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"I can make use of a manual water-pump to enhance smart farming": voices from Lira City, mid-North Uganda

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Abstract: **Smart farming has become a world-wide sensation and Uganda is no exemption to this movement. In Uganda, the impact of climate change presents farmers with new challenges and so is the aggregate demand for food in the country. Farmers, in Uganda, represent the biggest constituency and the situation is less likely to change for many years to come. However, there have been a substantial amount of studies, reports documented as well as investigations being circulated with a consistent inference that there are tenacious dangers facing the farmer in Uganda. Thus, evolving and executing proper policies, guidelines and programmes that are aimed to alleviate dangers facing the farmer need to become a pre-eminence for the government than it presently does. Winning the farmer into water-pump technologies as one of the means to enhancing smart farming is one such optimism seeing that the dry spell is now overriding the wet season and the farmer can no longer rely solely on rain fed agri-production. In this study, we examine the budding potential enshrined in this endeavour by looking at manual water pumping in Ober parish in Lira city, mid-north Uganda. It is concluded that this technology has the prospect of transforming a smallholder farmer into a smart farmer thereby the aggregate output per unit.**

Keywords: **Water pump, smart farming, smallholder farmer, farming.**

1. INTRODUCTION

This part of the survey report handles background of the selected technology and is mainly comprised of related literature from different sources. According to Collins English dictionary (1979), farming is the activity of growing crops or keeping animals on a farm. Farming is an activity that requires water throughout. Farming takes place in various forms. It entails crop growing which very much need water, animal production where different species of animals are kept, fruit growing, and flower gardening. Farming is of different types which include chicken keeping, goats keeping, mushroom production, urban farming and cultivation of food crops. Farmers involved in animal production and other agricultural production need water for irrigating their crops and for animal consumption. Unfortunately, water becomes scarce during some times of the farming seasons because of climatic changes. In the absence of rain, crops do not do well and this requires farmers to have reserves of water for use in their farms during times when it is not raining.

Smart farming is now used as a solution to problems that affect farmers as a result of unfavourable climatic changes. Smart farming according to Bernstein (2019) is a management concept focused on providing agricultural industry with the infrastructure to leverage advanced technology including big data, the cloud and the internet of things for tracking, monitoring, automating and analysing operations. Other scholars referred to smart farming as the 4.0 green revolution in the field of agriculture combining agriculture methodologies with technology sensors and Actuators, information and communication technology, Internet of Things, Robotics and Drones to achieve desired efficiencies of production with managed cost. According to a survey, eighty % of farmers in the United States of America and twenty four % of farmers in the United kingdoms have already started using smart farming tools. Smart irrigation is thus part of the smart farming systems that are being used by farmers today.

Smart irrigation systems are a combination of an advanced technology of sprinklers with nozzles that improve coverage and irrigation controllers that are watering and water conservation systems that monitor moisture and related conditions of someone's property and automatically adjust watering to optimal level. According to Hawkins (2018), irrigation systems are of various forms; there is one called sprinkler irrigation where water is pumped through pipes and then distributed via high pressure overhead sprinklers. The sprinkler can be put at a central location in the field or can be located on a moving platform. The second one is the central pivot irrigation and is the most popular one in use and is where water is sprinkled round the farmer. In Georgia, the primary agricultural irrigation system is the pivot irrigation system and it is stated that approximately twenty-three thousand centre pivot systems are located across the state. Drip irrigation is also in use but there are other forms of irrigation that are not in use and are solid set sprinklers and traveling guns.

The third one is the drip irrigation itself mentioned above where water is distributed directly to the roots of plants through pipes with small openings called drippers. Another form is the micro irrigation which uses low pressure, low volume system that offer control over watering. Researches have shown that farmers are already actively exploring high technology solutions in smart irrigation. Intellias (2020) pointed out that for ages, farmers across the world have had to be resourceful when rain fails to come and to take matters into their hands, farmers have technologies like irrigation systems to overcome water deficits and maximise yields. A number of farmers have adopted use of irrigation system to combat this problem of water failure during dry season. Smart irrigation is an aspect of smart farming that is commonly in use today by quite a number of farmers who produce on small scale and large scale for home consumption and commercial purposes.

A good number of farmers have taken to adopting smart irrigation because of the advantages that are associated with the technology. Due to use of smart farming and smart irrigation in particular, many farmers around the world are getting much income and have become rich. Richard Hobson (2019) indicates that there are now five richest farmers in the world as being Liu Yongxing and Liu Yonghao from China, Harry Stine and Steward from the United States of America, and Prince Sultan bin Muhammad of Saudi Arabia. This is a clear manifestation that adoption of smart farming technologies can very much benefit farmers and their status are raised. By 2025, smart irrigation market is expected to reach 2.1 billion dollars. It is pointed out that, Agribusinesses and farmers throughout the world are embracing smart irrigation technology to improve their day-to-day operations. The technology is said to be useful in monitoring soil moisture. Other benefits of smart irrigation are that: (i) It is cost savings due to minimised water waste; (ii) Reduced human efforts; and (iii) Ensures better long term landscape health. According to Jagdish Reddy (2019), smart farming is a farming management theory using modern technology to increase the quantity and quality of agricultural products.

In the United States of America, smart farming is in use and one of the aspects of smart farming used is smart irrigation. Smart irrigation systems are said to be tailoring-watching-schedules and run times automatically to meet specific landscape needs. Smart irrigation controllers monitor weather, soils condition, evaporation and plant water use to automatically adjust the watering schedule to actual condition of the site. The smart irrigation controllers are said to save water and money and researches conducted by a number of scholars indicate that the controllers saved water from 30 to 50%. Jagdish (2019) notes that smart farming systems reduce waste, develop productivity and enable management of a greater number of resources through remote sensing etc. In this case, smart farming helps to save water which would otherwise be wasted since water can be kept or drawn from underground for use in farms.

A number of countries in the world now look at smart farming as the key to the future of the agriculture industry. Irrigation is thus one of the aspects of smart farming. In the US, more than nine billion gallons of water is used on a daily basis for landscape irrigation. A study by Yingdano (2020) shows that smart irrigation systems are the focus of modern agriculture and have many engineering applications in China. Horti (2020) reveals that water scarcity is a threat to food security and this has been a critical concern in China. In many countries, shortage of water especially due to rain failure affects food production and this is partly due to heavy dependence on rain water by most farmers. A few farmers have been sensitive over this matter but of recent many farmers throughout the world have started embracing smart farming in which irrigation systems are being used. In China, the China-Israel international Agricultural Science and Technology Demonstration Park introduced advanced water and fertilizer irrigation equipment and irrigation control system to help in farming. Through demonstration and promotion, relevant technologies and equipment to improve the utilisation of local water resources and improve the quantity and production efficiency of agricultural products (Yingduo, 2020). From that, it is very clear that use of smart irrigation improves the quality of agricultural products since crops require water for them to do well.

In Africa, smart farming is widely in practice since a good number of Africans are agriculturalists. Since they are involved in farming, they cannot be an exception in issues about water shortage that affects their farming. Reynold (2019) pointed out that more than half of the working Africans have jobs in agriculture but poor infrastructure, inadequate tools and lack of investment have left the continent's mostly small-scale farmers struggling to feed a growing population but a wave of technological solution is aiming to help farmers overcome the above problems. In Ghana, a company called Acauatimeyer is renting drones to keep small scale farmers check the health of their crops. In West Africa, climate smart agriculture is also being practised as a remedy to farmers' problems and it is indicated that smart farming is being used to combat the effects of a changing climate. The world Agroforestry Centre is charged with the responsibility of rolling out the program to the community. Smart farming is seen as a relief to farmers since they are able to get rid of problems that affect their operations. Smart farming provides agricultural industry with the infrastructure to leverage advanced technology. Wendy levy (2017) indicates that precision agriculture promises better returns to investment and improved livelihoods for farmers around the world.

In East Africa, farmers have also adopted smart farming technologies in their farming. In Kenya, www.practica.org> projects pointed out that farmers were assisted by a four-year project (2016 - 2019) that was an irrigation-based project. This was a move that was aimed at increasing areas covered by irrigation system. An article titled "A big bet on irrigation for Kenya (2020) shows that, over the last ten years, Kenya had significantly increased the area under irrigation out of government efforts as well as private sector in the dissemination of smart irrigation technologies. It is indicated that Kenya' massive support to the farmers by supplying farmers with smart solar irrigation which led to increase in yields and income to farmers amidst locust infestation and Covid-19. One of the farmers confessed that before he received the solar panel, he was harvesting 4000 heads of cabbages but after getting the smart solar irrigation, his harvest increased to 20000 heads of cabbages. He said the pump allowed him to harvest during high prices and it's indicated that the use of solar water pump can double agricultural yields and, in some instances, outputs are quadrupled.

In Tanzania, smart farming is being practised under what is called climate smart agriculture technologies and schools have been tasked to spearhead the program by teaching the learners from schools so that they can transmit the program to the grassroots level and this is known as smart education. Examples of climate smart agriculture indicated here are: (i) Soil management, (ii) Drought tolerant maize, (iii) Dairy development, (iv) Carbon finance to restore crop yields, and (v) Waste reducing rice thresher.

CGLAR (2020) reveals that climate smart agriculture interventions as those that increase productivity, adjust farming systems with respect to perceived or future projected climate change impacts, and reduce or remove (where possible) GHG emissions. In Rwanda, farmers have adopted smart farming technologies too and they are using an internet of things-based irrigation system and this is used to enable farmers increase crop yields. In Rwanda, farmers are greatly affected by climate change, and as it is stated, climate change dependence on rain fed farming strategy only affects yield production. Smart irrigation can help to overcome these dependencies and to ensure food security. Thus, an internet of things-based irrigation system is intended to assist Rwandan farmers to use the right amount of water and fertilizer for the crops. One of the farmers was quoted as saying "the days of consulting clocks and calendars are over; we are now using real time data to apply the right amount of water at the right time of day and year-round". Because of smart farming technologies, Rwanda is continuously experiencing a renewal of technological development. www.mdpi.com shows that smart irrigation system in Rwanda is being supported by use of sensors, mobile phone, and cloud.

Uganda is also among the countries that are using smart farming. This is because Uganda is among those countries whose farmers are greatly affected by unfavourable climatic changes. FANRPAN (2017) indicates that, climate smart farmers in Uganda get thrice their usual yields and an organization called Dubbed climate- smart agriculture was in charge of the program. Another organization by the name smart farming Uganda (SFU) was also initiated to help farmers acquire skills and knowledge required in smart farming. According to Agro Food (2019), one of Uganda's agribusiness enterprises was providing resourceful knowledge, skills training and support to farmers from all backgrounds to become more productive and profitable through a range of practical creativity programs, while at the same time engaging in production of agriculture crops and rearing of livestock. According to the source above, Uganda's main food crops have been plantains, cassava, sweet potatoes, millet among others whose production is affected by a number of problems which smart farming technologies are looked at as solutions.

In Uganda, farmers are faced with a number of challenges and these challenges include: Use of traditional methods of farming; high cost of investment to finance the farming activities because many farmers are not financially viable; inadequate physical infrastructure to support the sector, where by the roads, stores and others are limited in most rural areas; limited access to quality farm inputs and in this case most farmers cannot access farm inputs like quality seeds, the greenhouse materials and others; too much relying on rain and this is very common among farmers in rural areas since they lack irrigation skills and water harvest methods which make their farming activities affected during dry season, hence leading to unstable production of crops. This means that, smart technology can be of great importance in solving problems that are faced by farmers as a result of drought; inadequate production and post-harvest technologies too is a challenge; and lack of marketing data and information since most farmers in rural areas are not much educated so that it is difficult for them to know the marketing data and information for their products.

Smart farming in Uganda is said to be providing ways to help farmers get a taste of the world of work and the excitement of running a farming business and in this case, "learning and doing and learning to earn" is the slogan being used in the smart farming campaign in Uganda. The mission of smart farming in Uganda is: To organize and transform farmers in to prosperous communities. Its objectives are: (i) To promote and establish agriculture as a business to increase household income of the small holder farmers through appropriate methods across all sub sectors; (ii) to acquire post-harvest technologies and train farmers in to the same technologies; (iii) to establish structured marketing system for farmers in Uganda and Africa at large; (iv) to enable farmers acquire food processing and storage facilities. And (v) to empower the children, youths and other marginalised groups to have promising and stable livelihoods.

The initiative of smart farming has vigorously been adopted in Uganda and many vocational colleges have too joined the government in spreading the culture of smart farming technologies. In one of the farms in Uganda and this farm is called Jolly Kabirizi Urban Farm, a researchers on practice was seen exhibiting a machine that cuts grass used for controlling foliage and many farmers have taken on to acquire and use this machine on their farms.

In Uganda, quite a good number of farmers, both small scale and large-scale farmers are also using smart irrigation for their farming. In Pader district, a farmer by the name Okot uses a solar powered pump to tap water from a swamp to irrigate his plantations of onions and cabbage. Rupiny, a local newspaper in Luo (Monday 16th, Feb, 2017) pointed out that Okot produces cabbages and onions throughout the year due to use of solar irrigation on his farm. This resulted into a rise in Okot's monthly income. Food and Agricultural Organization's Report (2021) points out that Gayaza High School in central Uganda is practicing smart farming. It is indicated that the school together with the Food and Agricultural Organization are struggling and working together to ensure that other schools can implement the idea of school gardening which uses smart farming technologies not only to provide researchers with variety of nutritious foods but also to allow them acquire farming and entrepreneurial skills. From the above related literature smart farming is of great importance to farmers.

Smart farming technology used at the study site

The technology used at the site is water pump that is manually operated and electrically powered. The technology is an original technology designed by the owner by the name Okello Albert. The technology is a small water pump which he made from his workshop at home and is used for tapping water from underground to the surface to water fish pond, banana plantation and for domestic consumption. Okello said he preferred to use the technology since he had the skills of making it and more so it was easy to access water since his home is just near wetland which is some meters away from his home. Consequently, the researchers picked interest in the selected technology because of the originality of the technology. Unlike many other farmers who use innovations of other people who are already on the market, this technology was an original innovation of the owner who is using it. What makes the technology original is that the owner did not train from anywhere to make it and he said that his level of education is primary six and from that level he never went anywhere for training but he put his imagination in practice and it started working. Prior to this survey, the researchers had ever taken interest in the technology and as such it became very easy to consult the farm owner since he had ever interacted with the researchers and more so it became easy for him to accept to give the researchers his audience.

The specific aspects covered in this survey report are the make-up of the technology, that is to say, the future of the technology including the materials used for making it and how it operates, areas covered by the technology, beneficiaries of the technology and the future plan of the farmer. To collect information presented in this report, the researchers used interview, discussion, observation and demonstration. The researchers had ample time with the user and designer of the

selected technology. This ample time enabled the researchers to ask questions to which Okello responded to. Discussion was also held to find out more about the technology. Apart from listening from him, the researchers also made observation by using his eyes to see how the technology looks like, how it works and the areas that the technology serves, e.g., the fish pond, the banana plantation etc. The researchers also demonstrated how the technology works by operating the technology and was able to see how the technology works. These methods used in data collection were selected because they were intended to allow free interaction between the technology designer and the researchers and they worked out very well as expected by the researchers. All the methods used for information collection were concurrently used. Discussion and interview dominated the process of data collection. The researchers asked various questions to which the farmer responded. The researchers however had challenge of time due to rainy weather that day since which made the interaction to start beyond the initially scheduled time. The farmer had started saying he had to go somewhere but the researchers requested him to give a little time for more questions before he could go away. The farmer gladly accepted the request.

2. OUTCOMES

This part of the report handles results or findings from the interview, discussion, observation and demonstration. It is comprised of findings about the make-up of the technology, areas covered by the technology, beneficiaries of the technology and the future plans in regard to the technology.

Structure of the technology

According to Okello, his water-pump technology has now lasted for five years. Being a primary six drop out, he thought of the means of survival and he ended up coming up with the technology he is currently using. The technology according to Okello is a simple one which is not costly to make because he moves to collect materials which are thrown away by people. The materials from which he made the technology and of which he still makes and sells to people are metal, plastic pipes, drum, strings, stones and rubber. A hole is drilled 15 feet down till water is reached and a drum is placed in the hole, holes are made under the drum to sieve water. This drum is supported by stones that are placed around the water drum up to the surface and a pump which he makes by himself from home workshop which is inside his incomplete building. To bring water to the surface, electricity is used and this is mainly to sprinkle water to the plantation. But for domestic uses, water is manually pumped using hand by rotating a wheel on which a string is attached and the string is connected to the pump.

Also, around the wheel is the rubber which he said is for generating friction and for protecting the string from getting damaged by the metallic wheel. Water is transported to the plantation and fish pond through tubes that is connected to the pipe that brings water from the ground. The stand on which the wheel is connected is also made by the technology designer through welding. The wheel is also self-made by Mr. Okello from a thin metal which he fabricates in to a wheel. The wheel was at the time of the survey manually operated but the owner of the technology intends to buy a solar panel which will be used for running the wheel instead of using hand to rotate it. The cost of the technology according to Mr. Okello is two million shillings. He however expressed problem of difficulty in getting the materials because of shortage of money and said this is very much limiting him from further development of the technology. He however expressed his concern on the low pressure whenever water is being supplied to the banana plantation. This, he said, is due to power shortage since he uses a small solar panel due to fear of accumulating huge Power bill from use of electricity power.

Geographical coverage of the technology

Water from this technology is used to irrigate banana plantation that's just within the compound of the home, it is also used in the fish pond which is just in front of the house which is under construction and is also used for drinking, cooking, washing and other purposes. Because of steady supply of water, the banana plants looked so healthy and those that had borne fruits had their fruits looking big and healthy. According to Okello, before he thought of the technology he is using right now, his crops used not to do well much as his home is near wetland because water could dry up and he could just sit to wait for rain but now with his technology, he does not have time to waste other than thinking of how to advance his technology and become more innovative. Because of the high quality of his banana, he sells a bunch at twenty thousand shillings and people just struggle for the banana.

Okello said that being someone who stays within town he had problem of land shortage and this forced him to be innovative. He had interest in fish farming but land was not enough to make fish pond and as a result, with the help of his technology, he made one fish pond just within the compound by Dec 2020. Currently, there are one hundred and twenty

fish in the pond. According to him, the fish are doing very well since he has forged a way of making the fish pond looks more natural by plantation some wild water plant and rice in the pond. The plants in the pond provide shade for the fish and the fish also eat the roots of rice. The rice in the pond according to him is also for demonstration purpose of which he wants to venture in as well. Water in the fish pond is replaced regularly to protect the fish in case the water gets contaminated.

Beneficiaries of the technology

As noted, this technology benefits mostly the home of its designer since water which this technology taps from the ground is used for farming and for domestic purposes. However, the technology is not only helping the home of Mr. Okello but also helps the community members since they come and buy water from the technology especially during the time when tap water goes off. Because it is manual, some people refuse to come for this water since they prefer tap water which is easy to draw, said Okello. To this challenge Mr. Okello intends to buy a high-powered solar system to bring to an end this problem. Other than the family of Okello and the local people benefiting from the technology, of recent, people started looking for Okello to go and make for them the same technology in their homes and he is the only one who can make this technology and that is why people from many parts of northern Uganda look for him to make for them this technology. His charges for making this technology varied according to the depths of the holes. He said for areas that are within wetlands, it takes only 15 feet to reach water and he charges shillings 1.5 million but from 20 to 30 feet, he charges shillings two million.

Future plan

According to Okello, he intends to make a bigger water pump than the one he is currently using and this will enable him expand his farming activities. He also said he intends to mobilise money to buy a 3D printer which he hopes will address the problem of shortage of water pump and sprinkler and other equipment for smart farming technology. He also said he intends to begin training farmers on how to harvest rain water for use during dry season and this is going to be made out of holes in which water is going to be stored. He said that he would do much if at all good-hearted individuals would link him to His Excellency the President of the Republic of Uganda, for assistance. He requested the researchers to encourage their fellow researchers to sell him nationally and even globally now that they (researchers) from Lira University have started visiting his technology. Okello also added that he wants to design a pump that he will use to tap water directly from the nearby water-logged area instead of depending on the one he has made from home. Also seen by the researchers is a biogas which Okello made but is not yet functional but said he intends to make it begin working to supply his farm with manure since the biogas technology is going to use cow dung, peels from potatoes, cassava and rubbish of other forms. Another technology that the researchers got so much interested in was the machine that cuts grass for storage to be used as animal feeds especially cows and goats during the time of dry season when it is hard to get pasture for these animals.

3. CONCLUSION

From the survey, smart farming technologies are very helpful for farming. Farming can take place throughout the year with the help of smart irrigation. Use of smart farming in form of smart irrigation helps to supply crops with water throughout the year and this results in increased yields and quality of faming products. Throughout the world with Uganda inclusive, farmers have and are adopting smart farming technologies to address problems which they face in their farming activities. Many farmers are now farming throughout unlike those days when farmers used to depend on only nature for their farming activities. If all farmers embrace smart farming, then they will be in a position to overcome hindrances to successful farming. The government of Uganda should take lead in promoting smart farming as it is happening in some countries. This means that local people should be ready to adopt and where possible be more innovative.

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