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THE USE OF INTERNET OF THINGS FOR THE SUSTAINABILITY OF THE AGRICULTURAL SECTOR:THE CASE OF CLIMATE SMART AGRICULTURE

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ABSTRACT

Global climate change has huge effects on the agricultural system and its productivity. Scientists report that changing climatic conditions led to a decrease in global wheat yields by 5, 5% and corn by 3, 8% and that by 2090, climate change is projected to lead to a loss of 8-24% of total world production of corn, soybeans, wheat and rice. According with others Scientists, Africa is threatened with a loss of the corn crop by 5% and wheat by 17% until 2050.Taking all of this into account agricultural sector needs to adapt to climate change. The goal of the paper is analyze the Climate-Smart Agriculture (CSA), verify the results of this approach in some significant Country in terms of vulnerability to climate change and asses what are the impacts. The paper intends responding to why should CSA be a good alternative and how it is different from what is being practiced right now. The conclusions put evidence on what is good in it and why it is important to pursue this practice.

Key words: sustainability, agriculture, technologies, smart, climate change.

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1. INTRODUCTION

In recent years, the climate on Earth has noticeably changed, and it is now well known that polluting factors represented from GHGs (green house gas emissions) contribute to these changes.

Today agriculture sector contributes about a quarter of human-induced GHGs. This means that a lot can be done in order to reduce these emissions, and to mitigate other unfavorable effects of agriculture on the environment [1]. At the same time global climate change has huge effects on the agricultural system and its productivity.

Agriculture is very fragile in terms of natural phenomena and it is easily affected by the changing climatic conditions and consequential extreme natural events. Indeed, globally there

are significant changes in seasonality and average temperatures, which heavily affect the harvests and in most cases even destroy them.

Climate Smart Agriculture (CSA) aims to enhance the capacity of the agricultural systems to support food security, incorporating the need for adaptation and the potential for mitigation into sustainable agriculture development strategies [2].

This definition of CSA considers the transformation of agriculture in accordance with the new realities of a changing climatic background in the world. Currently, the concept of CSA is widespread among governments, regional and international agencies, civil society and the private sector and new global and regional alliances provide frameworks for collaboration between all stakeholders.

CSA is made of specific approaches dependent on three fundamental pillars that constitute a win-win-win combo. The approaches are: better management of resource (i.e. farms, crops, livestock, aquaculture and capture fisheries); improvements in conservation of ecosystem and landscape because of their importance in increasing resource efficiency and resilience; and more adequate services for farmers and land managers to ensure they are able to implement the necessary changes. These approaches, put together form the ideological background for the creation of the three-win pillars: productivity, adaptation and mitigation.

In a broad sense, CSA allows to have the triple effect of increasing productivity, sustainability and reducing emissions.

For that CSA plays a crucial role in the process of achieving part of Sustainable Development Goals (SDGs) established by United Nations in 2015.

The CSA pillar of productivity consists in increasing agricultural production and income from crops livestock and fish, in a sustainable manner.

In doing so, it also tries to reduce or (remove when possible) the negative impacts on nature due to the extreme pressure on the environment. Moreover, a further outcome would be the increases food and nutritional safety.

So, in its own way, this first pillar of CSA is strictly linked with the first and second SDGs (poverty reduction and hunger ending all over the world).

The aim of CSA pillar of adaptation is to reduce the short-term risk of farmers, as well as increase their ability to adapt and thrive in time and face shocks. It is especially worth emphasizing the need to protect the ecosystem’s services. In accomplishing these tasks, however, it is very important not to disrupt the balance of the functioning ecosystem, because it is a major dependent factor of our ability to adapt to climate change and maintain high levels of productivity.

CSA's aim is to adapt farming in order to ensure the resilience of agricultural systems to the changing climate. In this context, the process of adaptation of CSA is a key element for supporting SDGs sustainable and responsible consumption and production arrangements. Adaptation can involve some certain changes as the use of new technologies or innovations, changing the livestock or the crop that are cultivated and finally applying climate or weather data to make clear decisions for the future.

The mitigation pillar of CSA aims to reduce and if possible remove completely GHGs. With the use of CSA innovations and practice it could maximizing potential of the land and its resources, while at the same time having minimal impact on the environment [1]. In this sense, it will reduce emissions for each unit of food, fiber and fuel, but can still get a quality product out of the correct processes.

Also the mitigation pillar has its own link to some SDGs. For what concerns Goal 13 indeed, by reducing the GHGs emissions it could have the possibility to combat and prevent climate change and its destructive impact on our atmosphere. Then taking into account the

problem of water scarcity, with CSA's practices on water management could help reduce water pollution and keep the oceans clean and safe for its inhabitants, as well as ensure access to portable water. Another important effect of CSA's activities is also visible on the matter of appropriate soil management. Thanks to better use of lands, indeed, CSA allows for more absorption of CO2 by soils and plants and reduces its concentration and negative impact on the atmosphere.

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Concerning previous work the practice of CSA was first launched in 2012 by the World Bank and the Food and Agriculture Organization (FAO). At the time, it was already clear to researchers and academics that climate change was becoming a more a more immanent problem for the planet as a whole [3] [4] [5]. What's more, researches showed that among the several field that were having negative impact on the changing climatic conditions, agriculture was not the least in giving its damaging contribution[6][7]. To this raising issue, there was also the acknowledgment of the need for ways to increase productivity of food supply in the face of the growing global population.

In response to the pending global questions, the World Bank took the initiative and in the last decade has managed to create a network of think tanks, research programs, action plans and reports in order to turn the theoretical framework of CSA into actual practice in the best and most sustainable way possible [8]. In applying such a practice, it allows not only to have a better food-production and food-distribution chain, but also a more self-conscious system of production that takes into account its own impact on climate change.

One of the most discussed topic has been why should CSA be a good alternative and how is it different from what is being practiced right now. The amount of paper on its aspect, impacts and exploitation for market purpose is example to understand that this framework is not free from problems and accusation. The present contribution wants to try and understand what is good in it and why it is important to pursue this practice.

The goal of the paper is analyze the Climate-Smart Agriculture (CSA), verify the results of this approach in some significant Country as Philippine in terms of vulnerability to climate change and asses what are the impacts.

The choice of Philippines as case study has been based on the fact that it is represents one of the top five countries that are most affected by the risks of climate change, specifically the weather patterns changes, between the years 1996-2015[9].

On the basis of the empirical evidence the paper put evidence on what is good in it and why it is important to pursue this practice in the conclusion.

2. FROM THEORY TO PRACTICE

Digital technology is indeed changing the traditional way in agriculture. Smart Farming, a significant component of CSA, requires the use of ICT, the Information Communication Technologies. The latter includes the IoT, the so-called Internet of Things which examine agricultural issues related to the conditions of the environment, soil, fertilization, and irrigation, through electronic monitoring of crops. The data obtained from this particular monitoring is later used to predict the specific variety of crop that could be better produced in any farm and in any place in the world. What Smart Farming does therefore, is to correlate the

precise crop varieties such as genes and phenotypes, with the crop data of its performance, fertilization, soil, or environment and the outcome of its data analysis [10].

There is no doubt that the adoption of IoT resulted in great potentials for agriculture but also significant benefits such as: data collection, increased production, reduced cost, greater efficiency and eventually environmental protection [1].

Five-hundred twenty-five million of farms were reported as being connected to IoT in the year 2000, according to a study conducted in 2016, and the number is expected to reach two billion farms by the year 2050[11]. Therefore, there is no doubt that smart farming and its applications are significant for the agriculture and its future.

Unfortunately, the implementation of the Smart Farming and in general CSA faces few challenges that prevent their proper functions. The two most important are the limited technical knowledge and skills of the farmers and the high cost of the equipment and products [12] [13]. Today the farmer is not just a simple person, who works with the land or animals, but he/she must also be an expert of data analysis, an economist and an accountant since farmers sell agricultural products, have market chains and know about market's price volatility. Not only that, but farmers must get used to the implementation of cutting-edge technologies. For this reason, Smart Farming requires knowledge and limits the room for errors because lack of the former can be dangerous and thus can lead to loses [14].

The second challenge is the high cost of equipment and products in Smart Farming (SF) especially for small-farm holders or domestic farmers. Machineries like the driverless tractors with sensors tend to have high prices and thus benefit economically just the large-farm holders. At the same time seed and fertilizers tend also to have high prices. Fertilizer costs are rising and represent between 30-50 percent of the cost of production for wheat and corn on most farms [15]. For this reason, thus, implementation of SF requires high initial investment, skilled and informed farmers and above all efficient farming instruments.

Worth mentioning is another challenge in the CSA, the law margin of the agricultural sector, especially in the case of small-farm holders or remote rural locations. For example, providing investments let's say in innovation, especially for vast territories or for a lot of livestock, could be quite difficult. But this doesn't mean that SF can't be done in small places, for instance vineyards. Besides that, there is problem of connectivity for those specific areas in the developing countries because there is less strong and reliable connectivity to the internet. Unless the network performances and bandwidth speeds are significantly improved, implementation of digital farming will remain problematic [14]. Reception of GPS signals is also important here because of the location.

One last challenge and maybe one of the most important is the SF system is security. Unfortunately, since IoT's connected devices grow at an incredible rate, security becomes a fundamental priority. There is a strong presence of data thefts and malware in the connected systems, therefore also in Smart Culture, and it is not easy to detect or removing them. And since system's tools are costly, farmers opt to go for the cheaper one that is lacking safety insurance.

That is why the government and local organizations are always looking for more secure methods to incorporate IoT technologies.

3. CASE STUDY

Philippines is one of the top five countries that are most affected by the risks of climate change, specifically the weather patterns changes, between the years 1996-2015[9].

Negative effects on weather are paramount because they tend to bring a domino effect on the land, the production, the prices, the income, and finally on the lives. As such, it would be interesting to analyze how the country is reacting to these changes in the climate, what strategies it adopted to face and to fight them, and what results it achieved so far. But before moving there, some quick facts about the Philippines are necessary to be mentioned.

First, its key economic sector is agriculture and it contributes to the country's GDP (Gross Domestic Product) with nearly 12 percent, while crops such as rice, coconut, and maize consists approximatively 76 percent of the harvested land [16]. Second agriculture is practiced by roughly five million farmers in the Philippines, the large majority of whom operate at the subsistence, small-scale level. Third, it is among the countries in which a considerable part of its population inhabits the areas prone to disaster, such as typhoons and flooding [17]. Forth, ¼ of its population lives below the national poverty line, with farmers and fishers being affected by poverty the most. Fifth, the total GHG emissions are considered to be 101 megatons of equivalent CO2, with ¼ of it being attributed to agriculture, mostly to rice cultivation.

Realizing the crucial situation on the country, the Filipino government had to take some kind of action against those facts. What it did then, was to reach out for a policy and an institutional framework based on climate change vulnerability and which targeted topics such as reduction of risk coming from disasters, the build-up of resilience, and most importantly the food security: the adoption of CSA and its three pillars (adaptation, mitigation, and productivity).

A study conducted in 2013[17] on the implementation of CSA mentions a variety of strategies used by the Filipino farmers to reduce the effects of climate change, some of which are the climate resilience rice, where farmers joined the process of selection of rice varieties so that they could adopt them faster in farming. The rain water harvesting is another strategy characterized by water irrigation during the dry seasons and the reduction of inundations through the creation of rainwater storage tanks. One more strategy was biotechnology, which provided farmers additional income from planting GM (Genetically Modified) corn, since it resulted in greater production in comparison to the traditional ways of production.

Generally speaking the Philippines moved further in term of its strategies and adopted ICT innovations in order to have further results. Four examples of ICT innovation that allows the development of agricultural chains and ease the life of farmers have been mentioned from FAO. They are the Pinoy Farmer's Internet, the Nutrient Management for rice Mobile or shortly MNRiceMobile, the Philippines Aquarium Fish Project, and lastly the i-ExEL which is the Interactive system for agricultural exchange and electronic learning.
Part of the Open Academy for Philippine Agriculture, the Pinoy Farmer's Internet is an idea that was put into practice in 2003 as an extension support system which provides help for the farmers by offering online courses and SMS messaging on several crops and weather. It is an internet, SMS and MMS based innovation.

The second innovation, the MNRiceMobile began in 2010 aiming at advising farmers on how to maximize the profits and productivity through advices they receive on their mobile phones. More specific, the farmer has the chance to use a toll-free number he/she can call and is required to enter a site-specific data on the keypad.

The third innovation concerns the fishers in the Philippines, who used to capture plenty amounts of fish and eventually throwing away the unwanted one. As a result, many fishes were left to die, thus the waste was significant. Philippines Aquarium Fish Project is using the help of PDAs (personal digital assistant) to train and certify fishers in abandoning the

traditionally methods of fishing and adopting the new ones that are environmentally and ethically safe. What is interesting about this service is that it takes into account illiterate farmers and eases their position.

Last on the list is i-ExEL, the Interactive System for Agricultural Exchange and Electronic Learning, saw its beginning in 2007, as part of the Agricultural Training Institute (ATI), through the use of internet and local e-learning offices where online courses where delivered. This service was created to help so farmers as fishers to improve their expansion through assistance.

The same study mentioned before underlines the variety of strategies the Filipino farmers are opting for the least costly practices when it comes to agriculture. Those that cultivate vegetables for example are mostly using the adaptive crop calendars that allow them to schedule harvesting and planting based on the weather forecast, or the stress-tolerant varieties mentioned in the above paragraph. In terms of smartness level, from a scale of 0-10, these two practices are between 4 and 5, while the organic farming that has a higher level (over 6), is less practiced because farmers need technical support for its implementation.

The above examples have demonstrated that Agriculture technology exists in the country, but farmers must be better educated on how to use it and be informed of the benefits [18].

This means that CSA practices in the Philippines are not only low, but also limited by various factors such as poor availability of improved seed, limited resources to extend services, but above all limited financial resources because the majority of the farmers and especially small-farmers do not have enough money.

Indeed, there are indications that CSA practices were adopted in the aquaculture systems, the livestock systems, the vegetable production system, integrated farming system, or the maize and rice cultivation system. The government and the private sector worked together to achieve significant improvements in addressing the climate change impacts and vulnerability through an institutional framework and mainly policies that target the food security, the flexibility creation, and the reduction of risks on one side. On the other side, the policies applied were less effective for the small-scale farmers. Proof for this is the least costly practices that are opted by farmers, who on one hand have benefits, but on the other hand these benefits are not high as would be from more advanced ICT practices. This leads us to the conclusion that there is need for further practices that could be practiced by all farmers all-over the country.

4. CONCLUSIONS

After having done some research on the topic of CSA, what came out as mostly the understanding of how to approach the issue of global change linkages to agriculture.

The case study of Philippines has demonstrated that the farmers, because of the limited capital available, lean towards the cheaper options that don’t always bring the expected outcome in comparison the pricier technologies.

Concerning the general assessment of CSA, it does not presume to have the sufficient tools to know, nor dare us to give a judgment on its being a good or a bad approach to the problems it is facing.

When CSA was mentioned for the first time, it was raised as an alternative framework that could prevent the planet Earth from reaching the Malthusian crisis at the end of the path it was and is walking on. Only one thing differs from the period in which Malthus was expressing his own similar worries; the impact of climate change. According to many studies of the last decade, indeed, the pressure of population growth is very much doubled by the climatic effect on the natural resources; so much so, that if we keep living, producing and wasting the way we are now, it will be difficult for us to sustain an estimated population of 9 Billion of people

in 2050. In this context, it's quite clear that, at the time, the reference to CSA was nothing more than a theoretical attempt to set out a series of principles. These guidelines were supposed to be used then as a starting point from which to develop better policies on a global level. Policies, that could aim to be win-win in terms of increased and improved food production in a global scale, as well as in mitigating and adapting to climate change risks. It is in this sense, that the definition of smart-agriculture can be clearly understood.

The problem with this more-that-valuable and worthy ideals is the practice. It is true that we are planning a lot of implementation and it is as well true that we are striving to increase productivity, improve resilience capability and reduce emissions. The best and honest answer we came up with is: not always. We are trying; but trying does not mean succeeding. Even more so, when it comes to such a broad context of application and such detailed requirements of implementation. Without throughout control and checks along with attempts and failures on the path, it is really hard to complete this quest we are pursuing. Of course, this doesn't mean we can give up this easily. The theoretical framework is there, the practices are being applied worldwide and they are giving result. Sometimes they are good, sometimes they are bad; nevertheless they are helping FAO, World Bank and other research institutes to gather information and more accurate and concrete guidelines, cutting out the practices that have failed and improve those that might have potential better outcomes.

Furthermore, Countries have their own framework of application of these practices. The majority of national governments and institutions are funding and helping these developments and even where there are no regional uniform guidelines to follow this does not prevent local population and government to use CSA practices.

At this point, eventually, some of our doubts and question about the CSA framework got answered by themselves. Some of the practice attempted is not sustainable; others are giving good results; and some others can be improved. For now, however, more adequate or better solution to fight back climate change and its effects do not exist. Therefore, if our choice is between going on with practices that have been recognized as harmful for the Earth's future and adopting new practices that are better (even if not enough and not always) for the survival of the planet, then, there is no other question to ask about what we should do. The question that it should start asking now is different. Of course, it is not supposed to put aside doubts on the efficiency of CSA. Instead, keeping them in mind, it should focus on how to improve what we are already improving.

Adaptation is something that has always been part of the development of human kind and its surrounding. The only difference today is in its application. Nowadays' farmers are not doing something they never did before, but it is true that they are doing it in a global network that never existed before. Shared information, worldwide guidelines and resources; newer tools and practices to adapt to the changing conditions; all of this is building up to a potential success for the whole planet when adaptation is not merely an individual concern, but a universal common one.

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