Agriculture 4.0 and its contribution to the 2030 Agenda for Sustainable Development

***Abstract* – Farmers are under pressure to increase productivity as global demand for agricultural products increases with population. This report focuses on the high-tech revolution that promises to help meet this demand, the challenges it presents to farmers, and how it can help eradicate world hunger.**

1. Introduction

The global population is expected to grow to 8.6 billion by 2030 and almost 10 billion by 2050 compared to an estimated 7.7 billion in 2019 as reported in [1]. By 2050, a net addition of 2.4 billion people will be moving to cities and towns, resulting in increasing demand for processed and animal-source foods: raising livestock accounts for 18% of human-caused greenhouse gas emissions.

Giving the elevated increase in population and demographics, arable and productive land is decreasing due to land degradation – 25% of all farmland is rated as highly degraded [2] - caused by deforestation, overgrazing, chemical-heavy farming methods and with climate change affecting every aspect of food security [3], i.e. production, supply, quality, access and utilisation. Change is needed as only sixty years of farming is left if soil degradation continues at this rate as described by a senior UN official [4].

In recent years, advancements in digital technologies have led to an innovation-based revolution known as Agriculture 4.0, which aims to provide solutions for the aforementioned societal challenges with promises of increased yield, quality products and environmental protection [5]. In this report, the author set out to provide a general overview of Agriculture 4.0, the challenges to overcome with a focus in sub-Saharan Africa, and an attempt will be made to provide a brief summary of how this can help achieve the UN's sustainable development goals.

2. Agriculture 4.0

The "fourth agricultural revolution" or Agriculture 4.0 [6], [7] is the incorporation of cross-industry and emerging technologies and applications: Big Data, Internet of Things, Artificial Intelligence, precision agriculture, genetic modification etc. interacting in unison with farming operations to sustainably increase productivity and yields, whilst providing consumers a history of how their food was produced. It will also enable farms to adapt autonomously and in real-time to changes.

These technologies are currently in use to increase the precision of fertilizer and pesticide application [8]. Microsoft's Cortana Intelligence Suite is currently in global use [9] to determine optimal conditions and dates for crops cultivation and production, see Figure 1. Drones are identifying weeds [10] and robots are helping farmers to remove them, and milk their cattle [11].

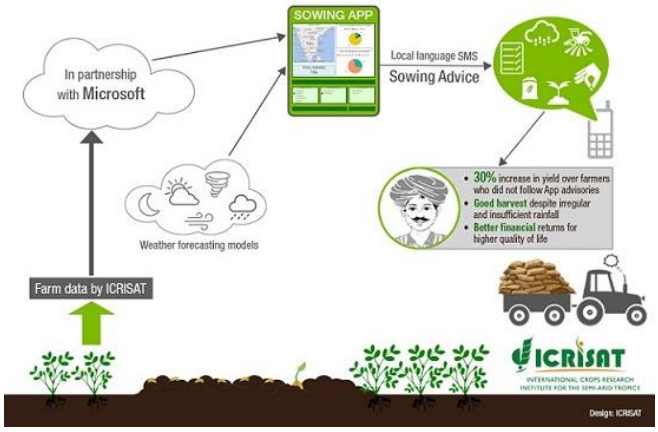

Figure 1: Microsoft's Cortana Intelligence Suite using weather models and data on local crop yield and rainfall to help farmers increase yields through the AI-sowing App [12].

Figure 2: Low-cost UAV used for field monitoring (left) as well as an analysed image (right) [10].

However, deploying these technologies present challenges for farmers and investors in developing countries, especially in sub-Saharan Africa – with 60% of the world's uncultivated arable land – where most farmers lack the basic infrastructure for this revolution.

Challenges

Deploying Agriculture 4.0 highly depends on the equipment used, the infrastructure and workforce [13]. These are major constraints in sub-Saharan Africa where there are wide gaps in rural connectivity and access to mobile phones vary considerably between countries as shown by Nakasone and Torero [14]. Internet access is scarce, with an overall average close to 25% of the urban population with access, while only 10% for rural [15]. These deficiencies in the telecommunications infrastructure in rural areas make the wide adaptation of new technologies difficult.

Even if farmers have reliable access to the internet, mobile phones and applications that provide access to buyers (such as Digifarm [16] in Kenya), and sensors that show production, it's pointless if their products cannot reach the market due to heavy rains that render the roads

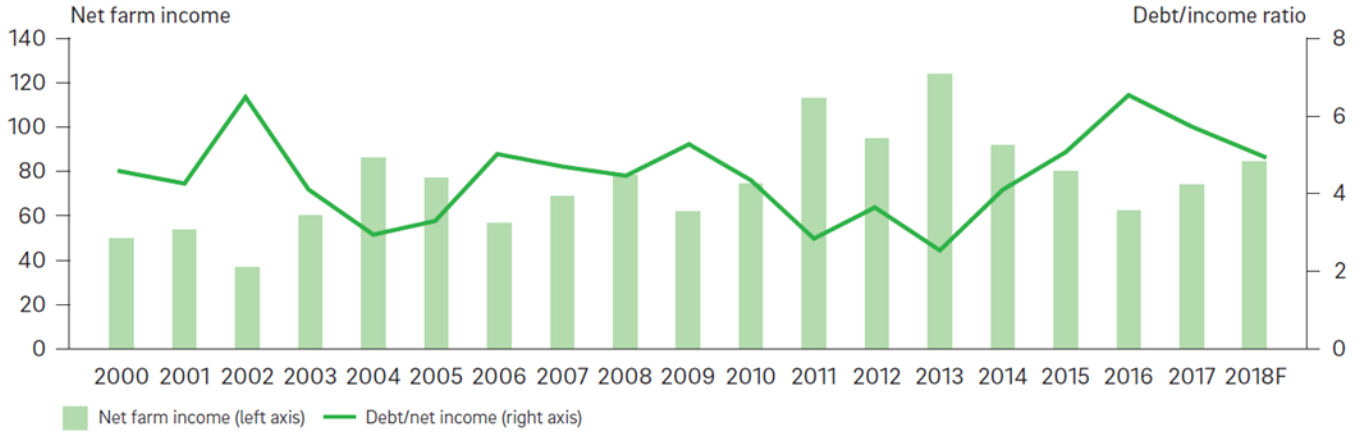

Figure 3: United States net farm income [USD bn] and debt/net income ratio [2].

inaccessible. Unfortunately, this is the case for the majority of smallholder farmers whose output value chains provides 80% of Africa's food consumption [17]. These farmers lack the basic infrastructure – reliable roads, electricity and water supply- to make the most of this agricultural technology or "agtech".

Global farmers face connectivity challenges with agricultural equipment - mobile and stationary machinery used for indoor and outdoor operations. An estimated 60 to 70% of all agricultural machinery used in Germany are still analogue due to their longevity and high purchasing costs- tractors have an average age of 27.5 years and purchasing costs of 50,000 to 150,000 euros [13] - making it difficult for farmers to replace these long-term investments with new digital technologies. In addition, the time and money needed to train staff in new technology presents very difficult challenges. Combine these with the uncertainty over farm data protection creates the general uncertainty and distrusts that is holding back the development of agtech.

With farmers being fully aware of these challenges, they are getting older and under increasing financial pressure due to falling crop prices and income, with increased debts as shown in Figure 3. In addition, the uncertainty with adverse climate conditions and lack of workforce due to a shrinking rural population makes it especially difficult to convince farmers to invest in unproven technologies.

The outcome of all these challenges has contributed to global poverty and hunger, with

"700 million people extremely poor, 800 million in chronic hunger, and 2 billion suffering from micronutrient deficiencies"

as reported by the UN in [18]. This global crisis formed the focus of the 2030 Agenda for sustainable development, which aims to eradicate world hunger and poverty, protect the planet from degradation by taking urgent action on climate change.

3. Discussions and Conclusion

Governments can take a crucial role in fostering agtech by not only providing policies that will reduce transaction costs and investment risks, but also offer financial incentives, flexible regulations, commerce support and creating partnerships for access to new markets. They should also provide affordable rural-urban infrastructure (i.e. wholesale markets, roads, electrification etc.), which in turn leads to more traders, truckers and warehouses to form longer supply chains.

On the data protection frontend, service providers and tech companies are responsible for removing all grey areas to ensure the trust of farmers in the long run. Training courses need to be adjusted to focus on communicating practical knowledge and hands-on experiences with the technology. Wide collaboration between companies, smallholder farmers, training establishments and public sector must be prioritised to make the most of Agriculture 4.0.

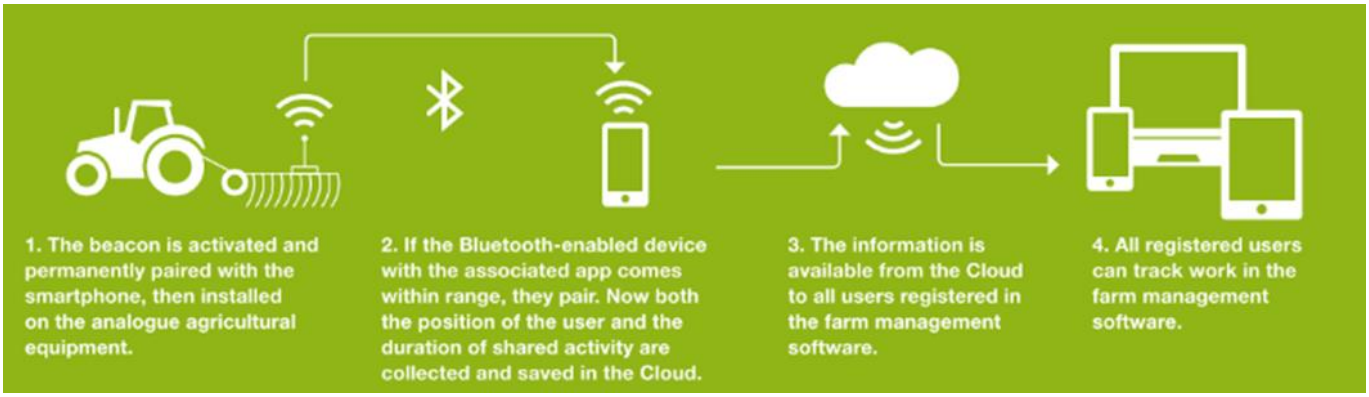

Figure 4: A practical application of a Bluetooth "beacon" in use on 365ActiveBox from 365FarmNet for the monitoring, recording of positions and movements on an autonomous or assisted driving tractor [13].

The partial digitisation of current analogue machinery and equipment is an important step towards realising Agriculture 4.0. For example, integrating simple technologies such as Bluetooth, GPS or RFID with analogue equipment can form part of the digital landscape as shown in Figure 4. AI and robotics could compensate for lost labour due to migration from rural to urban areas [19].

To conclude, the report has shown that whilst some form of Agriculture 4.0 is already in use in parts of the world, there is still much work to be done in combating the infrastructural and policy challenges that are holding back the world from achieving the true potential of this revolution. With significant investments, extensive user-centric and systematic research, and collaboration from all parties involved, we can grasp this opportunity and vigorously address the challenges to bring us a step closer in eradicating world hunger.

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