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Research Paper

Indigenous Tractor Development: Panacea for Agricultural Revolution in Nigeria

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Abstract: *Farming in Nigeria hitherto is majorly executed through human energy followed by work animals in northern parts of Nigeria, where tsetse flies are not prevalent. This has been the practice since origin. In northern Nigeria, the use of work animals is drastically reducing due to the high cost of keeping the animals and the steadily increasing cost of meat. Nigerian governments at the three tiers have made great efforts towards agricultural mechanization for improved crop production without commensurate success. These efforts have concentrated on tractor importation. Year after year tractors in their numbers are imported into the country but the expected improvement in crop production has been abysmally low. A number of reasons have been adduced ranging from lack of spare parts for the tractors, scarcity of specialized mechanics and land fragmentation. The opinion is that tractors imported and utilized in Nigeria are not appropriate for the socio-technological background of the Nigerian people. This paper investigates tractorization in Nigeria and recommends the development of locally serviceable appropriate farm machineries with spare parts abounding locally; for accelerated improvement in Agricultural productivity in the country.*
Keywords*: Farming, Nigeria, Tractor, Indigenous, Appropriate, Production*

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I. Introduction

Agricultural development involves three approaches namely bio-chemical, socio-economic, and engineering known as the trio of technologies. The bio chemical approach includes the development of improved animal and plant species, animal and plant nutrients (fertilizer and feed) and plant and animal protection (veterinary drugs, pesticides and herbicides). The socio-economic approach includes financial packages and management programmes (economics, business management, accounting, sociology, extension services, agricultural marketing and pricing strategies). The engineering approach deals with the provision of agricultural machines and equipment (be they human, animal or mechanically powered) for production and post-harvest systems, handling and storage systems and farm structures, erosion control measures, water resources development as well as irrigation and drainage structures, meteorological systems, and the technologies for optimally utilizing the above and their proper and economic use and management (Asoegwu and Asoegwu, 2007).. The Nigerian Engineer should be concerned with the requisite engineering inputs to better the sector leading to enhanced agricultural productivity in the country. These engineering components are grouped and classified as Agricultural Mechanization; implying machines involved in cultivation or rearing and processing of agricultural products. No realistic change can be expected from the present nature of Nigerian Agriculture, due to the drudgery attached to it, until the farmer finds an alternative to the hoe and cutlass technique of production. The clearing of bush, preparation of land, the sowing of seeds, the various post-planting operations are all processes in which the farmer’s present tools can do little for high productivity per man day or per hectare. The over reliance on hand tool technology (over 70%) for agricultural production is one of the greatest technical problems facing the present generation of Nigerian farmers. This is because with the low work rate efficiency of less than 10% in the humid tropics, using hand power is arduous, inefficient and can barely produce enough to feed the family (Asoegwu and Asoegwu, 2007).

Nigeria needs to develop her agricultural sector and be relatively self-sufficient in food production through appropriate agricultural mechanization. Although farm mechanization encompasses in its widest sense, hand tools, draught animals and mechanical technologies, tractor is one of the most important mechanical power because it is a major element in farm mechanization. In fact agricultural mechanization is synonymous with tractorization. It is a critical input for agricultural mechanization and a major indicator for assessing level of agricultural development in any country. To embrace agricultural mechanization, one of the most important agricultural technologies that Nigerian farmers must have access to is tractor and implements suitable for common farm sizes and maintainable by available mechanics. (Ajah, 2014).Appropriate technology is a concept, a set of ideas or a framework within which to think and act for the development of a society. The aim of the concept is to provide a basis and a method for the choice of technology. It is a concept intimately connected with development, whereby the development is of people rather than things, although the development of goods and services is seen to be a necessary appendage. The concept of appropriate technology derives its definition and methodology from clear understanding that technology is a social activity. Appropriate technology is neither another exercise in technological determinism nor is it a search for a new technological fix; but is truly a search for an alternative technology that matches the technical environment of the community. Appropriate technology should be seen to be appropriate to development, understanding development not merely as economic growth but as socioeconomic change primarily directed towards satisfaction of basic human needs (food, clothing, shelter, health, education, transport/communication, etc., and employment which makes all this possible), starting from the needs of neediest, in order to reduce inequalities between and within countries thereby strengthening self-reliance that grows form within as well as achieve ecological soundness in order to achieve harmony with the environment and make development sustainable over the long run (Date, 1981). Obviously equipment that is appropriate for cultivation in the United States of America (USA), for instance may not be suitable for farmers in Sub Saharan Africa.

It is opined that the type and size of tractors imported and utilized in the Nigeria do not match the county's technical environment. The dearth of mechanics and lack of spare parts as well the outrageous cost of the equipment are evidence to this fact. Hence upon the fair usage of the tractors in Nigeria, the intensity of mechanization of farming activities in the country is still quite low at 18W/ha as compared to 37W/ha in Africa and 783W/ha in the United States of America in 1977; and as such the agricultural energy consumption is not yet as high as in the developed countries. However, the key to economic development lies in raising agricultural productivity which directly involves the utilization of more energy resources. The reason why Nigeria's agriculture has not made any tangible forward movement is that there has been very little engineering input into it by government, agricultural engineers and farmers. There is the need to put more power into Nigeria's agriculture (Asoegwu and Asoegwu, 2007). This work aims to develop Nigerian tractors that match our socio-technological setting offering the farmers machinery they can easily maintain and employ for enhanced agricultural productivity.

II. Overview of the Situation (from Literature)

Nigeria's agriculture industry has performed abysmally, notwithstanding the importation and utilization of huge foreign machineries and equipment. The reason suggested is that in Nigeria's agriculture industry, the importation and utilization of foreign machineries have not been matched to the people's socio-economic and technological setting. Since 1960 Nigeria has been importing equipment for different agricultural processes and purposes without a thought as to their suitability to the ability and socio-technological system of the people who use the machines.Specifically the importation of the tractor and pesticide technology has not yielded the desired benefits. Several Nigerian Government Agricultural Programmes such as Operation Feed the Nation (OFN), Green Revolution and Food for All Programme, have been geared towards tractorization which have not yielded expected results, for a number of reasons such as: lack of skilled operators and personnel, lack of suitable implements and spare parts, farm land fragmentation, and increase in the cost of tractors and implements. (Abubakar and Ahmad 2010)

Nigeria as a nation has almost all the natural and human resources that will make it self-reliant in food production but ironically the country is threatened by food insecurity. The inability of Nigeria to produce enough food has been attributed to the country's failure to accept farm mechanization to the extent that the greater proportion of the farming population are peasant farmers that depend on manually operated implements. The findings indicated that the major limiting factors to farm mechanization were the cost of hiring tractor services and inadequate sources of hiring points resulting in poor access to tractors and its implements (Ajah, 2014). Investigations reveals that over 50 percent of thousands of tractors procured in Nigeria have either broken down or are unserviceable due to various reasons including; lack of spares, poor operation and maintenance, and the unhealthy national macro-economic trend which has affected adversely tractor and equipment prices. The accumulated repair costs of tractors may be as high as 1.6 times the purchase price mainly due to inflation. The current high cost of ownership of farm tractors in Nigeria, militates against the use of tractors by majority of the farmers who are poor and live in rural areas (Abubakar and Ahmad, 2010).

Despite the concerted effort to introduce mechanization and improved seeds, the desired goal of realizing sufficiency in the production of food, cash crops and agro-industrial raw materials has not been fully achieved. The operation of imported machinery has been bedeviled by the problems of spare parts, repair facilities, capital, skill manpower (operators and mechanics) and the fact that most machinery applications are incompatible with farmers cropping techniques. Available information showed that 1000 tractors imported in 2003 were without required implements, thus rendering them unusable. Also about 50.5 per cent of the estimated 10,000 tractors in the country are in a state of disrepair. The very low tractor density of 0.03 horse power per hectare makes the realization of food security through mechanization more difficult (Ukeje 2004). The experience in many developing countries including Nigeria is that tractors have not been an appropriate solution. (Daramola 1999).

In 2006, the World Food and Agricultural Organization (FAO) classified levels of agricultural mechanization. Farm sizes close to and above 50ha are classified as large farms which are suited to tractor operation. Those of 5ha and above are classified as medium farms most viable for animal traction. Farm lands of not more than 5ha are small sized farms currently undertaken by human labour. Currently 86 per cent of farm lands in Nigeria are cultivated by human labour, 6 per cent by animal traction and 9 per cent by tractor power. (Takeshima and Salau 2010). In sub-Saharan Africa and especially in Nigeria farm lands are fragmented mostly in the range of less than one hectare to about ten hectares. Only very few farm lands in Nigeria are up to fifty hectares which is the minimum land area needed to make tractor usage economically viable. It is thus clear that apart from cost and maintenance difficulties, land fragmentation is another setback to viable tractor utilization in Nigeria.

The fundamental problems facing agricultural mechanization in Edo state (and indeed the nation); includes adoption of mechanization strategies that are often done by governments and international agencies that do not pay sufficient attention to the interest of the farmers and to the process of technical change. Others includes prevalence of small fragmental farm holdings which hinder efficient use of machinery; high cost of bush clearing and hiring of tractors; The failure of agricultural mechanization in Edo state has been explained by many as being the result of shortcomings in maintenance. This has been an excellent excuse for those responsible for agricultural mechanization development policies. A more fundamental reason for the failure is a result of inappropriate choice of equipment leading to maintenance problem (Enaboifo and Anerua-Yakubu, 2014).

Machinery breakdown in Nigeria was said to be very high and that with the high cost of maintenance, no repair is carried out promptly once the tractor or machine breakdown. Most of the machinery in Nigeria becomes malfunctioned in the first one or two years of operation. The result of this poor maintenance yielded high percentage of about (90%) of tractors breakdown yearly in some states. The repair and maintenance constitutes 47.7% of the total operating cost.Despite the fact that Zamfara State is an agrarian state with over 90 per cent of the total populations in State being farmers, yet the Agricultural Mechanization level is very low. The State has a reasonable number of government owned functional tractors, yet it was proved that there is low level of Agricultural Tractors and Machinery Management with lack of proper Record Keeping for the maintenance operations, lack of equipped standard workshops and qualified personnel to operate and maintain the tractors and machinery as major hindrance (Maradun*et al.,* 2013).

Agricultural machinery is a capital asset that requires a relatively large initial investment. However, an important historical pattern in other countries with relevance to West Africa is that the size of agricultural machinery employed had been relatively small at the beginning of agricultural mechanization process. Historically, agricultural mechanization started with the adoption of two-wheel tractors or lower horsepower four-wheel tractors, rather than the high horsepower four-wheel tractors. This pattern is seen around the world. In the United States in the early 1900s, average tractor horsepower was around 10 to 20 horsepower (hp) when the adoption of tractors began. In many Asian countries, both two-wheel tractors with typically less than 15 hp and four-wheel tractors generally with around 30 hp were widely adopted in the early period of agricultural mechanization. Currently in Nigeria and Ghana, the power range for most tractors is typically between 50 and 70 hp. Plates 1 and 2 depict Mini Tractors (≤ 30 Hp.), which employ Animal Drawn Plow in China and Japan for small farms; while Plate 3 and 4 show big Tractors used in USA and Germany for ≥ 50 hectare farms but imported by Nigeria where majority farms are ≤ 10 hectares.

Plate 1 and 2: Mini Tractors(≤ 30 Hp.).
(Employing Animal Drawn Plow in China and Japan for small farms)

Plate 3 and 4: Conventional Tractors used in USA and Germany(For ≥ 50 hectare farms but imported by Nigeria where majority farms are ≤ 10 hectares)

Tractor horse-power largely determines the optimal operational scale for the machine and the size of the required fixed investment. Historically, agricultural machinery has been a relatively scale-neutral technology around the world. However, this is not the case in present day Nigeria. Tractor horsepower has been relatively high in Latin America, but as is shown below, farmers have been much wealthier than current farmers in Nigeria. While it is often argued that small tractors were designed and adopted in Asia or Europe to better serve their smaller farm sizes. But this does not seem to fully explain the situations in West Africa. In Nigeria, the size of the cultivated area of farmers using tractor services (including tractor owners) is less than 2 hectares (ha), which may be slightly larger than in some Asian countries, but considerably smaller than is the case in Latin America. In the United States, the trend toward fewer but larger farms has increased demand for larger horsepower tractors to exploit the economies of scale larger tractors offer. The pattern in Nigeria contradicts this (Takeshima, 2016).

Taiwan is a subtropical island in East Asia, characterized by high temperatures and heavy rainfalls. Taiwan's agricultural development has been recognized as a positive model throughout the world, especially for small-scale farming economies. The average farmland is about one hectare in Taiwan. Taiwan started its ten-year mechanization program in 1960 through the introduction of power tillers. During this initial stage of mechanization (1960-1970), power tillers replaced animal power and mechanical threshers did work that had traditionally been done by hand (Fu-Ming, 2009). A characteristic feature of the agricultural production system in Nigeria is that a disproportionately large fraction of the agricultural output is in the hands of smallholder farmers whose average holding is about 1.0-3.0 hectares (Mgbenka and Mbah, 2016). Nigeria and Taiwan share similar farm sizes in the hands smallholder farmers but while Taiwan developed and introduced power tiller technology appropriate to their farm sizes and socio-technology environment, Nigeria continued importing gigantic tractors designed and built for very large farms which are inappropriate for agricultural setting. Taiwan's success in applying new agricultural technology was due to the efforts of rural institutions, particularly agricultural research stations, farmers' associations, and rural credit and extension services (Yu-Kang and Schive, 1995).

Plate 5: A Power Tiller

The scenario shows the success of indigenous technology designed and developed with the socio-technological setting of the people in mind. Taiwan's agro-technology stakeholders developed new machines under their 'mechanization and automation projects' and these are effectively employed for cultivation, transplanting, fertilizer application, harvesting, cleaning, sorting, drying, and packaging of produce within Taiwan; leading to enhanced traditional field operations on farms during the past thirty years. Nigeria must rejig its mechanization strategy and evolve indigenous appropriate technologies for cultivation and processing of produce in the country. An equitable Nigerian tractor designed and built with locally available components would be within the maintenance capability of our technicians using locally available spare parts. This is the type of cultivation farm power for agricultural revolution in Nigeria.

Nigeria must align itself to what works. Number of tractors and agricultural tools and machinery in a country is an indicator of its agricultural mechanization. We cannot rely on importation to mechanize our agricultural sector. Other developing countries that succeeded are doing it themselves. An example is Turkey; one of the few countries in the World today which are self-sufficient in food. At present, Turkey is the largest producer and exporter of agricultural products in the Near East and North Africa. In fact, Turkey has traditionally been described as the world's food storehouse by many analysts. As at 2011, the total number of tractors employed in Turkey was one million one hundred and twenty five thousand and one (1,125,001). Out of this number, four hundred and twenty two thousand three hundred and eighty nine (422,389) tractors were between 50-70 HP ranges. The rest were small tractors and power tillers that matched their farm holding and land fragmentation. There are 13 tractors manufacturer and more than 1000 agricultural machinery manufacturers in Turkey. Export of tractor and agricultural equipment and machinery in Turkey gradually increases and contribute to the economy of the country. Despite a strong Tractor manufacturers firms, there are many small agricultural machinery manufacturers (Akdemir, 2013).

III. Road Automobile (Cars/Lorries) Versus Farm Automobile (Tractor)

Power is defined as the rate of doing work or work done per unit time. In S. I. units, the unit of power is watt (briefly written as W) which is equal to 1Joule per second (J/s) or 1newton metre per second (1N-m/s). Thus the power developed by a force of F (in newton) moving with a velocity v m/s is equal to:

$$P = F \times v \text{ watts.} \quad \text{---------------------- (1)}$$

Similarly if T is the torque transmitted in N-m or J and w is the angular speed in rad/s; the power

$$P = Tw = T \times 2\pi N/60 \text{ watts} \quad \text{-------------- (2)}$$

$$\text{Since } w = 2\pi N/60 \quad \text{-------------------------- (3)}$$

Where N= Revolutions per minute (Khurmi and Gupta 2002). Take the radius of the shaft = "r"

$$v = wr \quad \text{------------------------------- (4)}$$

Road automobile is principally intended for speed to move from place to place in a short time. Farm automobile is designed to do work on the farm. While speed is required in road automobile, force or torque is needed in farm automobile. The implication of the power equations 1 and 2 is that for a given value of power, the desired design values of force and velocity or torque and angular velocity can be extracted by varying the counterpart component accordingly. Hence large force or torque can be extracted at low velocities while increased speed can be achieved at the expense of force and torque. For a vehicle used for transport, the desired function is speed in so far as enough force is allowed for carrying the vehicle mass and that of goods and passengers. A farm vehicle or tractor however requires great force to be able to pull the implements easily across the soil. Thus any road automobile (especially rear wheel drives and four wheel drives), can be converted to farm automobile by installing requisite gear reducer or gear box between the original gear box and its rear axle to achieve greater drawbar force or torque at reduced speed. We will notice that all tractors and heavy duty vehicles for road construction and excavations move at very low speeds compared to cars, passenger buses and goods Lorries. The work of Adewoyin and Ajav (2013) gives specifications for three models of tractors commonly used in Nigeria namely: Massey Fergusson, Fiat and Steyras depicted in table 1 alongside their various ploughing speed and varying depths. It can be seen in the seventh row of table 1 that the powers of these tractors are far above the 50-70 Hp range of tractors employed in Turkey. The maximum ploughing speed of cultivation depicted in table 2 is 7.5 km/hr compared to maximum speed of road vehicles some of which are put at 200 km/hr.

Table 1: Farm Tractor specifications
(Source:Adewoyin and Ajav, 2013)

Specifications	Massey fergusson	Fiat	Steyr
Model	MF 435	F130 D	CVT 170
Type of engine	4-Cylinder	4-Cylinder	4-Cylinder
Type of fuel	Diesel	Diesel	Diesel
Type of steering system	Power-assisted	Power-assisted	Power-assisted
Transmission	8X2 4WD	8X2 4WD	8X2 4WD
Type of injector pump	In-line Injector	In-line Injector	In-line Injector
Power output/hp	110	100	100
Fuel tank capacity/L	70	70	70
Rated engine speed/r min^{-1}	2600	2600	2500
Type of cooling system	Water-cooled	Water-cooled	Water-cooled
Front tyre size	6.0- 16	6.0- 16	6.0- 16
Front inflation pressure/psi	32	32	32
Rear tyre size	15.4-28	14-28	16.5-28
Rear inflation pressure/psi	28	28	28

Table 2: Average fuel consumption of tractors at various ploughing speeds and depths
(Source:Adewoyin and Ajav, 2013)

	Ploughing Speed /km h^{-1}			Ploughing Depth /cm			Tractor Type		
	5.5	6.5	7.5	20	25	30	Fiat	MF	Steyr
F_c	20.00	24.25	27.23	16.79	22.02	32.67	23.35	23.58	24.55
S_d	6.23	7.97	7.93	1.10	6.44	4.02	7.62	7.98	8.29

Note: F_c = Fuel Consumption (l/ha), S_d = Standard Deviation, MF = Massey Ferguson.

IV. Implements and their Drafts

Draft: Draft is the force (pounds-force, lbf 0r Newton, N) required to move an implement in the direction of travel. Total draft of most tillage implements is primarily resistance to soil and crop residues. Under normal conditions wide variations in draft of tillage tools are common both within and between soil textural groups due to soil moisture, soil strength, residue cover and other physical characteristics. Dry, consolidated soil generally provides greater resistance to tillage tools than the same soil when moist and friable. The tractive surface in the field can vary from firm and compact to soft or muddy. Loose soil increases rolling resistance of farm vehicles and increases slippage of the animal’s hooves. Also draft increases when moving up a slope due of course to the extra energy needed to climb the slope. All these are normal variations in field conditions that can greatly vary the demand an implement can present. In estimating tillage draft, soils can be conveniently categorized as fine, medium or coarse rather than using the traditional but more confusing classifications such as clay, sandy-loam or silty-clay-loam. Fine textured soils can be considered as high in silt and clay, medium textured are loamy soils and coarse textured soils are sandy soils. Implement draft generally increases in going from coarse to fine textured soils(Harrigan*et al.*, 2002).

Tractor Implements: Askari and Khalifahamzehghasem (2013) measured various conventional tractor ploughing implements draft and compared the experimental values with estimated drafts of the implements given byAmerican Society of Agricultural Engineers (ASAE). The experiment was conducted at the Urmia University Research Farm, Urmia, Iran. The topography was flat (<1% slope) and the soil type was a clay loam (29% sand, 28% silt and 43% clay), which was poorly drained and poorly aerated. Average organic carbon content was 0.74 weight % and average pH was 7.8. The soil can be classified as medium textured as suggested by Harrigan*et al.,* 2002. The implements shown respectively in Plates 6-9 are Moldboard Plow, Chisel Plow, Disk Harrow and Field Cultivator. The implements structural properties and subjected condition in the field study are given in table 3; while their measured and estimated drafts are depicted in table 4.

Plate 6: Moldboard Plow: The moldboard plow was a three furrow mounted plow. Furrow width was set to 365 mm and plowing depth was set to 250 mm.

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Disk harrow	-	2060	100	5.5
Field cultivator	9	2200	100	5.5

Table 4: Draft (kN) for primary and secondary tillage implements
(Askari and Khalifahamzehghasem, 2013)

Implement	Dynamometer average data	ASABE Estimate
Moldboard plow	16.30	19.55
Chisel plow	15.41	13.67
Disk harrow	1.80	2.28
Field cultivator	3.49	3.82

Animal Drawn Implements and Drafts

Estimation of animal drawn implement draft was carried out by Harrigan*et al.*, 2002) and presented in Table 5.Table 6 from Sims and O'Neil (2002) provides us with the average weight, approximate draft capabilities and developed powers of various animals which are employed on the farm. Table 5 shows drafts of common tillage tools range from 489 N for a Disc Bedder-Ridger to 4,403 N for a standard Moldboard plow cutting at 8 inches depth. Table 6 shows the average drafts of work animals. Engine drafts of motorcycles, cars, trucks and Lorries are presented as varied as engines are produced to powers of varied range. Thus for any implement carried by one or two or three work animals we can get a petrol or diesel engine of matching capacity. In essence, we can employ available vehicles in the country to drive common tillage implements to cultivate our farms and enhance agricultural productivity and food security.

Table 5: Expected range in draft for common tillage tools in a range of pound force and Newton per machine width Lbf(N)
(Source: Harrigan*et al.*, 2002).

	Coarse	Medium	Fine
Moldboard Plow			
6-inch depth	**320 (1,423)***	**490 (2,180)**	**740 (3,292)**
8-inch depth	**420 (1,868)**	**650 (2,891)**	**990 (4,403)**
Disk, Tandem			
3- to 4-inch depth	**140 (623)**	**160 (712)**	**180 (800)**
Disk, Single Gang			
3- to 4-inch depth	**55 (245)**	**65 (290)**	**75 (334)**
Spring-Tooth Harrow			
2-inch depth	**90 (400)**	**115 (512)**	**135 (600)**
3-inch depth	**130 (578)**	**170 (756)**	**195 (867)**
Draft, lbf/row			
	Coarse	**Medium**	**Fine**
Row Crop Cultivator			
2.5-inch depth	**85 (378)**	**115 (511)**	**135 (600)**
Disk Bedder-Ridger			
3-inch depth	**90 (400)**	**100 (445)**	**110 (489)**
5-inch depth	**145**	**165**	**190**

*Figures in parenthesis are values of draft in Newton

Table 6: Mobile Farm Powers
(Source: Sims and O"Neil, 2002)

Animal	Average weight (kg)	Approximate draft capability (N)	Average speed (m/s)	Power developed (W)
Bullock	500 - 900	600 - 800	0.56 -0.83	560
Cow	400 - 600	500 - 600	0.70	340
Water buffalo	400 - 900	500 - 800	0.80 - 0.90	560
Light horse	400 - 700	600 - 800	1.0	750
Mule	350 - 500	500 - 600	0.9 - 1.0	520
Donkey	150 - 300	300 - 400	0.70	260
Camel	450 - 500	400 - 500	1.1	500
Man	60 - 90	300	0.28	75
Engine				
(Petrol or Diesel)	**varied**	**varied**	**varied**	**varied**
Motorcycle	"	"	"	"
Car	"	"	"	"
Truck	"	"	"	"
Lorry	"	"	"	"

V. Conclusion

There is food scarcity in Nigeria occasioned by unsuitable and poor agricultural mechanization especially with regard to cultivation. Since inception, our agricultural mechanization programme have been focused on tractor importation. But the tractors apart from being very expensive, lack available spare parts and specialized technicians for maintenance. Their sizes are also beyond the proper capacity for optimal production in our small farm holdings. It is opined that we can develop appropriately sized tractors to work our farms. Components for the manufacture of indigenous tractors shall be sourced from locally available technologies so that they can be easily maintained by our mechanics. The Power equation explains we can convert any cost effective road automobile in the country into a farm mobile power by reducing the speed to acceptable tractor working speed or animal walking speed. Draft of various cultivation implements and mobile farm powers from literature will guide the engineer towards developing appropriate tractors and power tillers for use by Nigerian Farmers. Lots of automobiles have existed in Nigeria for decades. Their spare parts are found in every locality. Automobile technicians and artisans also abound who can easily repair and maintain the vehicles. It is believed that proper design and component selection would lead us to the development of various indigenous farm powers that would match our need and farm fragmentation lead to enhanced agricultural productivity and food security.

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