provided at the centre of the horizontal side bars. This gives the two wheels (i.e. driving and the driven) the proper surface area to enhance their contact and avoid slippage or roll over.

4.2 Field Operational Principle of the Motorcycle Powered Boom Sprayer.

The operational principle behind this sprayer is by building up the required spray pressure through the direct action of the pump on the liquid spray material. The pressure thus developed, force the liquid through the nozzles; which break the spray into the proper size droplets and disperse them in the spray pattern desired

The essential parts of this sprayer is the pump, with air chamber, plastic tank, frame work for monitoring the sprayer, filters and screens, control valves, piping sources.

The pump is a positive displacement pump capable of developing the pressure in the range required for may spray jobs. The discharge capacity of these pumps is approximately proportional to the speed. The air from the pump is first collected in the pre-compressed chamber, which id provided on the discharge line of the pump to level out the pulsation of the pump, thereby providing a constant nozzle pressure spray.

Tank which is made of plastic has it capacity ranging from 25liters to 50 litres or more to suit the wide range of spraying needs. The flow of water is through gravitational means with a regulating valve provided on the discharge line of the tank in order to supply adequate amount of liquid required for the spray.

Other valves are included in the piping system for use in connection with the tank and pump filters, also a ratchet – type, quick acting cut off valve is supplied to control the flow to the boom.

The spray boom which is supported by the horizontal structure member on which the nozzle are properly spaced and mounted, can be adjusted vertically to spraying plants of various heights. And finally, when the liquid get into the nozzles it breaks the spray liquid into desired size of droplets for application to the surface to be sprayed. Since no single nozzle can meat all of the various spray requirement, they are now commonly manufactured with in expensive replaceable nozzle tips or disc which can be selected to give the desired spray characteristic and volume for specified job. But for the purpose of this design a conduct plastic pipe is use to serve the purpose of nozzles. A perforation is made on the length of this pipe with a small deflectors placed at each point of the perforation to reflect the liquid into a spray fog.

Power source of this spray is from the rear wheel of a motorcycle. An auxiliary (driven) wheel is meshed with the rear wheel in a tight compressed manner, in order to avoid slippage or roll over. The auxiliary wheel which is in a certain ratio, says 2:1 to the driving wheel driven the pump via a pulley system. The pulley belt attached to the pump gives it a drive of 1:2 with the auxiliary wheel. This means that with one single revolution in turns. With this multiple revolution on the pump drive lead, the required pressure built up in the air chamber for appropriate spray pattern.

4.3 Tank Filling System of the Sprayer

This is the pouring in of chemical – water mixture into the tank to a appropriate level or mark. Every sprayer tank has it continuous on the field. For best operation achievement, the water source should be with 10 to 14m from the filed of operation so as to eliminate time wastage during transportation for refilling.

The refilling system recommended in this type of spraying machine is the direct tank opening refill system.

In direct tank opening system, the water is collected in a bucket or using tap flow hoses to refill the tank through it opening at the top. A funnel with a specified filter is placed on the opening before running in the water. This is to avoid debris from getting into the tank, as it blocks the nozzles during field operation.

Cane must be taken, not to pour concentrated chemicals into empty tank. First fill tank about one-half full of water; then add chemical.

4.4 Calibration of the Boom Sprayer

The user needs to know the volume of spray applied to a particular area of crops so that correct amount of pesticide is added to each tank load of spray.

Where the user can do the calculations, the following technique can be used.

i. Method A

- Put clean water into the sprayer, check for linkages.
- Spray water into a bucket for one minute and measure the volume.
- Measure the swath width by spraying water on a dry surface
- Measure the distance covered by the motorcycle through the crop in one minute while spraying.

The calculation is as follows:

$$\frac{Volume per minute (litre/minutes)}{swath(meters) X speed of motorcycle (m/s)} = litres/minute$$

The answer can be multiplied by 10,000 to give litres / hectare.

ii. Method B

This eliminates some of the calculation by using a calibrated bottle, known as KALINOTTLE to collect the spray while treating 25 meter. The user needs to measure a distance of 25 meters if the swath is 1 meter wide, or adjust the distance in relation to the swath width so that the same area is treated. Thus, if the swath is 0.5meters, then measure out 50 meters. The nozzle tips is removed and the cap of the "Kalibottle" attached to the end of the lance.. the nozzle tips are replaced and the bottle measured area in the normal way and then determine the volume of liquid collected.

iii. Method C

Put a small volume of water into the sprayer tank and operate pump to check for leakages and that the nozzles are operating correctly. Then, when all the liquid has been pumped from the tank, put in a known volume say 2.5 litres into a 25 litres tank or 5 litres into a 50 litres tank. Spray pact of the crop and measure the numbers of rows treated. This number multiplied by 10 will give the number of rows treated by one tank load. From this, the number of tank needed to cover the whole of the crop area can be estimated. If 12 tank loads are needed for one hectare, then the dosage per hectare divided by 12 equal the amount that has to be added to each tank load.

Calculating the nozzle flow is

Flow through one nozzle (l/min) =

$$\frac{Requiredvolume(l/ha)xNozzlespacing(cm)xspeed(kn/h)}{60,000}$$

Length of the Belt

$$L = \Pi(r_1 + r_2) + 2l + \frac{(r_1 - r_2)}{l}$$

Where, r_1= 8.5cm, r_2= 6cm and l= 60cm

$$L = 3.142(8.5 + 6) + 2 \times 60 + \frac{(8.5 - 6)}{60}$$

$$L = 45.6 + 120 + 0.104$$

L= 165.70cm

Total percentage of slip, S

$$\frac{S}{100} = \frac{N_2(d_2 + t)}{N_1(d_1 + t)} - 1$$

Where d_1=17cm, d_2 = 12cm, t = 1cm, N_2= 40rpm and N_1= 28.2rpm

$$\frac{S}{100} = \frac{40(12+1)}{28.2(17+1)} - 1$$

$$\frac{S}{100} = \frac{520}{507.6} - 1$$

$$\frac{S}{100} = 1.024 - 1$$

$$\frac{S}{100} = 0.024$$

$$S = 2.4\%$$

4.5 Maintenance of the Boom Sprayer

The purchase of equipment to apply pesticides is expensive for the small scale farmers. The equipment therefore needs to be durable so that the capital cost can be spread over as long a period as possible. However, use often equipment inevitably cause wear of some parts so routine maintenance, together with careful storage when not in use should prolong its life. All equipment should be provided with an instructional manual which set out the routine maintenance required to keep it in efficient working conditions. Unfortunately some manufactures provide a separate manual for any engine on motorized equipment instead of integrating the information into one manual. The manual for all equipment should be kept in a safe place and accessible at any time when equipment needs to be repaired.

All equipment should be cleaned daily after use and store in a dry secure place, well away from any food in accessible to children and farm animals. The equipment should be protected from rats that can chew hoses. When it is used next, a simple check of a sprayer for any leakage should be a standard procedure before any pesticide spray is put into it. Unfortunately, often under field condition, users will continue to use equipment until it fails before doing any maintenance.

Washing of the Sprayer

At the end of each day's pesticide application, all chemicals must be removed from the equipments. Any residuals left inside equipment are liable to cause corrosion.

A spray tank should be emptied as much as possible then a small quantity of water added to the tank, which is shaken to wash the inside surface. This water is then pumped, through to the nozzles and disposed safely.

Nozzles

The nozzles should be removed and washed each component separately. This is particularly important as small residues of pesticides can dry and after the size and shape of the orifice.

Filters

All filters should be removed and washed after daily spraying operation, the filter inside the tank is not usually removed, but cleaned by the washing of the tank. If the filter in the tank opening or the one in the funnel has been kept clean, the risk of blockage else where in the spray line is reduced

The Frame Work and the Side Support Bars

The general frame work on which the tank air compressor and the water pumps are attached, need to be clean immediately after spraying. This is done by wiping every part of the frame using clean water soaked in a foam or special rag, so as to remove any chemical deposit that may cause corrosion. Heavy oil (grease) is also rubbed on every part of the frame to avoid rusting during storage.

Air Compressor

This is frequently checked during the operation process in order to avoid suck in debris during it air intake. And also, the lubricating oil inside the casing is of good condition for proper lubricating the reciprocating crank and the cylinder walls.

Water Pump

This is the radiator type used in cars. It has pure iron shaft and curve –vane arrange axially. This curved vane made of metal need frequent maintenance as the salt deposit from the water or chemical reaction of the mixture may cause it to corrode. The axial blades are greased after user that is after the residues are drained out and the pump washed in a clean detergent emulsify water.

Pulley Belt and the Auxiliary Wheel

The pulley belt is removed from the pulley system and store along with the wheel so as to avoid rodents from biting the rubber component. And the ball bearings on the wheel be greased before storage. For prolong storage, the tyre has to be deflected to avoid damage due to changes in environmental conditions such as increase in temperature.

4.6 Health and Safety Consideration of the Sprayer

The majority of agricultural accident occurs when spray tanks are being filled or when pesticides are mixed. The resulting injuries usually to the face can be serious; apart from the possibility of being blinded, the face may be badly burned and scared.

It is essential when using chemicals to follow these simple guide lines:

i. If the chemicals being used are poisonous, full protective clothing must be worn.

ii. Read the label if it says to wear eye protection goggle must worm. Follow instruction carefully.

iii. Only compatible pesticides should be mixed. If any doubt contact the manufacture, other wise a chemical reaction may occur giving noxious fumes or even worse an explosion.

iv. Never mix acid and alkali. The result in many cases is a poisonous vapour. If a pesticides has to be diluted using water.

v. When filing sprayer manually they should be first filled to about three – quarters full with water. The chemical should then be carefully added.

vi. When operating sprayers, stand up – wind and keep well away from the nozzles of the sprayer.

vii. Wash hand after touching chemical or equipment used in mixing.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMEDATIONS.

In conclusion, the need for the fabrication of the motorcycle powered boom sprayer can not be over emphasized. It would create room for farm mechanization despite the incessant tenure system in Africa.

It is also observed that with the fabrication of this sprayer. It make motorized sprayer.

i. Portable, aesthetically attractive and simple to operate.

ii. The machine is easy to disassemble from the motorcycle as most joint in it were bolted and not welded.

iii. The efficiency of the machine to spray chemical was higher compared to lever operated and other compression sprayers.

iv. The cost of the machine is low. It would be thus economically available to the rural dwellers.

Recommendation

The designed motorcycle powered boom sprayer despite its higher consistency level is still associated with some short coming such as leakage, wheel slippage and non-uniformity of discharge between the delivery nozzles. However, in view of the above mentioned problems, it could be highly recommended that more effort be put in place to modify the sprayer and modify the wheel for better traction and appropriate nozzle delivery.

Cost Analysis

The cost required to construct a machine is not complete until a good ideal of the engineering materials are evaluated. An understanding of the elements that make up the cost is also very important. Therefore, the cost estimate for a project I usually considered for the following reasons.

i. To be used as a basic for a cost reduction programme

ii. To determine standard of production performance that may be used to control cost.

iii. To provide information to be used in the establishment of the establishment of the selling price of the project.

iv. To determine the most economical method, process or material for the construction of a particular project.

When analyzing the cost of a project, the project is analyzed under three categories namely:

1) Material cost: This is further divided into
   - Direct material cost
   - Indirect material cost.

2) Labour cost: This includes
   i. Direct labour cost
   ii. Indirect labour cost

3) Over head cost:

Direct material cost

This has to do with the actual and real market price of the material used for the fabrication. Although the price in the market is subjected to change, the current market price is used

Indirect material cost

This comes up as a result of the material used indirectly during fabrication.

Example: Hack saw blades, grinding disc, drill bits electrodes etc. Actually some of the expenses incurred here are difficult to pencil down

Table for estimated cost of materials

S/N	Materials	Units	Cost (₦)	Direct labour	Cost (₦)
1	Iron bars	6	600	**a)** Transportation **b)** Cutting **c)** Drilling **d)** Welding **e)** Grinding	100 500 500 1,800 200
2	Compressor	1	5,000		
3	Plastic tank	1	300		
4	Pipes	-	400		
5	Drive belt	2	600		
6	Hand lever	1	300		
7	Side support bars	4	600		
8	Water pump	1	800		
9	u-nuts	6	200		
10	Water tap	1	250		
Total			9,050		3,100

Direct labour cost

This is the cost estimated involve in the production of the motorcycle powered boom sprayer. This include the payment of both skilled and unskilled workers, who were directly involved in the fabrication. For instance, welding, cutting, grinding and painting.

Indirect labour cost

This is approximated in the total cost and the labour cost; is expressed as 35% of the material cost.

$$\therefore labour cost = \frac{35}{100} x9050$$

$$= \frac{35x9050}{100} = ₦\,3{,}167.5$$

Overhead cost

The examples of overhead cost include:

1. Indirect labour cost
2. Indirect material cost
3. Assemble cost
4. Electricity cost
5. Transportation cost.

It is taken to be 30% of the material cost.

$$\therefore Overhead cost = {}^{30}/_{100} x9050$$

$$= \frac{271500}{100} = ₦2,\ 715$$

The total cost of the project will be the total sum of the cost

:. Total cost = material cost + labour cost + overhead cost.

Total cost = ₦9050 +₦3, 165 + ₦2, 715

= **<u>₦ 14,930</u>**

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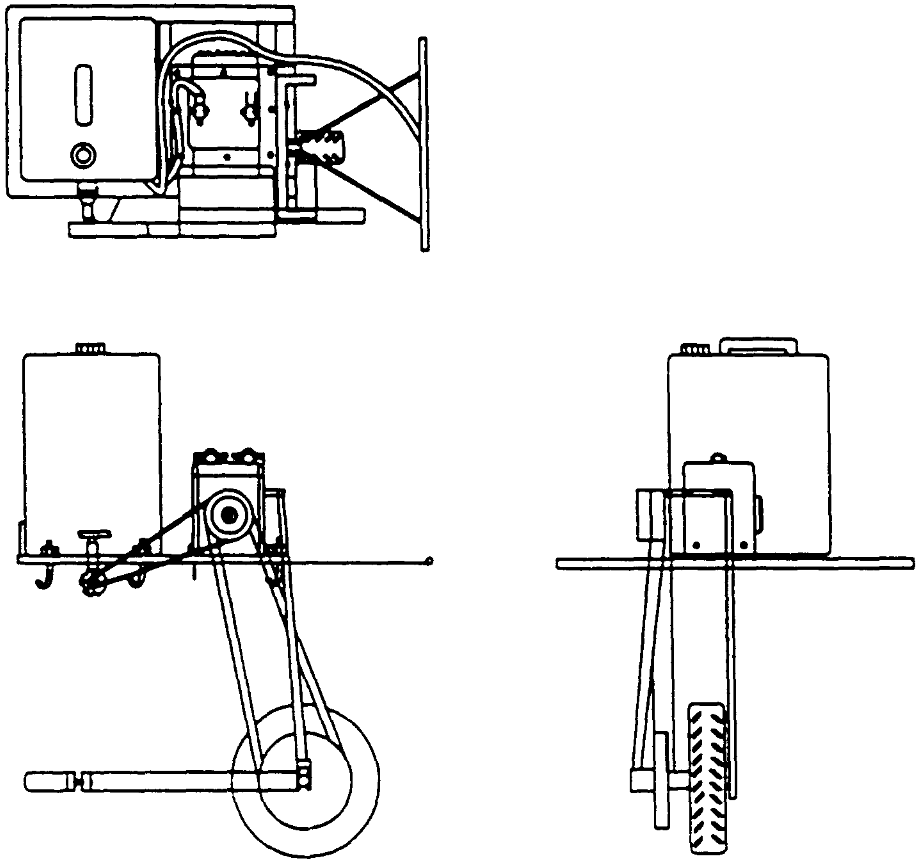

ORTHOGRAPHIC VIEW OF A MOTORCYCLE POWERED BOOM SPRAYER

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA	
TITLE	DESIGN AND FABRICATION OF A MOTOCYCLE POWER BOOM SPRAYER
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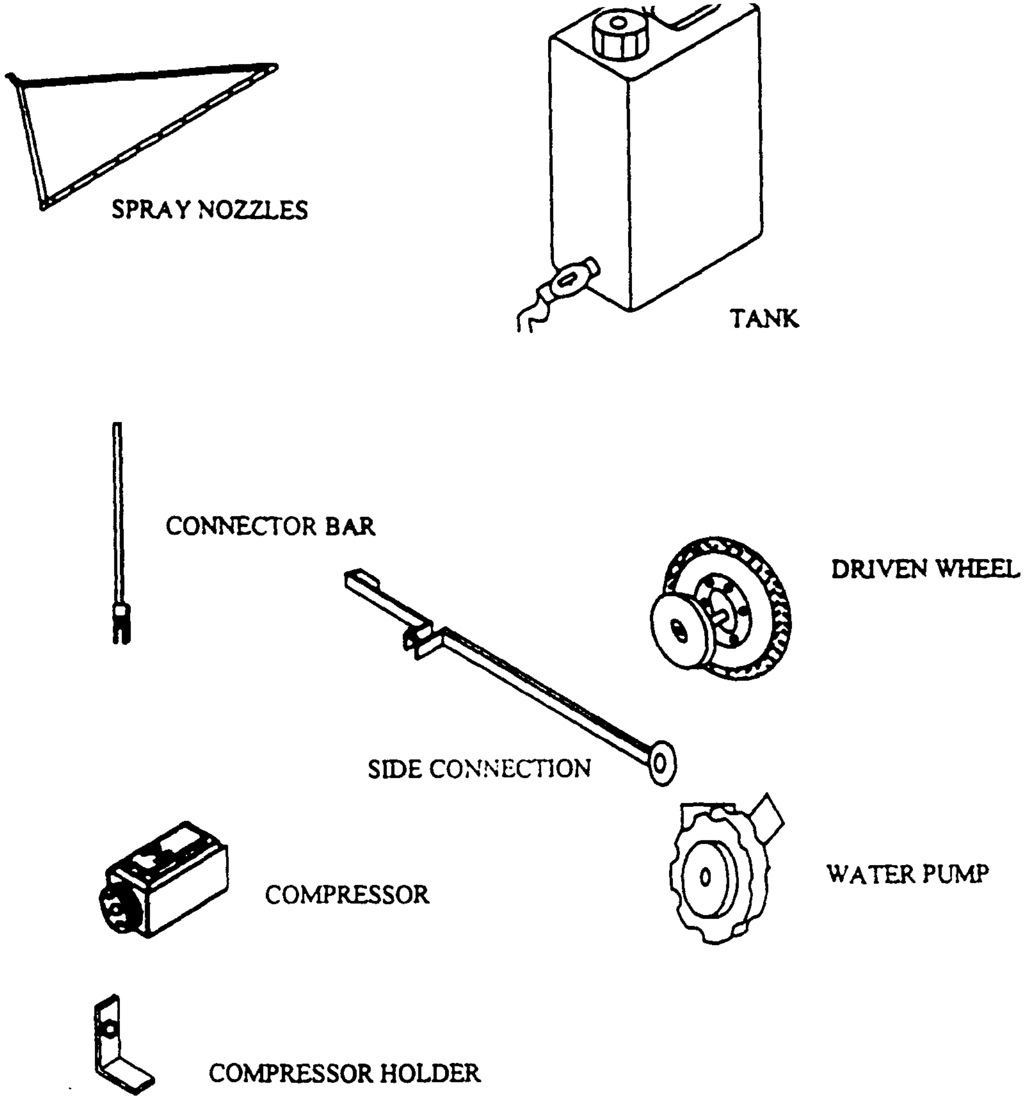
SUPERVISED BY	ENGR. PROF. E.S.A. AJISEGIRI
SCALE 1:1	DATE : NOVEMBER, 2008



PART DRAWING OF A MOTOR CYCLE POWERED BOOM SPRAYER

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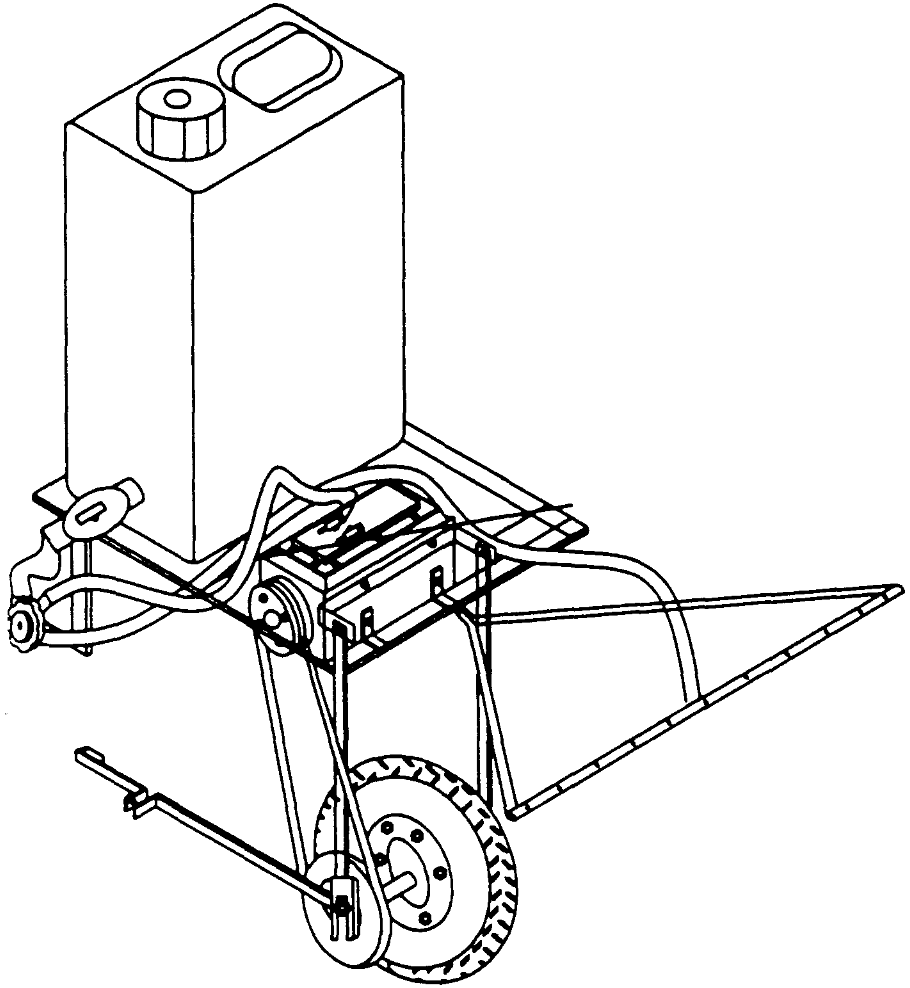

ISOMETRIC VIEW OF A MOTORCYCLE POWERED BOOM SPRAYER

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