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АГРОЭЛЕКТРИЧЕСКИЕ СИСТЕМЫ: КАТАЛИЗАТОР ПРОДОВОЛЬСТВЕННОЙ БЕЗОПАСНОСТИ В НИГЕРИИ

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Аннотация: Продовольство и энергия являются очень важными потребностями для каждого человека, и, таким образом, новая концепция совместного освоения одного и того же участка земли как для производства электроэнергии на основе фотоэлектрических систем, так и для сельскохозяйственного производства, именуемая агроэлектрической системой (AVS) или агрофотоэлектрической системой (APV), набирает популярность во многих странах мира. В статье делается попытка обсудить потенциальную роль AV в повышении и улучшении средств к существованию нигерийских фермеров и может стать двигателем устойчивой экономики Нигерии. Далее в статье обсуждаются преимущества AVS для фермеров, такие как возможность сбора и хранения дождевой воды с верхней поверхности фотоэлектрических панелей в AVS, которую можно использовать для обеспечения дополнительного орошения сельскохозяйственных культур, выращиваемых в AVS, а также для очистки от осевшей пыли. с верхней поверхности фотоэлектрических панелей, помимо выработки электроэнергии, улучшая при этом коэффициент земельного эквивалента (LER), тем самым повышая продовольственную безопасность. Наконец, в статье рекомендуется, чтобы принятие AVS правительством Нигерии в сельскохозяйственной отрасли стало стратегией развития продовольственной безопасности, способной совместить создание доходов и рабочих мест с искоренением бедности и сохранением природного капитала. Его также можно использовать в качестве средства для обеспечения землевладения, а также для повышения энергетической и продовольственной безопасности, социально-экономической осуществимости и средств к существованию страны.

Abstract: Food and energy are very essential requirements for every human being, and thus a novel concept of co-developing the same area of land for both PV-based electricity generation and farming production, referred to as agrivoltaic system (AVS) or agrophotovoltaic (APV) is gaining popularity in many countries of the world. The paper tries to discuss the potential role of AV in enhancing and improving the livelihood of Nigerian farmers and could become the engines of a sustainable Nigerian economy. The paper further discusses advantages of AVS to farmers such as possibility to collect and store rainwater from the top surface of PV panels in AVS which could be used to provide supplemental irrigation the crops to be grown in the AVS as well as to clean the deposited dust from top surface of PV panels apart from electricity generation, while improving the Land Equivalent Ratio (LER) thereby enhancing food security. Finally, the paper recommends that adoption of AVS by Nigeria government and individuals in agricultural industry would become a strategy to pursue food security which is capable of aligning income and employment generation with poverty eradication and natural capital conservation. It could also be used as means to secure land tenure as well as enhance energy-food security, socio-economic feasibility, and livelihoods of the country.

Ключевые слова: агроэнергетика; фотогальванический; Продовольственная безопасность; коэффициент земельного эквивалента.
Keywords: agrivoltaic; photovoltaic; food security; land equivalent ratio.

Introduction. In Nigeria energy security is a big challenge while sunlight is in abundance, solar energy can be an obvious solution to these problems. However, installing huge arrays of photovoltaic (PV) panels mostly means clearing away hectares of land to a bare soil. Hitherto, this has a negative impact on land sustainability, and thus affecting soil stability, water retention, carbon sequestration and biodiversity. Sometimes, this also results to competition for land by farmers for their food production. Farmers nowadays are pose to danger of kidnapping in exercising their legitimate business in the rural areas while demand for energy is enormous in the urban areas. A situation which will require both crop production and electricity generation on the same land may enhance farmers' energy-food security.

Combination or co-developing the same area of land for both solar photovoltaic power for agricultural purposes. This dual-use of planting crops on arable land for solar energy production can improve overall production. The crops are normally planted beneath the panels gives some promising results. The concept is known under several names in the world: «agrophotovoltaics» in Germany, «agrovoltaics» in Italy, "solar sharing" in Asia. In a study conducted by [1] shows that it is possible to produce renewable energy without any meaningful negative impact on farming. AVS allows agricultural use and electricity generating on the same land in a very cost-effective way [2]. According to [3], photovoltaic agriculture can effectively alleviate the contradiction between more population and less land, powerfully promote the development of controlled environmental agriculture, evidently increase economic benefits of farmers, and significantly improve environment due to emissions reduction.

According to [4], the potential role of AVS enhances farmer's income and improves livelihood. That is why the issue of land utilization as a means of future food security and energy production is being debated at several different platforms. [5] opined that in view of the future requirement of energy and food production, AVS has been proposed as a mixed system associating solar panels and crop at the same time on the same land area. Using large tracts of land for solar farms will increase competition for land resources as food production demand and energy demand are both growing and vie for the limited land resources [6]. These coupled land challenges can be ameliorated using the concept of agrivoltaics or co-developing the same area of land for both a solar PV power station as well as for conventional agriculture [6].

According to (7), several studies mentioned that crops cultivated under the APV system benefited from more effective water/rainfall redistribution [8], reduced evapotranspiration, greater carbon uptake and water use efficiency for plant growth and reproduction [9], decrease in soil and crop temperature, improvement in soil humidity [10], protection against climatic uncertainty and extreme events such as hailstones and excess rain [11].

Conceptual clarifications. ***Agrivoltaic*** – According to [7] agrivoltaic (AVS) or agro-photovoltaic (APV) system is a new alternative to conventional photovoltaic power plants, which can simultaneously generate renewable energy and increase agricultural productivity by the use of solar panels on the same farmland. agri-voltaic system (AVS) has been proposed as a "mixed systems associating solar panels and crop at the same time on the same land area" [12].

Food security – Food security, as defined by the United Nations' Committee on World Food Security, means that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. Over the coming decades, a changing climate, growing global population, rising food prices, and environmental stressors will have significant yet uncertain impacts on food security. Adaptation strategies and policy responses to global change, including options for handling water allocation, land use patterns, food trade, postharvest food processing, and food prices and safety are urgently needed [13].

Renewable energy – Renewable energy (RE) refers to energy resources that are cyclic and naturally replenished within some time intervals [14]. According to Collins English Online Dictionary, 2022 (Harper Collins Publishers) renewable energy is a form of energy that can be derived from a natural source, such as the sun, wind, tides, or waves, without exhausting natural resources or causing severe ecological damage. Therefore, in short, renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed.

Photovoltaic – photovoltaic also known as PV is a device that produces electric energy directly from sunlight through an electronic procedure which naturally transpires in certain kind of materials refers to as semiconductors. Solar energy freed electrons in the semiconductors which are induced in an electrical circuit to power electrical equipment or national grid [15].

Availability of solar irradiation in Northern Nigeria. More than half of the country's land mass is located in the Northern part mainly comprising of the three geopolitical zones. These zones cover an area of 60 hectares of land and lies below the equator which makes the area receives more solar radiation compared to the rest of the geopolitical zones. The annual average sunshine in the country is about 6.25 h while in the north is 9.0 h. The mean daily solar irradiance in Nigeria is about 5.25 kWh/m^2/day, whereas in the North, which lies at hotter part of the country, it is about 7.0 kWh/m^2/day [16]. Spatial pattern on availability of solar irradiation in Northern Nigeria is shown in Fig. 1.

From the Fig. 1, zones I and II make up the Northern Nigeria (zone I depicts Northeast while zone II - Northwest and North-central) that have high solar radiation incident on the horizontal surface and excellent and viable potential for large-scale solar PV especially in the semi-arid region of the country. The sunshine duration and annual average of solar energy intensity in the Northern part of the country is 6 hours and 2,000 kWh/m2/year respectively. It is cloud free region most of the time (about 300 days) per year in North, which shows that the region is more advantageous in harnessing solar energy for farmers. Therefore, the potential of AVS application in the region may be a viable option for the future.

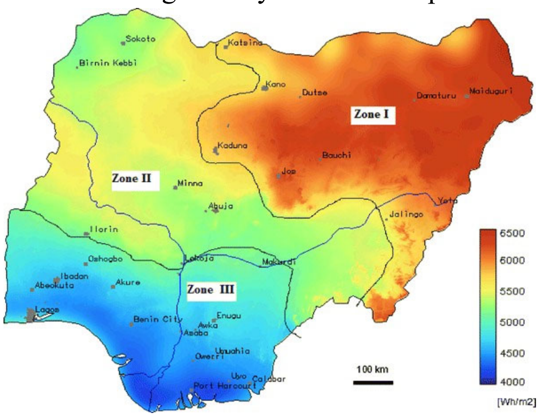

Figure 1. Availability of solar irradiation in Nigeria (Source: [17])

Food security and AVS. In comparison, the income that can be generated from agricultural activity is far less than income generated from PV electricity, but the former has several environmental and societal benefits. If AVS is to be employed in cropping activity in areas where there is shortfall of rain water apart from electricity generation which boost food security on the other side. There will also be a possibility of judicial use of the scarce rainwater as well as soil erosion control through wind action which can reduce the dust load on PV panels, and improving the microclimate surround the PV panels and thereby helps in optimum generation of electricity from PV panels, and subsequently will improve the land equivalent ration (LER) [12].

Conclusion and Recommendations. Moreover, installing AVS on farm will give ability to install high-value, shade-resistant crops for new markets because the shading by the PV panels provides multiple additive and synergistic benefits, including reduced plant drought stress and more constant temperature as the panel will maintain the temperature higher at night and colder during the day. Other benefits are: potential to extend growing seasons, ability to maintain crop production during solar generation and allowing for nutrient and land recharge of degraded lands. AVS reduces competition for land and works efficiently too while providing additional income for farmers. All these indices if properly harnessed can increase crop production which leads to food security for both farmer and the general populace. The paper recommends that agrivoltaic systems should be harnessed to make a meaningful impact on food security mix in the nation.

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НАПРАВЛЕНИЯ СНИЖЕНИЯ ПОТЕРЬ ПЕСТИЦИДОВ ИЗ-ЗА СНОСА ПРИ ОБРАБОТКАХ В ВЕТРЕНУЮ ПОГОДУ

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Аннотация: обоснованы направления возможного снижения потерь из-за сноса.

Abstract: justified directions of possible reduction of losses due to demolition.

Ключевые слова: потери пестицидов, ветер, снос.

Keywords: pesticide losses, wind, demolition.

Введение. Работа полевых штанговых опрыскивателей допускается при скорости ветра не более 4м/с. При этом отмечаются непроизводительные потери пестицидов из-за сноса капель небольших размеров за пределы обрабаотываемого участка. Поэтому разработка рекомендаций, технологий и технических устройств для решения проблемы сноса является важной и актуальной.

Основная часть. При исследованиях процесса сноса рабочих растворов пестицидов определяются потенциальные и абсолютные