Sub-Sahara African Academic
Research Publications
December, 2022, Editions

JRATR
Journal of Renewable Agricultural Tech. Research
Vol. 26, No.1, ISSN 2813 – 9650

SOLUTIONS TO ENERGY CHALLENGES IN AGRO ALLIED INDUSTRIES

ABUBAKAR ALIYU ALIYU
National Metallurgical Development Center, (NMDC), Zaria Road Jos Nigeria. (Federal Ministry of Mines and Steel Development)

ABSTRACT
This report examines the challenges of energy use and efficiency in Agro-allied industries and proffer a possible solutions in sustainable energy options across the sector. focusing on and in unlocking greater energy efficiency within the sector. Energy demand across the sector is projected to grow steadily, both in agriculture and agro-allied industries. Increasing dependence on energy usage (mainly fossil fuels) throughout the entire Agricultural value chain raises concerns about the impact of high or variable energy prices on production costs, competitiveness, the final price of the product for the consumer ,greenhouse gas emissions, as well as concerns about energy security.

INRODUCTION

Agro allied industries are industries which depend on agriculture for their raw materials so as to operate successfully in the production of finished goods that are useful to livestock and humans. Industries produce machineries and equipment for agricultural uses. Agriculture and industry compete for labour. Industries provide a large range of products that the rural dwellers (mostly famers) want to buy and produce agro-chemicals for agricultural uses e.g. pesticides, fertilizers, vaccines, and herbicides. Agriculture is a source of food for, consumption by man, feed for animals, and raw materials for agro-allied industries (Edoumiekumo and Audu, 2009; Oji-Okoro, 2011). Central Bank of Nigeria (2016) noted that agricultural sector's contribution to the gross domestic product in Nigeria is 24.18 percent. Over 70 percent of the informal sector jobs created in the Nigerian economy were related to rural agriculture. Most experts were also of the view economic sectors will not stand without the practice of agriculture. This is due to the fact that it is the major raw materials for the functioning of those sectors. The agro-allied industry is regarded as an extended arm of agriculture. Its development could help to stabilize and make agriculture more lucrative, thereby creating employment opportunities both at the production and marketing stages (NPCS, 2000). The importance of agriculture extends beyond the provision of food for man and animals,

but also the provision of basic raw materials for industrial purpose, such that other products which are not directly utilized could be transform into usable materials.
Ajila (2014) further explained that the agro-allied industries bring about diversification and commercialization of agriculture and also enhance the income of farmers and create food surpluses. It is in this sense that the agro-industry is an important and vital part of the manufacturing sector in developing countries (NPCS, 2000). In the same line, Chengappa (2004) reported that agro-processing offers great scope for conversion of farm produce to consumer commodity and in the process, reduce wastage, increase shelf-life resulting in value addition and higher income transfer to the farmers from different classes of consumers as the processed commodities have wider market outlets. Developing agriculture is one of the means of developing the rural communities as it is the primary occupation of most people in the rural areas and a major source of national income for most African countries (Mahmood, 2011). Agro-allied industries have been viewed as a safety valve that needs to be built within rural areas to absorb surplus labour and provide relief to the problem of large scale unemployment. Thus, inadequate attention paid to the agro-processing sector in the past, puts both producer and the consumer at a dis- advantage and this hurts the economy of the country (Kachru, 2008). Rural dwellers stand to enjoy some benefits with the existence of agro-allied industries in the rural areas. The populace in the rural areas where the industries are sited begin to enjoy benefits such as availability of market for the rural farmers, this further increases their production level and thus generates more income with which the living conditions of the people can be improved. Besides the above benefits, they enjoy infrastructural amenities like good roads, water supply, electricity, schools, and hospitals. All of these benefits describe some of the impact of agro-allied industries on the rural dwellers. An impact analysis, according to Iheanacho (2012), can be carried out from three different approaches; the before and after approach, with and without approach, and the benchmark or set target approach. The focus of this study, however, is on the with and without approach which shows the comparison between areas where agro-allied industries are sited and areas that do not have agro-allied industries. There is therefore, a link between agriculture, agro-allied industries, and rural dwellers in that without agriculture, the agro-allied industry will not have the availability of resources to carry out it performance. The rural communities which constitute a greater percentage of the labour force in the agricultural sector also have an opportunity to increase their production because of the availability of a good market outlet brought about by the agro-industrial sector.

METHODOLOGY

In carrying out this study, the following methods were used to get information from the target industries:

- On Spot Assessment and Inspection Visits were paid to the factory of selected companies for an —on the spot assessment. In doing this, the physical conditions of the factory units operations and other energy intensive units were inspected including the working environment. The problems that workers were having in each sub-division were also noted.

- Personal Interviews were conducted with some of the cadres and sections of the companies. This included the, administrative director/accountant, factory manager, heads of production, fabrication sub-divisional heads, etc. These were able to shed light on area of enquiry.

RESULTS AND DISCUSSION

The private sector and the government are paying increased attention towards the importance of energy efficiency due to growing awareness of the limitations of fossil fuels for sustainable productivity, of the implications of GHG emissions and of variable and rising energy prices on competitiveness and productivity. Indeed, energy efficiency is increasingly being recognized as one of the most important and cost-effective solutions to reduce GHG emissions and other important air pollutants (IEA, 2014a; Masanet et al., 2012). However Importan progress has been made by the private sector to improve energy efficiency in the agro-allied sector through innovation, investments in more efficient technologies and adoption of more energy-efficient management practices. But more is anticipated, and more can still be done.

Challenges

The challenge of Increasing Energy Usage.

Agricultural value chains are diverse and highly complex with many final products drawing on inputs from a variety of industries. The type of and the way energy is used in the Agriculture value chain can influence the extent to which the food system in a country will be able to support growth and productivity objectives in an environmentally sustainable manner. This is the case as energy is used throughout the entire processes involved: in the production of crops, fish, livestock, and forestry products; in post-harvest operations; in food storage and processing; in food transport and distribution; and in food preparation. Moreover, energy contributes to the transformation and reuse of the various forms of by products and waste which the production process generates. Agricultural product is a composite and perishable product and the amount of energy for processing it varies greatly from one product to another. Even when considering the same type of product, the Energy "cost" differs notably, reflecting changes on cultivation area, farming practices, efficiency of processing and storage, season of production and/or consumption, transportation needs, etc. Moreover, in most countries, supply chains have evolved in multi-stage production and processing operations with varying degrees of vertical and horizontal integration. In addition, the diversity of product-specific chains means that a precise accounting of energy consumed in the production is extremely challenging.

Most Agro-allied products have a specific life-cycle which involves a combination of direct energy use at specific stages of the cycle (e.g. drying process) plus indirect energy use related to the production of other intermediate inputs that ultimately go into a final product. The more complex a product life-cycle, the less adequate direct measures become in measuring total energy consumption. For example, with regard to the agro-allied industries, direct energy for production would include electricity, heating fuel and machinery fuel used in the production, grain drying, animal and animal production, heating/cooling of animal incubator, transportation of products and personal energy use . Indirect energy would consist of the energy consumed in the production, packaging and transport to the gate of fertilizers, pesticides, farm machinery and buildings (CAEEDAC, 2000).

The Challenge of Measuring Energy Usage

Tracking trends in energy efficiency and comparing the performance of countries is made challenging by the lack of a single indicator to measure energy efficiency levels and changes. Instead, in the energy balance for a given production process, a variety of indicators may serve and support energy efficiency analysis (IEA, 2014b). Possible indicators include: primary energy per area or per tone of agricultural product, or energy contained in the products divided by the energy consumed (OFAG, 2015). Although the area is often used as a denominator, the link between this variable and energy consumption is not very strong. For example, in the EU, energy use by agriculture per cultivation area in hectares was highest in the Netherlands, which is mainly due to intensive greenhouse farming.

The quantitative assessment of energy flows in Agriculture value chain systems is most often carried out following one of two approaches: the life cycle analysis (LCA) and the input-output (IO) accounting (Burney, 2001). These two approaches differ fundamentally in both the conception and the data inputs, and therefore it is not surprising that results often differ. From the variety of metrics it is clear that energy analysis has nevertheless not evolved into an exact science, and this explains the few comprehensive studies of any sector let alone one as complex as Agriculture value chain. Challenges and ultimately subjective decisions lay in determining boundaries, aggregating different forms of energy, and defining energy credits for by-products.

LCA, as a product-focused methodology, takes into consideration all energy inputs along the full production (and disposal) chain, wherever these occur and as such it isolates the direct and indirect energy requirements of specific products. All the steps involved in creating a certain product are analyzed, starting from raw material extraction and conversion, then manufacture (process) and distribution, to the final use and/or consumption. LCA also includes re-use, recycling of materials, energy recovery and ultimate disposal. Interest in forms of LCA, particularly energy use and emissions, has recently increased as retailers attempt to develop consistent “energy foot printing” labels for their products.

LCA, however, needs detailed data on product "history" and is sensitive to the definition of the boundaries of the production system and to the methodology used for allocating the embodied energy among co-products or by-products. LCA remains challenging when applied to large economic sectors as apparently "similar" products can be enormously diverse in reality.

Numerous LCA studies have shown the cumulative energy intensity of food products (e.g. de Vries and de Boer 2010; Carlsson-Kanyama et al. 2003; Heller and Keoleian, 2000).6 However, when comparing across studies an important methodological caveat is the boundary of the analysis can often vary.

The I-O analysis is a tool that can be used to provide estimates of inputs (including energy) per unit of final product based on how various sectors of an economy are linked and exchange resources (including energy) and can provide very precise results down to a certain level of aggregation, taking into account direct and indirect contributions. Nevertheless, I-O needs to be complemented with exogenous data as far as process steps taking place outside the studied economic area are concerned. However, the accuracy of this approach is also dependent on the accuracy of input-output data, which are prone to become outdated. COM/TAD/CA/ENV/EPOC(2016)19/FINAL

Unpredictable Government Actions

There is high level of uncertainty and lack of confidence in government and its intentions in the business sector especially with the inability to predict government policy. Uncertainty basically rises as a result of the conflicting objectives of government agencies. For instance Federal Ministry Of Agriculture and Rural Development has the mandate of supervising farming activities and Federal Ministry of Industry oversees the Agribusiness Firms and large Industries. But because of inter-ministerial relations are almost nonexistent leading to implementation conflicts and this one reason for policy inconsistencies in the Nigerian agribusiness environment.

SUSTAINABLE ENERGY SOLUTIONS IN AGRO ALLIED INDUSTRIES

"Tackling the challenges of food security, economic development and energy security in a context of ongoing population growth will require a renewed andre-imagined focus on agricultural enhancement .Agriculture value chain can and should become the backbone of tomorrow's green economy. It's time to stop treating Agriculture value chain and energy as separate issues and tackle the challenge of intelligently balancing the needs of these two sectors, building on synergies, finding opportunities to reduce waste and identifying ways that can be shared and reused rather than competed for "Climate-smart systems that make efficient use of resources like water and energy must become the basis of tomorrow's agricultural economy .In practice, most of the technologies and other options needed for providing sustainable energy solutions in ago-allied industries already exist. The suggested measures have been described many times ,and importantly, components of such system , have been available.

Energy Efficiency and Energy Conservation

Improving energy efficiency and energy conservation in agro-allied are essential to reduce energy demand and therefore reduce costs. Improving energy efficiency, and thus reducing reliance on fossil fuels, will further reduce greenhouse gas emissions. In addition, it must be taken into consideration that a reduced energy demand will also proportionally reduce investment costs for shifting from fossil fuels to sustainable energy sources. Everywhere in agriculture where energy is used, its demand can be reduced. For example, it has been shown that fossil energy use in the current food system could be significantly reduced by appropriate technology changes. It is estimated (Pimentel, *et al*., 2008) that the total energy in agricultural products production could be reduced by more than 50% with the following changes of practices: (i) using smaller machinery and less fuel; (ii) replacing commercial nitrogen with livestock manure and (iii) adopting alternative and conservation techniques. Pellizzi*et al*. (1988) showed that with improved management and operation, energy saving of around 12–15% of present consumption can be realistically obtained for agro-allied industrial machine. Brown and Elliot (2005) found that the largest energy savings are available in motorized systems, Pathakand Bining (1985) showed that in agricultural processes, fuel savings of over 50% were feasible through improvements in equipment and water management practices. It not only makes a significant contribution to global food production but it also contributes significantly to national economies.

Cooling and Heating

There is a considerable requirement for heating and cooling in agro-allied industries. For example, greenhouse heating may be essential to the year-round production of fertilizers, vegetables, fruit and disinfectant chemicals. Temperature controlled storage and refrigeration systems also consume large amounts of electricity and thereby contribute greatly to the running costs of businesses which have considerable cooling requirements, particularly in the horticulture and vegetable industry. Improvements to technical elements and operation of modern refrigeration systems have the potential to reduce energy consumption by 15–40%. This will become more important as a price is placed on greenhouse gas emission and as energy prices rise. Improved thermal insulation to reduce the costs of heating and cooling would result in reduced demand for energy, while the on-farm production of energy and can produce more energy than is needed. The energy efficiency of all electrical devices used in agriculture processing can also be continuously increased. For example, energy consumption in the lighting sector can be reduced by shifting to energy-saving appliances. At the same time, increasing temperature may reduce the need for heating in many places as well. These emissions could be eliminated where they stem from electricity generated from fossil fuels, if zero emissions electricity sources were to replace current infrastructure.

There are many agricultural production processes, the energy efficiency of which can further be
Increased.

Use of biomass and Biomass Waste for Production of biofuel and Electricity.

Biomass can be produced by cultivating suitable crops and used for production of different types of biofuels. Bio-ethanol can be used to replace gasoline, and biogas to substitute natural gas. Biodiesel and pure plant oils can be produced from oil-rich plants. This biodiesel can substitute for fossil-fuel based diesel used in many agricultural processing activities and requires only minor changes to the diesel engines. These biofuels can also be used for electricity production, which is a very economic option, in particular in off-grid applications. Compared with biodiesel, pure plant oil can be easily produced without great technical effort. Older diesel engines, which are often used in developing and transitioning countries to supply electricity, can often run without conversion with pure plant oils as fuel. However, modern diesel engines require technical conversions to befueled with pure plant oils (Fell, 2012).Therefore, biofuels can reduce the need for agricultural installations to purchase expensive fossil fuels, which must often be transported over long distances, and hence significantly reduce production costs.. An example is given by Fell (2012) from Brazil where annually 100 megatons of sugar is produced from about 1 gigaton of sugar cane. About 90% of the sugar cane crop is burned without any further use. Such biomass waste can be used either for biofuel production and, if needed, electricity.
Alternatively, after converting it to bio-coal it can be use. All in all, such measures increase economic benefits and contribute to climate protection.

Decentralized Renewable Energy Systems (solar, wind, geothermal)

Many processes and applications in agro-allied industries require energy either in the form of heat, mechanical energy or electricity, which can be provided by solar, wind and/or geothermal energy, depending on the local sources and the specific application. For example, wind and solar energy can economically produce electricity to power off-grid machinery such as pumps for pumping of fluids; wind energy can also be used as mechanical energy for pumping; solar heat can be used directly for space heating/cooling and warm water production while solar and geothermal heat can economically power thermal water desalination and the treatment of agro-allied effluents. Electricity produced from wind and solar energy sources can also be used for water desalination using membrane technologies but at higher cost than thermal methods. Geothermal heat with temperature differences of a few degrees centigrade to the ambient temperature can be used through heat pumps for space heating/cooling. Depending on the temperature of the available resource, geothermal heat has many applications in agro-allied such as for dehydration of products, and heating for greenhouses. Biomass produced onsite can also provide an energy source as biofuel for machinery, as heat or as electricity produced from it.

Governments Have a Role to Play in Encouraging Energy Efficiency

Capturing economic incentives for efficiency improvements requires, transparent energy pricing, information on opportunities to improve efficiency and investments in research and development. In these areas, governments have an important role to play.

Governments can play a decisive role in boosting energy efficiency in the food-chain by putting in place appropriate business-enabling policies, in order to allow the private sector to realize its full potential. The key drivers of energy efficiency – namely investment and innovation – require the creation of enabling policy frameworks in which private sector-led and collaborative investment and innovation initiatives can thrive. This requires an approach in which policy coherence and partnerships with the private sector are key aspects.

The private sector response to the challenges of improving energy efficiency can be enhanced if firms are able to benefit from the business opportunities that this can create. However, there are many challenges to improving energy efficiency in the food-chain that can be identified. They include, among others, market distortions, lack of information, co-ordination and risk aversion elements. Energy efficiency in the agro-food chain also has to be considered alongside other factors that drive investment decisions such as new product development, market growth and production location decisions to meet those markets.

In addition, firms are likely to intensify their efforts to increase energy efficiency of food products if consumers respond by purchasing energy-efficient products. Greater government-led awareness raising campaigns and knowledge sharing in all parts of the agro-food chain – including consumers, as well as the role of regulation and explicit or implicit taxes to internalise the external environmental effects of production and consumption decisions, are very important.

Policy makers must bear in mind that improving energy efficiency may save less energy than expected due to a “rebound” of energy use and may, in some cases, actually lead to an increase in energy use. As energy consumers save on energy cost through energy efficiency, they may spend their savings on other energy-intensive activities, or increase their demand for the new service, thereby countering the potential savings of energy. For example, consumers buying more energy-efficient household appliances may then use them more frequently because they are cheaper to run (Gillingham, Rapson and Wagner, 2015; Sorrell and Dimitropoulos, 2008; Tollefson, 2011).4

Further, policy makers must take into account that improving energy efficiency does not necessarily translate into reduced CO2 emissions: the savings depend on the type of energy. If the energy is supplied from fossil fuels, then improved efficiency will cut emissions. But if the energy is supplied by a low-carbon source such as renewable, then improving efficiency may have little impact on emissions.5 Nonetheless, improving energy efficiency overall is a key tool for reducing CO2 emissions, alongside energy conservation and low-carbon energy sources such as renewable, carbon capture and storage. Additionally, if reducing energy use is the policy goal, then energy efficiency is only one of a number of factors that impact energy use, and energy conservation may or may not be associated with an increase in energy efficiency – depending on the input-output relationship. This is, energy consumption may be reduced with or without an increase in energy efficiency, and energy consumption may increase alongside an increase in energy efficiency. COM/TAD/CA/ENV/EPOC(2016)19/FINAL

CONCLUSIONS

Agro-allied industries are typically highly reliant on fossil fuels and energy is a significant input cost to production. Production of food and other agricultural products accounts for 70% of global freshwater withdrawals. In addition, in the 2010–2035 period, world primary energy demand is forecasted to rise by one-third and electricity demand by 70% increasing the cost of energy and production. Some of these demands will be met from bioenergy which will in turn intensify competition for resources, particularly water for food and fiber production and therefore the need to maximize the efficient use of these resources becomes increasingly important. As fossil fuel costs continue to increase, so does the focus on energy efficiency to help minimize the impacts of rising energy costs on profitability and competitiveness. This includes a growing number of renewable energy sources that could be considered as alternatives to fossil fuels. Renewable energy sources may include solar, wind, hydropower, biomass, biogas and geothermal power. Where the opportunities are appropriate, integrating renewable energies into the arming operations is likely to save energy, costs, and greenhouse gas emissions. Examples of specific applications include solar drying, solar space and water heating and using biomass for heating purpose and electricity generation. Other applications include wastewater treatment, communication and remote equipment operation and others. Overall, the long-term future for renewable energy is definitely positive, since the prices of fossil fuels will continue to rise as the resources are depleted while the prices of renewable energy will continue to decrease. There are already a good number of successful examples of application of alternative energy.

REFERENCES

Alexandratos, N. & Bruinsma, J(2013).World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Antonietti, M., Murach, D. & Titirici, M.M.(2010).Opportunities for technological transformations: From climate change to climate management? In: H.-J. Schellnhuber (ed): Global sustainability*:* A nobel cause. Cambridge University Press, Cambridge, UK. pp. 319–330.

Barber, A. (2004).Seven case study farms: total energy and carbon indicators for New Zealand arable and vegetable production. Agrilink New Zealand Limited, Auckland, New Zealand.

Chen, G., Baillie, C. & Kupke, P.(2009). Evaluating on-farm energy performance in agriculture. Austral. J. Multi Discipl. Eng. 7: pp. 55–61.

Chen, G., Baillie, C, Eady, S. & Grant, T.(2013).Developing life cycle inventory for life cycle assessment of Australian cotton: Australian Life Cycle Assessment Conference.

EWG (Energy Watch Group).(2007). Crude oil:The supply outlook. EWG-Series http://www.energywatchgroup.org/fileadmin/global/pdf/EWG_Oilreport_10-20019

FAO (Food and Agriculture Organization of the United Nations).(2009) : How to feed the world in 2050. Food and Agriculture Organization of the United Nations, Rome, Italy, www.fao.org/fileadmin/ntemplates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.

Jochen, B. & Guangnan, C.(2018). Sustainable Energy Development:Sustainable Energy Solution in Agriculture. University of Southern Queensland Toowomba, Australia.: pp .3-13.

Organization For Economic Co-operation and Agriculture and Enviroment: Improving Energy Efficiency In the Agro-Food chain.pp.8-17.

Segun,F. & Barau, A.d. .Role of Agro-Industries in increasing food production in Nigeria