

# SMART AGRICULTURE, VERTICAL FARMING AND AUTOMATED SYSTEM APPLICATION IN SUSTAINABLE CROP PRODUCTION

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## **Abstract**

*Dwindling planet resources, deteriorating environmental conditions, increasing population and demand, and continuous requirements for food security and safety; are just some of the challenges that we are facing today not just by the government and academician but by agricultural community as well. Adds to this, is the continuous rise of farm inputs supplies including oil and gasoline dependent products that adds to the burden of the farming community. Government's solution through attached agency for research and extension coupled with the coordinated support from the academe had mandated to focus on future-ready solution on achieving sustainable development. It has been a prolonged problem searching the gap between this researches and realizing its effect and application to the farmers. Recognizing these, transition of the research trends to including the impact and adoption of the farming community of every project and research are encouraged and even required. In the side of the academe, research and extension focused on smart agriculture, vertical farming and automated system application in crop production had gained popularity and interest especially on ensuring that this researches results will reach and will make impact on the lives of the farmers, their family and the community. This government strategy had made sure that the gap and the missing link of this researches will make positive impact to the lives of the agricultural community through ensuring sustainability of the programs and projects.*

*Keywords : smart agriculture, vertical farming, automated system, sustainable crop production*

## **I. INTRODUCTION**

Dwindling planet resources, deteriorating environmental conditions, increasing population and demand, continuous requirements for food security and safety and climate change; are just some of the challenges that we are facing today not just by the government, academicians, researchers and by agricultural community as well. Increasing population demands for food security posing challenges to the agriculture sector to provide food for the people and to the government to provide basic needs, otherwise economic development may be humpered in the attempt to meet this requirement. It will have domino effect to the already scarce natural resources.

Climate change had affected agriculture sector vastly. El niño and La Niña phenomenon in the Philippines that is characterized by severe drought and extended heavy rains respectively, had devastated many farms and produce. Erratic weather phenomenon had alter the production system, food supply, marketing system and the economy, human ecology in general. Though climate change may either improve or worsen agricultural productivity, its negative impact had created problems and challenges and even post threats to the already challenged farmers. Adds to this, is the continuous rise of farm inputs supplies including oil and gasoline dependent products that adds to the burden of the farming community.

Soil-based field production in low land tropical areas are currently experiencing challenges such as environmental and natural disasters and climate change, on top of land infertility that had resulted from residual effect of too much usage of chemicals and pesticides (Nisha et al., 2018). Another problem is the tropical weather conditions in the Philippines that is being erratic that had resulted to change crop calendars. Furthermore, due to the tropical weather, growing crops in the lowland areas of the Philippines is seen to be impractical, but the requirement for sustainability of produce and food source is essential due to the increasing population demand (Capuno et al., 2014). Due to climate change, there are threats in the form of rising temperatures, frequent dry periods, and the unpredictability of the weather patterns. These are the serious problems in conventional soil-based production risky and unsustainable.

Urgent call to provide solutions to these problems challenged all governments in all countries to unify in catering the basic needs of the people, delaying the effects of these problems, preserve and improving the natural resources and conserving the environment for the future generations. In this call, the United Nations in 2015, together with the member countries adopted the 2030 Sustainable Development Goals (SDG) in the strategy of ending poverty and other deprivations through improving health and education, lessen inequality, and encouraging economic stability and growth simultaneously working together adversely with climate change effect but still preserving and conserving our environment oceans and forests that is attainable until 2030.

Responsible consumption and production also known as SDG 12 and 13 as climate action set forward by the United Nations are directing researches and government policy-making focus on sustainable and improving life (SDG 1 and 2). Functioning with SDG 17 known as partnership for the goals that encouraging all member states to have an integrated strategy in solving these problems by working hand-in-hand to save th future generations. This calls for humane-driven solutions with sustainable impact to the end-users, the farmers and the community as well.

Philippine government's solution through attached agency for research and extension coupled with the coordinated support from the academe had mandated to focus on future-ready solution on achieving sustainable development. It has been a prolonged problem searching the gap between this researches and realizing its effect and application to the farmers. Recognizing these, transition of the research trends to including the impact and adoption of the farming community of every project and research are encouraged and even required. In the side of the academe, research and extension focused on smart agriculture, vertical farming and automated system application in crop production had gained popularity and interest especially on ensuring that this researches results will reach and will make impact on the lives of the farmers, their family and the community through extension activities.

## **II. SMART AGRICULTURE, VERTICAL FARMING AND AUTOMATED SYSTEM**

Smart agriculture, vertical farming, and automated systems have gained popularity and interest among researchers and farmers for showcasing its sustainability and impact to the lives of the farmers. It is seen as a viable solution as its approach may improve agricultural industry and productivity. Smart agriculture is known for its management concept, adoption and practice of usage of leverage advanced information and communication technologies like artificial intelligence (AI), drones, automation and robotics, sensors, location systems and the internet of things (IoT), in enhancing and optimizing thereby improving agriculture and food production. It is also known as smart farming and is also coined to reduce waste and optimize usage of farm inputs that include electricity, fuel, water and fertilizer. Precision agriculture, smart soil sensing for water optimization, cloud-based irrigation and climate-smart agriculture are some of the known smart agriculture strategies and techniques being

employed in improving agricultural industry and production and optimizing farm inputs.

Vertical farming allows the growing of crops vertically in small spaces thereby conserving planting area and optimizing space. This allows farmers to increase the planting density of the production by having a higher crop yield per square meter of area utilized. This is known an alternative to usual field production systems for some crops and is also expressed in higher area productivity that enables the farmer to recover the expenses for production and have higher profit. Usually, vertical farming is employed by the use of vertical growing structures, stacking pots or vertically stocked layers of plant boxes. Vertical farming is also introduced in peri-urban areas to allow agricultural production to satisfy the requirements in local setting.

Automated systems application in agriculture is usually coupled with smart agriculture in employing innovative leverage with the use of various advanced technological devices, sensors, programs and machinery to improve and automate operations in the farms including field production, monitoring and analytics, harvesting, processing, preserving and storage. The State of Food and Agriculture 2022 (FAO, 2022), presented the importance of the application of automation system in agriculture as having high potential for generating rural entrepreneurship opportunities, improving primary production contributing to higher income, reducing agricultural production risks, improving resilience and enhancing environmental sustainability. In general, the application of smart agriculture with automated systems and vertical farming will increase the efficiency of production and will optimize the use of natural resources. But for all these strategies to be effective, it has to impact to the lives of the end-users, the community or the farmers sustainably otherwise, all these efforts will just go to waste.

### **III. SUSTAINABLE AGRICULTURE AND CROP PRODUCTION**

Sustainable agriculture's primary objective is to be able to increase agriculture yield and profit while at least conserving if not improving the environment. The National Institute of Food and Agriculture of the United States Department of Agriculture (USDA, 2024), cited the general objective of sustainable agriculture including an increase in profitable farm income, promote environmental stewardship, enhance the quality of life of farm families and communities, and increase in production for human food and fiber needs. Its importance according to USDA is designed to produce long-term results such as food security including feed, fiber, and fuel to meet the needs of the increasing population, improve and conserve the environment and expand or prolong the supply of natural resources, and spur the economic growth and viability of agriculture sector.

With these at hand, the sustainable development strategy that will be implemented by the government must make a visible impact on the lives of the people. These strategies should engage farmers including their households and the community in the development and adoption of practicable and applicable agricultural production practices that are profitable but still preserving the environment. Coordinated and targeted approach in the academe in supporting research and extension that are intended to help uplift current agriculture sector's situation and the lives of the farmers through improve, profitable and efficient production. It is also important that by doing so, the process will not create another problem such as threats from pests and diseases as well as conserving the quality of surface water and groundwater resources.

The Bulacan Agricultural State College (BASC) had several smart agriculture, vertical farming and automated systems to cite a few are peri-urban gardening, aquaponics and hydroponics systems, root zone cooled hydroponics systems with

micro climate automated systems and automated drip irrigation system. The root zone cooling system are being employed to provide solution to control environmental factors affecting production such as temperature and relative humidity, that has direct effect on the water quality parameters especially with hydroponics production. Several studies had shown positive effect of regulating the nutrient solution (NS) focused on the root zone of the crops in increasing its viability. A study (Sulit, et al, 2023) revealed that regulating the nutrient solution using ground-heat exchanger cooling system and condenser cooling system technologies increases the fresh weight and water productivity of crops. Intensification of production is necessarily for this type of alternatives to cope with the capital and expenses while employing smart agriculture technologies. Crops growth and development was greatly affected by environmental factors especially high temperature in the rootzone that resulted to reduced leaf, stem, and fresh and dry weight (Thakulla, et al, 2021). Nutrient film technique hydroponic system with precision automated cooling systems and application of internet of things using rootzone cooling technologies (RZCT) system is one of the possible alternative technologies that may be use to regulated water quality parameters and climatic effects, alleviate low production in lowland tropical condition and ensure food security. Researches and programs conducted by BASC were being encouraged to extend to the end-users, farmers and their household. This strategy ensures that this researches and program will have positive impact to uplift their lives.

#### **IV. CONCLUSION**

The success of sustainable agriculture strategies like the application of smart agriculture, vertical farming and automated systems can be measured through the benefits and impact to the farmers by elevating the lives of the end-users, the farmers and the community, through increase crop yield and profits, enhanced agricultural production and optimized utilization of natural resources by simultaneously preserving and conserving if not improving the environment and natural resources.

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