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TOWARDS BETTER MANAGEMENT OF MACHINERY'S PASSIVE ENERGY FOR AGRICULTURAL AND RURAL DEVELOPMENT IN NIGERIA: - A REVIEW

[*1]Simeon, P. O, [2]Jijingi, H. E, and [3]Ngabea, S. A

[1,2] Department of Soil Science and Land Resources Management, Federal University Wukari, P.M.B 1020, Wukari Taraba State - Nigeria

[3] Department of Food Science and Technology, Federal University Wukari, P.M.B 1020, Wukari Taraba State - Nigeria

*Corresponding Author

ABSTRACT

For sustainable development, exhaustible and renewable resources must the exploited under strict planning and management that provides for the present and guarantees future availability. This paper highlights the forms of energy consumable in agricultural mechanization as well as the ways through which the resources have been well managed and conserved in developed nations to sustain continuous agricultural developments that transformed their rural communities. This is against the backdrop of Nigeria's saddening experience. The paper attempts to critically appraise energy utilization and conservation in agricultural mechanization in Nigeria and the attendant negative impact its poor management has had on the development of the agricultural sector and subsequently on rural development. The work is an outcome of original scholarly inquiry based on personal observations and experiences and literature review using certified published books and other forms of literature as resources. The paper ends with some suggestions aimed at improving the Nigerian situation to grow the agricultural and rural development sectors.

Keywords: Development, Energy, Rural, Management, Machinery's

1. INTRODUCTION

In agricultural production, energy flows from one level to another and from input to output. In these flows, so many materials, bodies/spheres and factors are involved. These are the Atmosphere, Hydrosphere, Lithosphere, Climatic factors/elements,

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Biological materials (living and dead plants and animals), forces, minerals, chemical reactions and interactions among the various elements and spheres, etc.

The passive energy referred to in this work is basically the energy consumed in the construction of farm machinery which would be released through wear and tear during exploitation of the machinery. It has been stated that the energy consumed in the exploitation of machinery is twice the energy consumed in their fribracation [1]. Also, we know that energy exist in many forms and that these forms, apart from Atomic Energy and the Energy due to natural flow/movement of water (river, streams, etc) originate from the Light and Heat radiated from the Sun. According to [2], "Although energy exist in many forms, they all, apart from atomic energy originate from the light and heat radiated from the sun".

The green plants most especially, and plants generally are known to absorb sunlight and to convert part of it, through the process of photosynthesis, to potential energy stored in organic molecules within. This energy is usually released when the molecules are broken down by oxidation, burning, digestion, etc. in the body systems of animals that feed on the plants, as well as under atmospheric and litospheric agents of degradation [3]. It is thought that many thousands of years ago, plant and animal organisms in the sea were covered by mud deposits which sealed air from them leading to anaerobic gradual decompositions to form peat or fossil fuel which are being drilled or mined today to run our engines [2]. The running engines realize production of all kinds of materials which themselves (produce/products) also have potential energies stored within them. It is thus a continuous state of consumed active energy and storage of potential energy [4].

Actions and reactions, that is, interactions among chemical elements as well as physical frictions occurring in the atmosphere, hydrosphere and lithosphere create one form or another of energy, including gravitational pull/force/energy [5]. Therefore, the energy flow chart is a complex one which must be meticulously studied and understood for efficient (effective and economic) management in the process of agricultural mechanization to realize sustainable large scale intensive agricultural production, most especially of arable field crops.

2. LITERATURE REVIEW

For the purpose of good structural organization of the literature review, it is expedient to itemize the sub-areas/heads the review is intended to be laid out [6]. These are:

i. The structure of energy consumed in agricultural mechanization.
ii. The conventional ways of reducing energy consumption in agricultural mechanization.

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iii. Agricultural Production in relation to Energy Resources.
iv. Agricultural development in relation to the Energy Ratio of the Manual Labour and Mechanized Types of Agriculture.

2.1 The Structure of Energy Consumed in Agricultural Mechanization.

The sustainability of mechanization in agriculture is a function of economic efficiency and affordability of the sources of energy available for the use of the engines and mechanical aggregates/installation. In the structure of energy consumed by agricultural equipment and installations are the energy [1], [7] :-

i. energy for the **manufacture** of the equipment (constituting the passive energy of the equipment).
ii. energy for the **exploitation** of the equipment. This type of energy include the wear and tear, the combustibles, lubricants and the human energy required for the control and servicing of the equipment and installations.

While so much emphasis and attention is paid to the energy consumed in the exploitation of farm equipment, the passive energy is substantially ignored. The level of abandonment of this area of energy management in attempt to mechanize agricultural production in Nigeria is very worrisome and this is the concern of the authors and this paper, hence the title of the paper aimed at drawing the necessary attention.

According to [1], the energy consumed in exploiting agricultural equipment is about twice the energy consumed in their fabrication. The authors are therefore of the opinion, that when equipment are bought and never used, abused or mismanaged and abandoned to rot away before the technical life span, great amount of energy is lost. This is the Nigerian experience that is very worrisome. [8] stated further that the main actions towards the rational consumption of energy in mechanization are:

i. the establishment of the correct dose of consumption for the correct usages, and
ii. the reduction of the specific consumption to the minimum possible.

2.2 The Conventional Ways of Reducing Energy Consumption in Agricultural Mechanisation.

2.2.1 THE WAYS:

i. **Constructively,** every new equipment and installation introduced into production contributes to reduction in energy consumption per working unit through the following:

   a. Simplification of the construction of the machines in view of reducing

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their weight hence the reduction in metal requirement as well as the energy required to move them about;

b. Increase in the working capacity of the machinery through increase in the speed and size of the working unit/organ and the reduction in unproductive time so as to realize increase volume of work per unit of time;

c. Reduction in the number of workers necessary to service the equipment or for putting finishing touches to works done mechanically.

d. Prolongation of the life span of the equipment and ensuring their stability on the field through good constructive features and appropriate exploitation, thus leading to reduction in the consumption of spare parts while distributing the metals initially consumed in the fabrication of the equipment over a large volume of work done.

ii. **Exploitatively,** there are great possibilities for the reduction of the energy consumption of agricultural machinery and installations. The emphasis is strongly in the area of non-renewable forms of energy. Principal among the ways of reduction in energy consumption are:

a. Improvement in the mode of use of self-propelling machines in agricultural operations/works;

b. The selection/choice and use of the most appropriate sources of energy for each type of work;

c. The perfection of the types of machinery available in view of reducing the specific consumption of fuel/combustibles and energy;

d. The reduction or elimination of unproductive transportation and movement of machinery within and outside the farms;

e. Prolongation of the functional duration (life span) of agricultural equipment and installation by timely and quality adjustments, maintenances and repairs

2.2.2 THE COMPONENTS OF THE EXPLOITATIVE WAYS

Each of the five (5) components of the conventional exploitative ways of reducing energy consumption in agricultural mechanization is further examined in detail below.

a. Improvement in the Mode of Use of Automobile Machinery in Agricultural Operation/Works

Tractors represent the principal factor of energy consumption in mechanized agriculture and the energy material principally consumed is **liquid fuel.** The major ways of reducing energy consumption in the use of automobile machinery include the following [9]:

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i. The use of recommend tractor, tractor aggregates and combine harvesters for every type of work and environmental conditions.
ii. Increase in performance efficiency which eventually affects energy consumption in regard to energy used over energy available.
iii. Increase in adherence during movements. Adherence can be increased with appropriate air pressure in the tubes of the tyres as recommended for each type of soil and soil conditions, use of chain-link embroided tyres in highly loosened soil (sand or already ploughed soil), use of supplementary weights, addition of water into the tubes of the tyres to increase their weight, and use of anti-slip devices.
iv. Improving the working parameters of all engines, especially in the area of their revolution/turning capacity, power capacity, time for effective work and the working speed of aggregates.
v. The use of alternative sources of fuel, which can be cheap and found in reasonably unlimited quantities. For example, alcohol, diesel, benzene, etc. to replace petrol. Other examples are plant oils like sunflower oil, etc, to replace diesel in diesel engines. Other alternative sources include wind, flowing water, sun, biomes, biogases and geothermal energy (hot solution contained in the earth crust) which can be used directly or used to generate electricity.

b. Application of the Most Appropriate Source of Energy for each type of Work

The type of energy used depends on such factors as the nature of the point of consumption (location such as field, in house, etc), the magnitude of work, the length of time required for the work and the economic efficiency of the sources of energy. There are two principal areas of great reduction and these are:

i. the replacement of heat engines with electrical energy drive and
ii. the harmonious combination of mechanical works with those of tamed big-size 4- legged animal.

The replacement of heat engines with electric motors reduces the necessity for combustible fossils which are not renewable while there is increase requirement for electrical energy which can be generated from renewable primary sources like flowing water (Hydro-Electric-Power) and the sun (Solar Energy). For any same produce/products obtained in agriculture, electrical energy consumption is always smaller than the energy of combustible fossils [8].

c. Perfection of the Types or Model of the Machinery Available in Production

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The perfection of the types or model of machinery available in production in view of reducing the specific consumption of combustibles and energy during exploitation, can be done principally in the following ways:

i. Reduction of directly active energy through reduction in the consumption of liquid combustibles, electrical energy and human power;
ii. Reduction of indirectly active energy by making rational use of fertilizer, insecticides, fungicides, herbicides, other chemicals, fodder and other materials as well as by reducing the doses of these materials consumed for the realization of unit produce (high output efficiency);
iii. Reduction in the consumption of passive energy through the reduction of the mass of the organs as well as that of the whole body of equipment and through the possibility of using a particular equipment for many types of work for many types of crops/livestocks and using equipment for a great part of the year as well;
iv. Introduction of automation (electronic gadgets) at greater level, both in crop and animal production installations; and
v. Reducing the length of transmission line as much as possible to reduce lost of energy and power, reduction of materials and reduction of wears/tears of the parts of machinery, equipment and installations.

d. Reduction or Elimination of Unproductive Movements of Auto-Machines and Transportation

The reduction or elimination of unproductive transportation and movements of auto-mobile machines within and outside the farms is achievable by the regulation of movement, the use of tractor trailed truck on land with vegetal remains, the use of lorries with diesel engines for long distance out-of-farm transportation, the replacement of petrol engine vehicles with those of diesel engines, optimum loading of the transport vehicles and by good management of the roads or transport routes. The roads can affect the travelling speed of vehicles transporting materials and persons, delivery time (time efficiency), specific consumption of combustibles and the **passive energy (wear and tear)** of the vehicles and the materials. The better the roads the more the reduction in consumption of these listed indices.

e. Prolongation of the Life Span of Agricultural Equipment and Installations through Timely Adjustments, Maintenances and Repairs

The replacement of an old engine with a new one constitutes an important consumption of passive energy. As equipment undergo more and more repairs, the need for metal continue to fall and the

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equipment reaches a certain grade of wear that the passive energy consumption becomes much reduced [8].

By refilling worn out parts, machine organs are preserved and through repairs the early removal of any equipment from production is reduced and by so doing the wholesome lost of the metals and materials contained therein is eliminated thus boosting long life span.

2.3 Agricultural Production in Relation to Energy Resources

In the industrialized nations of the world, the development of great energy resources and their economic (sustainable) exploitation enjoys priority attentions because the sources of energy are limited and the available petroleum products are costly while great energy consumption remains at the centre of human progress and the development of the society. Therefore, efficiency and optimization in the use of the available energy resources manifest as the most viable option even as researches continue into the discovery and exploitation of new and the renewable sources. According to [1], dependency was once on natural energy sources, but today, complex modern technological systems are employed in the generation and management of energy. According to [10], while at the beginning of the last century (twentieth) coal provided 85 – 90 % of the United of America demand for energy, this proportion declined to 50 % by 1930 and to 25 % by 1960. The decline in coal consumption was as a result of increased use of oil and natural gas which accounted for 40 % and 23 % respectively as at 1940.

Today, electricity plays major role in the activation of stationary farm equipment and installations. The electrical energy production, available human energy/power, coal production and crude petroleum production of some industrialized nations in 1973 are as follows:

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Table 1: Agricultural Production in Relation to Energy Resources

Country	Total population (million)	Annual population Growth rate (%)	Percentage of total population that are working (%)	Coal production (million tones)	Crude petroleum production (million tones	Electrical energy production (million kwh)	Contribution of agricultural production to the GDP (%)
USSR	251	1	47	461	429	914,653	20
USA	210	0.9	43	530	454	1,947,079	4
JAPAN	110	1.3	48	22	0.7	470,082	6
WEST GERMANY	62	0.7	43	103	6.6	298,995	3
EAST GERMANY	17	0.2	49	0.75	-	76,908	11
FRANCE	52	0.9	42	26	1.25	174,080	6
BRAZIL	99	2.8	30	2.3	8.3	81,381	13
ROMANIA	21	0.9	48	7	14	46,779	22
AUSTRALIA	13	1.6	44	54	16	64,802	6
SOUTH AFRICA	23	0.4	25	26	-	64,857	10
UNITED KINGDOM	56	0.3	44	132	0.88	282,128	3
ITALY	54	0.8	37	0.005	1.0	145,518	8
INDIA	563	2.1	32	77	7	70,516	44

2.4 Agricultural development in relation to the energy ratio of manual labour and mechanized types of agriculture

In order to increase agricultural production through the introduction of mechanization and irrigation, solar energy has to be maximally used and it is necessary also to consume greater quantity of combustible fossils and electrical energy [1]. Though manual agriculture is known to have high energy ratio (because of little or no use of fossils) the yields are also known to be so low that it cannot sustain the food requirements of the ever-increasing population. To add to this problem is the ageing population of farm workers due to massive urban migration from rural farming areas, and also the number of persons involved in agriculture that is in continuous decline (both in absolute figure and in percentage of the work force). However, education, application of chemicals, irrigation and mechanization have contributed immensely in overcoming these problems associated with manual labour agriculture, and thus **enhanced agricultural development** [10]. It is however of concern that these areas which enhanced development are also great consumers of non-renewable energy sources.

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The intensification of agricultural production, which has brought about agricultural development and rural transformation is characterized, in the forefront, by **increase in the number of tractors and automobile machines, by increase in the average power of the engines** and in some cases and **by increase in the energy consumption per unit of work done.** The extension of mechanization to animal production, irrigation and produce processing (which are stationary farm works) is known to have significantly increased the proportion of electrical energy in the agricultural energy equation [11]. This equation has great importance in the application of mechanization and electrification in stationary processing in agriculture because for every unit of same produce, the electrical energy consumed is always lower than the fuel energy [10], [12]. As at 1980, the ratio of the productivity of mechanical labour to that of manual labour in Agriculture were about 12 for Rumania, about 25 in then USSR and over 32 in USA. This ratio varies regularly in line with the level of technical advancement of the nations and the extension of this to agriculture [1].

Increase in the level of mechanization, use of chemicals and irrigation represents the unavoidable path to the realization of continuous increase in the quantity and quality of agriculture produce and products for the growing number of people and their domestic animals. The objectives of these increase however, can be considered fulfilled only on the conditions of proportional reduction in the consumption of **primary materials and energy per unit of useful produce and products.**

Agriculture has the peculiarity of using both **renewable and non-renewable sources** of energy [13]. The renewable sources are of natural inorganic type (sun, wind, and flowing water) and of natural biological type (micro-organisms, plants and animals) and human workforce [13]. The non-renewable sources are combustible fossils and radioactive atoms. While Crop Production is a primary producer of energy, the other sectors of agriculture are consumers of energy and can also be secondary sources of energy [14], [15]. Hence terrestrial vegetation (due to photosynthesis) constitutes a permanent producer of energy with an output-favoured ratio between the **energy input** (in the form of combustibles, fertilizers, insecto-fungicide, implements/tools, irrigation, machinery, etc) and the **energy output** (from the obtained plant produce). However, the reality of time is showing that there is a continuous fall in this ratio because the cost of energy is increasing at a higher rate than the cost of farm/biological produce [1].

3.0 DISCUSSION

The discussion of the fact emanating from the literature review shall take two (2) dimensions as follows:

- The Nigerian Experience/situation

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- The Impact of Sustained Development of Mechanization on Agricultural and Rural Development

3.1 The Nigerian Experience (1980 - 2015)

In Nigeria, the management and conservation of energy in agricultural mechanization falls greatly short of the foretasted standards in sub-chapter 2.2. These standards are aimed at good management and conservation of scare energy and material resources. Hence, agriculture has move from bad to worse and from few mechanized public and private large scale farms to ecological disasters and great economic lost in monetary considerations and passive energy. Factory purchased (brand new) equipment never used for one day are abandoned to rot away while those in use are grossly abused, ill-maintained and are out of use within 20 % of their life span.

From the honest assessment of conditions/situations in the several field visits the authors have been privileged to make to **"attempted mechanized"** farms reveal that the Nigerian experience/situation is generally a bad and horrifying one. The colossal waste can be seen at the levels of the Federal Government of Nigerian the State Governments, the Local Governments agencies/parastatals charge with advancing mechanisation in agricultural production. Same is the situation with majority of private entrepreneurs.

The country's agriculture has heavily remained in the hands of rural peasants hence undeveloped. The food needs of the populace are heavily supplemented by imported produce/products while the local produce does not correspond in terms of quality. The end result is the poor development of Nigeria's agricultural sector, greatly undeveloped rural areas and litters of agricultural machinery and installations in several areas where they were ill-conceived, ill executed and ill-financed with neither adequate policy goal nor employment of competent specialists to either plan, manage or purchase the suitable equipment for our agricultural and environmental needs.

Few examples will suffice:

i. River Basin Development Authorities created nationwide in 1976 under the programme of "Operation Feed the Nation (OFN)" "which were later heavily funded and mismanaged under the "Green Revolution Programme" of 1980 - 83 and worst till present date, 2016.
ii. National Centre for Agricultural Mechanization (NCAM) located near Ilorin in Kwara State which manifested colossal mismanagement of passive energy and materials in the period 1984-2000 during which the lead author was opportune to interact with facilities therein.
iii. National Agricultural Land Development Agency (NALDA) in the period 1990-93)

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and Directorate of Food and Rural Infrastructure Programme (DIFFRI) in the period of 1986-93 (under which several modern silo were completely constructed nationwide for strategic storage of farm produce. Great many of these have since been abandoned and wasting away.

iv. States Ministries of Agriculture Tractor Hiring Units from Adamawa State to Zamfara State (that is, first to the last respectively on the list of states in Nigeria).

v. Hilterto Leventis farms at Agenebode in Edo state.

vi. Aftcot cotton farm at Ngurore – yola in present Adamawa State.

vii. Cotton farm at Lau-Kunini in Lau Local Government Area of Taraba State.

viii. Hilterto Gongola Tomato industries farm at Lau in Taraba State.

ix. Agbede farms in Edo State.

x. Abiola farms Bali, in Bali Local Government Area of Taraba State.

xi. T.Y Acres, Takum in Takum Local Government Area of Taraba State etc.

xii. The least goes on in all the states of the Nigerian Federation.

3.2 The impact of sustained Development of Mechanisation on Agricultural and Rural Development.

[16] cited Eric R Wolf as describing peasants as rural cultivator while Robert Redfield sees a peasant as one whose main occupation is agriculture for subsistence. Therefore, it is very right to hold that anything that develops agriculture also develops the rural man and his rural area, and this is the position of engineering in agriculture **cum mechanisation,** in rural development. Today, agricultural development is basically a function of agricultural engineering and its related scientific technology input. And because of the availability of engines, motors and machines man has more power at his hand".

The increase in the use of modernised equipment on sustained basis has tremendously increased land, crops, livestock and labour productivities, making agriculture a big business sector which has attracted many investors into research and production resulting in massive growth and development of agriculture in the industrialised nations of the world **while reverse** is the case in greater number of the third world nations (Including Nigeria).

[17] refers to a human community as a group of people living within a defined area and having interest in each other for the purpose of making living as well as developing themselves. To live well, people need good food, clothes, good healthcare, shelter, adequate education, water and electricity supply and communication facilities in modern day and population has grown astronomically where these were developed/assured.

In 1855, practically 80 % of the population of the United State of America (USA) lived on farms (rural areas); while in 1973 more

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than 90 % lived in towns, cities and urban areas [18]. As the population on farms (rural areas) was falling both in absolute figure and percentage of workers, agricultural production was rising such that in 1973 the rise was about 20 % over the level of 1961-1965 period. It is worth mentioning that the manufacturing sector expanded and engaged more workers in both absolute figures and percentage of those working.

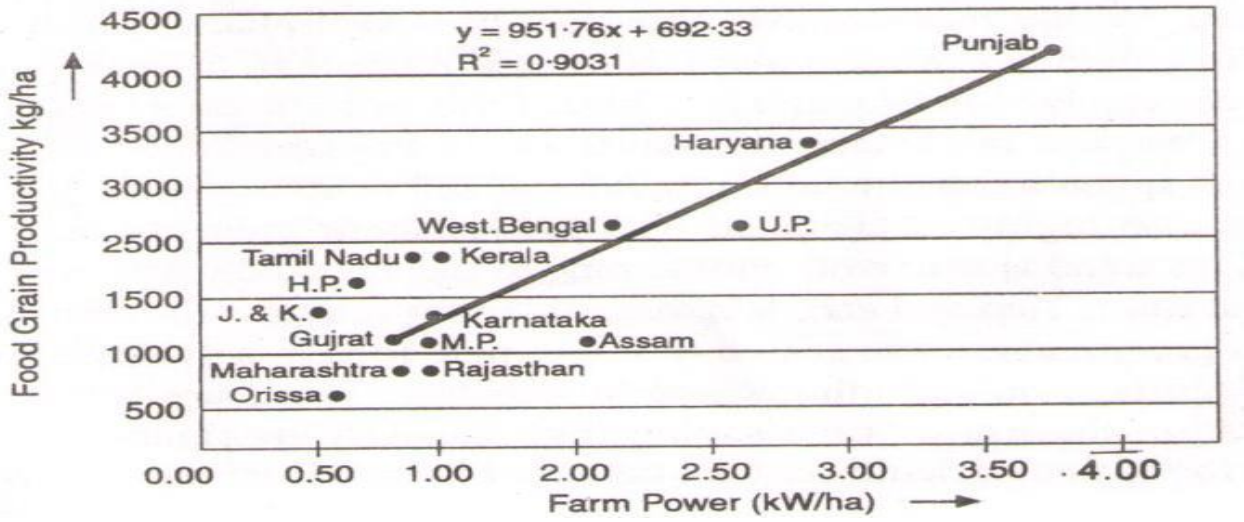
According to [19], the analysis of relationship between power and productivity was under taken in USA and is shown below.

Table 2: Relationship between Power and Yield (10)

Kw/ha	Yield kg/ha	Yield kW ratio
0.25	522	2.1
0.31	710	2.3
0.38	872	2.3
0.63	1023	1.6
0.92	1380	1.5
1.15	1604	1.4

Source: [19].

The availability of farm power and machinery since 1951 in India has greatly helped in increase in the food production as shown below:



- Food grain productivity Kg/ha

Linear (Food grain Productivity Kg/ha)

Fig. 1: Power Productivity relationship

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[20] stated that a very large part of America's forest has been removed in the interest of farming and settlement and that the U.S.A (as at 1975) has nearly three (3) millions of farms averaging about 160 hectares each. **The size of farms has been possible because there had been high level of mechanization and electrification.**

Mechanization and its related factors contributed to the development of U.S.A agriculture and this later played a great role in the establishment and management of the early manufacturing industries which in turn formed the basis of massive employment that led to high population drift. This removed the low population character of the rural areas and formed that of the urban areas .The approach and experience had served as tonic for most newly industrialised nations especially in Asia and Latin American economies but has failed to be of essence in sub- sahara Africa which include Nigeria.

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Energy management and conservation in agricultural mechanization and production is a very complex programme. Where this has been meticulously planned and carried out in combination with good soil study and management, agriculture has significantly progressed and consequently led to the development and progress of the society as well. But where they have failed, the catastrophies have been very great ecologically and economically and have been of long term negative effects on the society.

The recommendations below, if fully implemented, will go far in removing the little prepared persons currently in charge of the majority of our agricultural mechanization sector in particular and agricultural enterprises in general. This will bring about professionalism and expertise necessary for efficient and economic exploitation and management of agricultural machinery and installations and thus create the necessary pre-conditions for our agricultural development and national economic growth. The agricultural development and national economic growth will automatically transform the rural areas to higher urban level, considering the faith that the varied conditions of climate, soil and vegetation from north to south and from east to west combine to make Nigeria a country of great agricultural potentials.

4.2 Recommendation

i Immediate extension and functionality of the National Centre for Agricultural Mechanization (NCAM) in the 6(six) geopolitical zones of the country as well as directing it to the actual conception of mechanization away from its present misconception.

ii. Establishment and functionality of Agricultural Machinery Research and Development Centre to take over

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the present non corresponding duties of NCAM as the name implies.

iii. Establishment and functionality of Soil Study/Research Centre at the national and state levels to complement the Mechanization Centre.

iv. The integration of maintenance culture into the curriculum of all levels of education to save passive energy losses.

v. Availability of various brand of fertilizers and other agro-chemicals at reasonable economic price.

vi. Energetic mobilization of the people to create awareness on the need to always make use of the professionals or specialists at all stages of planning, acquisition and management of agricultural facilities.

vii. large scale mechanized farms should compulsorily have professionals in soil study/research, agricultural economics, agricultural engineering with specialization in mechanization, good technologists with specialization in designing, construction and repairs of machinery.

viii. Our orientation and approach to agriculture requires radical over-hauling from that of simplicity and unskilled profession to that of complex and highly technical scientific discipline.

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