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# Alternative Energy Sources for Agricultural Production and Processing in Nigeria

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**Around the world, it is recognized in agricultural production and processing that energy (farm power) is perhaps the second most important input besides land). Yet the agricultural sector in Nigeria has access to less than one percent of the total conventional energy supply in the country (EarthTrends 2003). This brief explores solutions to the rural area energy gap by reviewing the potential for conventional and alternative sources of energy for agricultural production and processing.**

## Introduction

Nigeria's energy sources for agricultural production include the use of human power to operate hand tools, animal power for drawn implements, and carbon fuel for motorized and mechanically-driven post-harvest handling and processing machines, and pumps for irrigation (Table 1).

**Table 1: Energy sources used for agriculture in rural areas**

| Rate of coverage of agricultural activities in Nigeria using energy sources (hour/ha) | | | | |
|---|---|---|---|---|
| | | **Human** | **Animal** | **Carbon-based** |
| **Activities** | Plowing | - | 17.25 | 1.7-2.5 |
| | Harrowing | - | 8.7 | 0.8-1.5 |
| | Ridging | 80-250 | 6-8 | 1.0-1.4 |
| | Fertilizer application | 2-70 | - | 0.4-1.0 |
| | Spraying | 2-3 | - | 0.4-0.5 |
| | Planting | 100-500 | 6-8 | 1-1.5 |
| | Weeding | 40-150 | 4-8 | 0.8-1.2 |

Source: Ozoemena and Onwualu 2008

There are no reliable estimates of the country's total energy use. However, out of the conventional energy sources such as electricity, petroleum, gas, coal,and fuel wood, only fuel wood has any substantial use in rural areas. For example, of the total households in Nigeria only 2 percent have access to power (through either rural electrification or self-generation) in 2009 (NBS 2009). Those with low incomes have limited access to petroleum, gas, coal and the tools that require their use.

To better understand how to deal with the energy deficiency in rural Nigeria, this study reviewed literature on the prospects and constraints faced in harnessing alternative energy sources and verifies them through focus group discussions (FGDs) with rural farmers and cottage operators. The FGDs involved a total of 30 rural farmers (10 from Tasha and 10 from Jiwa, which are both in Gwagwa, and 10 from Lugbe in Federal Capital Territory (FCT)) and 15 cottage operators (6 from Mararaba, FCT and 9 from Owerri, Imo State). Similarly, the ranking of the identified constraints involved only the literate members in each group: 11 rural farmers (4 from Gwagwa, 7 from Lugbe) and 15 cottage operators, for a total of 26.

## Findings

Potential alternative energy sources for the rural agricultural sector are biomass (including fuel wood, sawdust, crop and animal residue/waste and biogas), wind, solar power, and small hydropower (Table 2).

### *Fuel wood*

About 50 percent of Nigeria's total energy consumed for agriculture and other domestic food processing activities is from fuel wood. The current reserve potential of 80 million cubic meters per year is reported to be poorly utilized (CREDC 2008). Only a fraction of the wood is effectively used with traditional stoves. Improved wood/solid fuel stoves and coal briquettes of various designs have been shown to have 10 to 20 percent thermal efficiency, while traditional stoves have 5 to 7 percent thermal efficiency (Sambo 2010). The wood/fuel stoves can be used for cooking, fish smoking, and preservation. Nevertheless, its unregulated consumption could result in environmental decay such as deforestation, soil erosion, desertification, and carbon emissions.

**Table 2: Potential sources of energy for rural based agricultural production and processing activities**

| Source of energy | Potential/Reserves | Energy capacity |
|---|---|---|
| Fuel wood | 80 million $m^3$/year | 6.0 X $10^9$ MJ |
| Saw dust | 1.8 million tons/year | 31,433,000 MJ |
| Crop residue | 83 million tons/year | 5.3 X $10^{11}$ MJ |
| Animal waste | 227,500 tons daily | 2.2 X $10^9$ MJ |
| Biogas | 6.8 million $m^3$ daily | 2.7$m^3$ produces 79.11 MJ |
| Wind | 2-4 m/s at 10m height | 5MW |
| Solar | 6.25 hours daily | 6.25-7.0 KWh/$m^2$ per day |
| Small hydropower | 0.143 billion tons | 734.2MW |

Source: Sambo 2005

### *Crop residue, biogas, animal and human wastes*

Huge volumes of agricultural wastes in the form of livestock manure, corn cobs, cassava peelings, rice husks, groundnut shells, sawdust, bagasse, human excreta and the resultant gas (biogas) can be converted into potential sources of energy that can be plowed back into agricultural production and processing activities. This is achievable with the use of a biodigester (Tejoyuwonu 1982). Since 1 kilogram of fresh animal wastes could produce about 0.03 cubic meters of gas, Nigeria can produce about 6.8 million cubic meters of biogas daily (Okafor and Joe-Uzuegbu 2010). Presently, biogas is not widely used in Nigeria's rural economy due to poor knowledge of its energy potential as well as limited resources to purchase the required equipment for its conversion. Furthermore, even if the gas is produced, it may not be in a form that can be easily transported or converted into electricity, which is necessary to power farm equipment.

### *Wind power*

The use of wind power for rural agricultural production activities is practically adaptable for residents located along coastlines and in dry regions of Nigeria. This is useful in reducing the human energy involved in activities such as winnowing in rice mills. Since wind is not available in a sustained manner, it limits its usage for many farm activities in Nigeria.

### *Solar energy*

Nigeria receives an optimal supply of solar radiation (5.5 kilowatt hours per square meter unit). Of this amount, however, only about 0.005% is actually converted into energy. The energy challenge mentioned above could substantially be met by solar if 1 percent of the available solar energy can be tapped (FEC 1984). Solar power has been successfully used in controlled drying of agricultural products, domestic cooking, and pumping water for irrigation in rural areas of China, India, Finland, Kenya, and Bangladesh among others. The limiting factor in rural Nigeria is the lack of technology and funding.

### *Small hydropower*

Small rivers and streams exist within rural areas in Nigeria, most of which maintain a minimum flow all year round. These streams and rivers can be used to develop hydroelectric energy for rural agriculture (ICEED 2002). Studies (Aliyu and Eleagbam 1990) further confirm the great potential of small hydropower to improve on the energy deficits experienced in rural households in Nigeria as stated in Table 2.

## Constraints

Focus group discussions (FGDs) were used to identify the main constraints facing the development of alternative energy sources in Nigeria (Figure 1). Key factors facing rural farmers differed from those of cottage operators who design and manufacture labor-saving equipment.

The rural farm respondents' main constraints include poor technical know-how, low per capita income for maintaining and servicing alternative energy options (economic factors), and concern with some inputs used in biomass technology, especially the use of human/animal wastes. The results indicate that 63.3 percent of the respondents indicated unwillingness in the acceptance of alternative energy options generated from the use of human/animal excreta to generate biogas for cooking purposes.

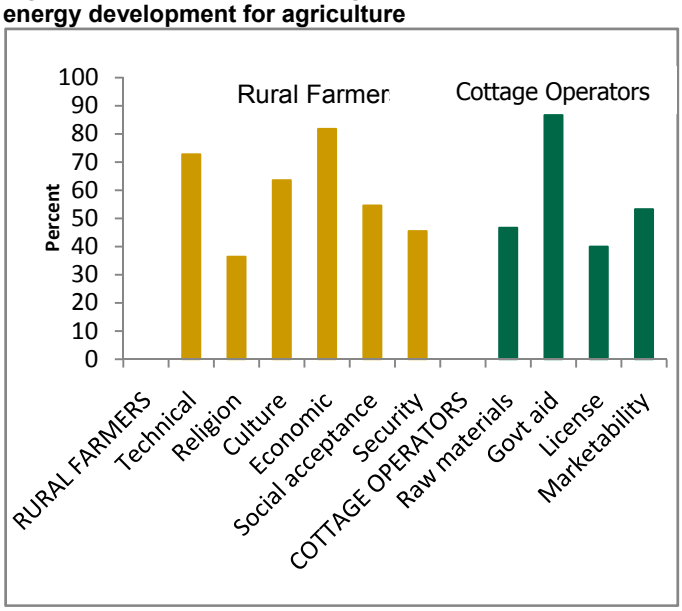
Economic considerations in this regard are explained by the low income base and dependence by the rural communities on subsistence farming for their livelihood. This makes it difficult for them to procure, service, and maintain costly energy alternatives for their small-scale agricultural activities.

Security concerns were also raised by the rural farmers with respect to installing technologically-superior equipment. About 45 percent of the rural farmers indicated that they had no arrangements to prevent theft and vandalism. In general, most villages do not have a strong central administrative mechanism to guarantee security.

The issues raised by the equipment manufacturers of cottage industries include the lack of government aid, low market for their products, scarcity of raw materials, and high cost of securing an operating license. The manufacturers (cottage operators in Figure 1) noted that the marketability of their products faced different limitations between urban and rural areas with respect to customer patronage. While marketing opportunities for alternative energy or energy-saving products are limited in urban areas, in rural locations substantial marketing opportunities exist, especially during farming seasons, although such prospects are also limited by the low income of farm communities.

Another constraining factor raised by the equipment manufacturers of cottage industries includes the scarcity of spare parts for manufacturing alternative energy products. The respondents noted that importing these materials also posed difficulties. About 40 percent of the cottage operators experienced substantial constraints in securing operating licenses and permits.

**Figure 1: Potential constraining factors to alternative energy development for agriculture**




Source: Author's calculations

## Recommendations

Human power and use of draft animals are the dominant inputs into rural agricultural production and processing activities in Nigeria. Alternative energy sources such as biomass, solar power, and small hydropower could serve to reduce the energy deficit in these communities. To do so certain constraints identified in this review need to be resolved.

Identifying the energy needs of rural communities, their capacity to generate and use different forms of existing alternative energy sources, and the likely constraints they face would be the first step to enhance success in harnessing alternative energy sources in rural Nigeria. Education, enlightenment, and the transfer of knowledge would be necessary for alternative energy development, management, monitoring, and evaluation in rural areas.

The development of an appropriate fiscal incentive system to prospective rural energy developers and equipment manufacturers could help ease the raw material constraints they face. Finally, the strengthening of local institutions, such as rural co-

operatives, could be used to promote awareness of renewable energy sources and also serve to ensure security and sustainability of rural installations for farm production and processing activities.

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