The Relevance of Solar Energy in the Agricultural Development of Nigeria

By

U. C. AGWUNOBI

Abstract

Energy is one of the key factors to sustainable development and one major backbone for developing an economy. It is of different kinds and forms with broad divisions under the renewable and non-renewable energy sources. As energy demand around the world increases, there is need for diversification of renewable energy resources available. Solar energy as a form of renewable energy if maximally employed and utilized can meet up to such demand especially in the agricultural sector. In agriculture, taking energy from the sun is a natural process. Plants absorb the sun's rays and store the energy; animals and human beings eat the plants, utilizing the energy for survival.

Nigeria is abundantly blessed with solar radiation. Harnessing this free gift of nature from the sun for agricultural productivity in the country is very important as it is one sure way to boosting agricultural output thus adding more value to her economic status since it is the fundamental economic base upon which developing economies depend. Its importance ranges from provision of food for human consumption to raw material for agro-based industries. Man and his environment cannot survive without solar energy since it is the catalyst for primary production of food (carbon source) for all herbivores and subsequently the starting for all industries. With all these in mind, one would agree convincingly that agriculture and solar energy are truly a natural fit both to plant, man and his environment. This paper focuses on solar energy application potentials in some agricultural practices in Nigeria. Areas of application include crop drying, green house heating, remote electricity supply, space and water heating/ disinfection. It also highlights some limitations to its application in agriculture and the various strategies through which they can be tackled. Also highlighted is solar energy as a form of renewable energy source and its several forms.

Keywords: solar energy, agriculture, photovoltaic, Nigeria

Introduction

Every day the sun showers the earth with several thousand times as much energy as we use. Even the small amount that strikes our roof is many times as much as all the energy that comes in through electric wires (solar expert.com, 2012). In less than three days the solar energy reaching Earth more than matches the estimated total of all the fossil fuels on Earth (Solar Expert.com, 2012). The logical question at this point is, why are we not making use of this incredible bonanza in the form of solar energy when we have plenty of it. Solar energy plays a very vital role in every facet of human life. In 2011, the International Energy Agency (IEA) said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries energy

security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise(IEA, 2011). These advantages are global. For our country Nigeria, not minding that we are abundantly blessed with solar radiation, we cannot boast about one way we have employed extremely this form of clean energy source. Integrating solar energy in agriculture in the country will go a long way towards fighting some of the problems the country is facing presently like food insecurity, climate change effect and epileptic power supply. The application of solar in agriculture is enormous. Its importance ranges from enhancing productivity and cost saving to reduction in environmental pollution. The economic structure of many developing countries today faces a downslide in the economic ladder as a result of neglect on agriculture.

In Nigeria, ever since the oil boom era, the target to develop the agricultural sector has been a mirage. Agriculture has been relegated to the floor yet a huge amount is mapped out for it yearly in the nation's budget. Acronyms like Operation Feed the Nation, Green Revolution are essentially political slogans and strategy for fund embezzlement. Nigeria is blessed with good vegetation, reasonable amount of rainfall per annum and sunshine which when properly harnessed will give a boost to agriculture. However, poor planning and over-dependence on oil has beclouded our thought towards the impact of agriculture on our economy. This has led to a situation where in most parts of the country, agricultural practices are still un-mechanised and localized. They are still on the subsistence level. However in the few areas where mechanised farming is being practised, the source of power still remains the conventional fuel-kerosene, diesel etc which poses a great danger to both farmer, livestock and the environment. Thus integrating these two natural fit (solar and agriculture) will help in fighting some o fthe above mentioned impediments to high product yield.

Solar Energy and its Forms

It is basic to remember that solar energy comes freely from the sun to earth in form of light energy (radiation). Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies (Wikipedia, 2012). Solar energy technologies include solar heating, solar photovoltaic, solar thermal electricity and solar architecture, which can make considerable contributions to solving some of the most urgent problems the world now faces(IEA, 2011). Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy (Wikipedia, 2012). Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air (Wikipedia, 2012).Generally in agriculture, the three harnessing methods apply.

Photovoltaic

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors devices (solar cell) that exhibit the photovoltaic effect. The conversion process is based on the photoelectric effect. The effect describes the release of positive and negative charge carriers in a solid state when light strikes its surface. When sunlight strikes a. photovoltaic cell, it may be reflected, ***diffused*** or absorbed. It is only the absorbed photons that provide energy to generate electricity. When enough sunlight (energy; is absorbed by the material (semiconductor), electrons are dislodged from their parent material atoms as a result of thermal agitation thus current is generated since electricity is dependent upon electron flow.

Solar Thermal- Solar Collectors

This simply means a form of solar energy whereby captured light energy is being converted to heat. In order to capture the heat well, specially designed surfaces called collectors are used. The principle upon which this operates is the principle of reflection by curved surfaces (**Okolo et al, 2006**). Depending on the need, the solar collector can be modeled into a solar heater, solar dryer, solar cooker etc

Solar Energy and Agriculture in Nigeria

Solar energy and agriculture are one winning combination that shouldn't be overlooked in the country. Capturing the sun's energy for light, heat and electricity not only make farm practices comfortable but also productive. The first and foremost way where the integration of solar energy and agriculture find a natural fit is in food chain. This is a one way flow of solar energy captured during photosynthetic process by living component of the ecosystem (bookrag.com, 2012). Thus food web source of energy is the sun. The solar energy is harvested by producer such as green plants and algae which produce their own food through a process called photosynthesis (in the presence of sunlight). After which they are eaten by herbivores then, the carnivores and omnivore (man) and finally to decomposers. Food web are energy web because the relationship represented by the connection represents the flow of energy from a class of organism to another (bookrag.com, 2012).

Crop and Grain Drying

Using the sun to dry crops and grain is one of the oldest and most widely used applications of solar energy. Solar drying equipment can dry crops faster and more evenly than leaving them in the field after harvest with the added advantage of avoiding damage by birds, pests, and weather. A typical solar dryer consists of an enclosure or shed, screened drying trays or racks, and a solar **collector (United States Department of Energy, 2011).** In a simple design, south-facing windows let sun into the shed. Other designs use a dark-colored box with a glass cover to capture the heat. Natural convection or a fan moves hot air through the crops to dry them. While the cost of a solar collector can be high, using the collector to heat other buildings at other times of the year makes it more cost effective. And small, low-cost dryers are easy to make out of simple materials.

Sun drying of farm produce is a major method employed by Nigeria farmer. As a country situated between 4-14 latitude north of the equator (Food and Agriculture Organisation, 1985), Nigeria is of course abundantly blessed with all year round solar radiation. It is common to see in the rural and urban Nigeria market sun dried pepper, dried powdered okro, fairly dried onion bulb and cowpea. This shows that Nigeria farmers like their counterpart elsewhere in the world, employ among others solar energy to save their crops after harvest. From the instance above, it can be said that the application of solar energy for the prevention of post harvest crop losses is a common practice among Nigerian farmers. However in-spite of the age long experience in the use of sun drying technology, post-harvest crop losses in the country still reach as high as 30-50% (FAO, 1985) for vegetable, fruits and some tuber crops. This is as a result of illiteracy and lack of proper orientation to farmers especially those at the grass root on the various advances that have been made in solar operated drying techniques.

Green House Heating

Another agricultural application of solar energy is greenhouse heating. A solar greenhouse is heated by collecting and storing heat energy throughout the day, then releasing it slow Iy at night, basically moderating the temperature (Greenmethod.com, 2007). To use the sun's energy, a solar greenhouse needs to collect, insulate and store energy. However apart from fans to circulate air, it is solely a passive solar system. The climate of Nigeria is tropical in nature, which is occasionally subjected to variations (Ajayi, 2009), thereby resulting to severe losses to some agricultural produce. During summers, major portions of the country come under the influence of moisture-laden tropical maritime air. Temperatures are high throughout the year, averaging from 25° to 28°C (Ajayi, 2009). In the higher elevations of the Jos Plateau north central area of Nigeria, temperature is at an average of 22°C. Northern Nigeria experiences greater temperature extremes than the south (Ajayi, 2009). Therefore to curb the effects of all these variations, greenhouse agricultural practice has the answer. A solar greenhouse has thermal mass to collect and store solar heat energy, and insulation to retain this heat for use during the night and on cloudy days (Energy Efficiency and Renewable Energy Clearinghouse, 2002). A solar green house is oriented to maximize southern glazing exposure. Its northern side has little or no glazing and is well insulated. To reduce heat loss, the glazing itself is also more efficient than single-pane glass, and various products are available ranging from double pane to cellular glazing (U.S.DE, 2011). Apart from boosting agricultural productivity, a solar greenhouse reduces the need for fossil fuels for heating purposes.

Space and Water Heating I Disinfection

Space and water heating is essential for higher agricultural productivity especially in livestock operation. Livestock and diary operations often have substantial air and water- heating requirements. I Nigeria, modern pig and poultry farms raise animals in enclosed buildings where it is necessary to carefully control temperature and air quality to maximize the health and growth of the animals. These facilities need to replace the indoor air regularly to remove moisture, toxic gases, odors, and dust. Heating this air, when necessary, requires large amount of energy. With proper planning and design solar air/space heaters can be incorporated into farm buildings to preheat incoming fresh air. These systems can also be

used to supplement natural ventilation levels during summer months depending on the region and weather.

The weather of Nigeria is generally quite hot throughout the year (Ajayi, 2009), thus this should be channeled towards water heating and treatment. Water heating can account for as much as 25 percent of a typical family's energy costs and up to 40 percent of the energy used in a typical dairy operation (Chikaire et al, 2010). A properly-sized solar water heating system could cut those costs in half. (Garg, 1987; Union of Concerned Scientists, 2009). Solar water heating can provide hot water for pen, equipment cleaning or for preheating water going into a conventional water heater **(Goedseels, 1986).** In water disinfection, it involves exposing water-filled plastic polyethylene terephthalate (PET) bottles to sunlight for several hours. Exposure times vary depending on weather and climate from a minimum of six hours to two days during fully overcast conditions **(Centre for Disease Control and Prevention, 2008)** It is recommended by the World Health Organization (WHO) as a viable method for household water treatment and safe storage **(WHO, 2008)** Over two million people in developing countries use this method for their daily drinking water **(CDC,2008).**

Remote Electricity Supply

In Nigeria, most of the agricultural practices are undertaken in the most remote rural areas where convectional grid power is not available. Using solar photovoltaic power is one way to solving this problem. Photovoltaic (PV) systems convert sunlight directly to electricity. They can power an electrical appliance directly, or store solar energy in a battery (EREC, 2002). PV allows for the production of electricity without noise or air pollution from a clean, renewable resource (sun). A PV system never runs out of fuel. Solar electric power comes in very handy on farm and ranches, and is often the most cost-effective and low maintenance solution at locations far from the nearest utility line (Chikaire et al, 2010). PV can be used to power lighting points, electric fencing, small motors, aeration fans, gate-openers, irrigation valve switches, automatic supplement feeders (Chikaire et ai, 2010). Solar electric energy can be used to move sprinkler irrigation systems (Svejkovsky, 2006). PV systems are also extremely well-suited for pumping water for livestock in remote pasture, where electricity from power lines is unavailable (Chikaire et ai, 2010). When properly sized and installed, PV systems are very reliable and require little maintenance. Although current prices for solar panels make them too expensive for most crop irrigation systems, photovoltaic systems are economical for remote livestock water supply, pond aeration, and small irrigation systems. In addition, the cost of PV is projected to decline significantly over time, which will make more applications cost-effective (UCS, 2004)

Challenges Facing the Application of Solar in Agriculture in Nigeria

Despite the advantages this technology proffers to improving the level of agricultural yield in Nigeria. It has not been widely embraced and adopted by many farmers in the country. This situation is attributed to the following reasons:

- Inadequate training and orientation: Most farmers in the country are not knowledgeable enough to understand the importance of the technology neither have they been ' properly trained and oriented towards the benefits involved.
- Poverty and Ignorance: Most Nigerian farmers are not only poor and ignorant but also resist changes like adopting the new improved solar techniques.
- Lack of co-operation among farmers: In Nigeria, most of the practising farmers are not wealthy enough to embark on some of the solar energy technology project and being that farmers co-operative are rarely existent in the country, individual farmers usually find it difficult to finance such project on their own.
- Inadequacy of incentives and subsidy from government and other related bodies.

CONCLUSION AND RECOMMENDATION

Agricultural technology is changing rapidly. Farm machinery, farm buildings and production facilities are constantly being improved. If Nigeria as one of the developing countries in the world can move with the trend thus concentrating and investing more on agriculture beyond what it is currently, there will be a boost on the nation's economy. One way to do this is by integrating and improving on solar energy innovations in agriculture. Sunlight is not regular but Nigeria is abundantly blessed with it. If it can be harnessed properly, fresh and good agricultural product will be available all year round thereby posing as a great weapon against the current food insecurity problem facing the country now. It is therefore recommended that government and individuals concerned should do the following as a matter of urgency;

- Give agriculture its required attention.
- Train and orientate farmers toward the importance and the benefits solar energy technology application in agriculture especially those at the grassroots
- Develop appropriate expertise to see to the implementation of these solar energy techniques
- Alleviate the problem of finance by providing farmers with subsidy and grants
- Develop policies on solar energy and integrate them into current energy policies.
- Establish research centres for subsequent improvement on already existing solar technique/methodology.

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