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Chapter 6
Prospects for Agriculture 4.0 in Developing Countries: Case Studies from Vietnam

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Abstract

This paper provides an overview of the situation and prospects of Agriculture 4.0 in Developing countries, especially in Vietnam. The following section describes the attitude of the Vietnamese Government toward the 4th Industrial Revolution, its strategy and policies, and actions from other civil organizations. The third section discusses some case studies featuring different stake holders participating in the provision and application of technologies 4.0 in agriculture in Vietnam. Through direct interviews with them, the sections highlight their achievement, challenges and their expectations from policy makers. The final section concludes with some policy implications for Vietnam to better facilitate the new waves of technologies in agriculture in the coming years.

Keywords: Technologies 4.0, agriculture, developing countries, Viet Nam

1. Introduction

There is a growing census that the world has entered the "Fourth Industrial Revolution", with breakthrough technologies that are going to bring about abrupt and radical changes to many aspects of life. In short, this revolution could be called Industry 4.0, which builds on the digital technology of the pervious revolution. Prominent technologies for Industry 4.0 (which can be referred as Technology 4.0) include artificial intelligence (AI), machine learning, remote sensors, the Internet of Things (IoT), blockchain, robots and new forms of automation, and 3D printing. In addition, the revolution is driven by breakthroughs in

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the physical realm (with the invention of new materials) and the biological realm (which can be seen in the genetics and bio-engineering fields).These technologies are believed to dramatically increase efficiency in production and resource utilization, and to enable new ways of communication, organization, and governance (WEF&ADB, 2017).

Technology 4.0 might be the solution to several challenges that the global agriculture sector is facing (Matthew et al. 2018). There are two key challenges for this sector, including (i) More adverse conditions for production (contracting arable land area due to urbanization and industrialization; shrinking labor supply as a result of structural change and population aging, and climate change); (ii) Higher demand for agricultural products, in volume, quality, and diversity due to higher income levels and population growth. Many technologies in Industry 4.0 provide measures to cope with these challenges. New forms of robotics and automation are replacing a large number of workers on farms. Remote sensors are providing a large stock of data about humidity, temperature and wind direction that are crucial regarding the decisions on the timing of planting, harvesting, watering, and fertilization. In this way, the productivity of agricultural production is increasing significantly. Development of genetic engineering is introducing new breeds with higher yields that are resistant to adverse conditions and contain more nutrition.

Further, the technologies in the 4th Industrial Revolution are changing many other aspects of agricultural production and business methods. Smart phones and the Internet enable farmers to access market information and extend their knowledge more easily. They also facilitate the realization of the "sharing economy", in which farmers share agricultural machinery which they cannot afford alone. Blockchain technology offers customers the power to trace the origin of agricultural products; therefore, they can select those offering higher standards of quality and food safety. These are only a few among the various benefits of the 4th Industrial Revolution's technologies in the agriculture sector.

Across the world, the majority of countries are proactive in promoting the application of modern technology in agriculture, especially the technologies of the 4th Industrial Revolution. In the developed countries, the concept of "precision agriculture" or "smart farming" is more popular even before the embarkation of "Agriculture 4.0". The first official definition of "precision agriculture" (PA) came from the US House of Representatives in 1997, which explained PA as "an integrated information and production-based farming system that is designed to increase the long-term, site-specific, and whole-farm production efficiency, productivity and profitability, while minimizing

any unintended impact on wildlife and the environment". In the simplest description, it can be understood as the way to "apply the right treatment in the right place at the right time" (Gebbers and Adamchuk, 2010)[3]. According to statistics, around 70-80% of new farm equipment sold in the market has some content of PA (EU, 2014). In the period 2018-2020, the EU committed to spend around EUR 100 million to promote the application of digital technology in agriculture. This budget will be spent on training programs for farmers to use new technology, develop data analysis tools, invest in digital infrastructure, establish an innovation ecosystem, and the construction digital and data platforms for agriculture[4]. In Asia, the Republic of South Korea started to follow strategy of "Agriculture's smartization" in 2013, in order to disseminate the use of ICT technology and the model of smart farming across the country[5]. In Taiwan, the "Productivity 4.0 Initiative" for the period 2016-2024 was approved in 2015, in which one important component is the "Agricultural Productivity 4.0" program. This program focuses on two main orientations: (i) Smart production, and (ii) Digital services[6]. In Thailand, "Agriculture 4.0" is one among three pillars of the "Thailand 4.0" initiative (PRD, 2017).

In Vietnam, the agricultural sector still accounts for an important share of the economy (contributing around 14% of total GDP and nearly 38% of total employment in 2018)[7]. Productivity by this sector equals 40% of the average level of the whole economy[8], and far below the level in many other ASEAN countries. Given the facts that many other countries, both developed and developing countries, are fostering the application of technology 4.0 in agriculture, Vietnam should not stand out from this trend in order to prevent the country from falling further behind.

2. Vietnam's Initial Action Towards Agriculture 4.0

The Vietnamese Government has long promoted the application of modern technology in agriculture, in order to improve the sector's productivity. Supporting policies cover

[3] http://www.europarl.europa.eu/RegData/etudes/note/join/2014/529049/IPOL-AGRI_NT(2014)529049_EN.pdf.
[4] https://ec.europa.eu/info/news/european-union-funds-digital-research-and-innovation-agriculture-tackle-societal-challenges_en.
[5] http://ap.fftc.agnet.org/ap_db.php?id=787.
[6] https://eng.coa.gov.tw/ws.php?id=2505350.
[7] Data taken from the General Statistics Offices of Vietnam (www.gso.gov.vn).
[8] Calculated from the General Statistics Offices of Vietnam (www.gso.gov.vn).

almost all aspects of agricultural production and distribution, including tax reduction and exemption, preferential credit, trade promotion, and training programs for farmers (a more detailed description of such policies can be viewed in (Hoang and Do, 2019)). In 2012, the Prime Minister approved the scheme for development of high-tech agriculture through 2020 in Decision No. 1895/QD-TTg. Later, in 2015, another decision was issued to approve the master plan on high-tech agricultural parks and zones through 2020, with the vision toward 2030 (Decision No. 575/QD-TTg). There were around 35 high-tech agricultural zones established across Vietnam by the middle of 2018. However, until recent times, there has been lack of specific policies aimed at promoting the application of technology 4.0 in agriculture. So far, the approach of Vietnam has been quite general in scope and not specifically targeting the application of modern techniques, especially ICT, in agriculture.

Being aware of the potential huge benefits of technology 4.0, the Government of Vietnam has proactively sought measures to reap the opportunities brought about by the 4th Industrial Revolution. In 2017, the Prime Minister issued Directive No. 16/CT-TTg on improving capacity to access the 4th Industrial Revolution. The directive requested line ministries to propose measures to promote the adoption of technology 4.0 in Vietnam, and to deal with any possible negative effects of this revolution. By the end of 2019, the Politburo of Vietnam promulgated Resolution No. 52-NQ/TW on 27/9/2019, on a number of guidelines and policies to actively take part in the 4th Industrial Revolution. As stated in the resolution, by 2025, Vietnam aims to maintain its position within the top three ASEAN countries in the Global Innovation Index (GII) rankings; the digital economy will account for about 20% of GDP, with labor productivity increasing on average by over 7% per year. The vision by 2030, is that Vietnam will be among top 40 countries in the GII index[9].

In August 2019, the Prime Minister signed Decision No. 999/QD-TTg to approve the project to promote the sharing economy in Vietnam. According to this project, many regulations and policies will be adjusted to create more favorable environment for new forms of the "sharing economy". In addition, the decision ensures that traditional and new forms of business establishments will be treated equally.

A more specific step is marked with establishment of the National Innovation

[9] http://tulieuvankien.dangcongsan.vn/he-thong-van-ban/van-ban-cua-dang/nghi-quyet-so-52-nqtw-ngay-2792019-cua-bo-chinh-tri-ve-mot-so-chu-truong-chinh-sach-chu-dong-tham-gia-cuoc-cach-mang-cong-5715

Center (NIC) by late 2019, to nurture high-tech and innovative enterprises[10]. This center will be built on an area of 23 hectares in Hoa Lac Hi-Tech Park, with a total investment of VND 1.9 trillion (USD 82.6 million) and could be operating by 2020. NIC targets to attract 40 large technological companies, 150 startups and SMEs, and 15 venture investment funds. The initial priorities of INC include network security, digital content, smart manufacturing, and smart city technologies.

Agricultural firms are not indifferent to this new wave of technology. In September 2019, the Vietnam Digital Agriculture Association (VIDA) was launched, with the participation of many prestigious companies and entrepreneurs in technology and agriculture. This association aims at connecting all interested stakeholders together in order to identify tailored digital solutions for each cultivation model, attract investors, and implement labor training programs.

3. Case Studies that Apply Technology 4.0 in Agriculture

At this stage, the agriculture of Vietnam is still dominated by individual households with small scale production and low skill techniques. However, there is a growing trend of private investment in agriculture, which apply modern techniques, from both foreign and domestic investors. More interesting, there are companies now specializing in technical solutions for agriculture. Our research team has the chance to discuss with both technology providers and adopters in agriculture. Their stories unveil a promising future for the application of Technology 4.0 in a developing country like Vietnam.

3.1 Providers of Technology 4.0 for Agriculture

3.1.1 Nextfarm Company

Nextfarm is a young company focusing on providing high-tech and digital solutions for agricultural production. This company has 100% capital from Vietnamese private stakeholders. Although established for less than five years, the company has achieved many national prizes and recognition for their contribution to high-tech agriculture in Vietnam.

Nextfarm provides three main categories, including: (1) Nextfarm Digital Diary

[10] Decision no. 1269/QD-TTg on 02/10/2019 by the Prime Minister.

integrated with traceability solutions (Nextfarm QR check); Nextfarm Data Platform to collect and analyze big data in agriculture; (2) Technical devices for smart farms; and (3) Technical devices for smart cities. With the Data Platform, Nextfarm aims to analyze big data in agriculture, using the technology of machine learning and AI, and in collaboration with agricultural specialists, to provide consultation for farmers on farming practices and market changes. For farming, the company promotes and develops the automatic nutrient dispensing system Nextfarm Fertikit 4G. With this system, farmers can control the nutrition dosing at the optimal level that takes into account the external environment (temperature, light intensity), type of crops, and soil quality. Its remote-control system can be operated on multiple platforms: Mobile (Adnroid & iOS), Web, Desktop, and HMI[11]. There are different systems designed for in-house or open farms larger or smaller than 1ha. This system resembles many features of similar technology from Israel and the Netherlands. However, the price offered by Nextfarm is 30%-50% lower than their prices. For this reason, many domestic customers are choosing Nextfarm technology instead of the imported product. Another device for precision farming is a remote sensor, which collects data on humidity, wind power, light intensity, and transfer the information to the control system.

According to the representative of Nextfarm, the company has contracts with over 100 customers so far. Annual growth rate in revenue by Nextfarm reached 100% quarterly in 2019. By 2020, the company has set the target of reaching 400 farms using its products. The company is fully financed by the group of founders, who are young technical entrepreneurs. Some venture funds from foreign countries have expressed interest in investing in the company that the founders are considering. The reason is that they do not want to lose control over the direction of the company. In the first few years, the company focused on improving the quality of products, before spending more on marketing their products. To our surprise, the company is targeting farms of medium and small size, as these farmers actually dominate the agricultural sector.

So far, Nextfarm has not accessed to any government support programs. They state that the conditions and procedures to access these programs are quite complicated and not attractive. Complementing on the many policies encouraging technical start-up businesses in Vietnam in recent time, the founder of Nextfarm thinks that these are quite superficial. The company expects the government to establish a venture fund, accept a failure rate of up to 90%, but a 10% success rate will create a huge positive impact in

[11] https://www.nextfarm.vn/he-thong-cham-phan-dinh-duong-nextfarm

terms of technology and its value to agriculture.

3.1.2 AgriConnect Digital Agriculture Ltd.

AgriConnect Digital Agriculture Co., Ltd. is a company providing digital solutions for farming in Vietnam. The company has collaborated with the John von Neumann Institute, National University, Ho Chi Minh City and the Institute of Biotechnology & Environment, Ho Chi Minh City University of Agriculture and Forestry to build an IoT platform for the Vietnamese agricultural sector. AgriConnect Digital Agriculture Company has successfully manufactured hardware (electronics, sensors) to collect data in various fields. Currently, AgriConnect's sensors focus on air humidity, temperature, soil moisture, light, CO2, and EC (electro-conductivity) of water (hydroponic solution).

Software is considered as the core value of the project, the software is designed through collaboration between agricultural experts and IT engineers and can function both horizontally and vertically in various fields including, data collection, analysis, and security. In the first stage, setting up an agricultural process using the "digitization" method is impossible because the digital data of Vietnamese agriculture is still very limited. Currently, agricultural production depends heavily on the experience of the farmers, so it is very difficult to set up an automated process using a "digitized" method. Therefore, AgriConnect has created software that combines both manual and automatic operations. Also, the software includes various crop management features, creating the basis for the development of dairy farming applications, traceability of products (barcode), and data analysis for supply and demand.

Application of IoT in agriculture: At present, AgriConnect's automation technology applications focus on developing automatic mushroom growers. The mushroom growers' parameters are set for the whole season from the time of planting the mushroom embryos into the growers until harvesting.

Automated hydroponic vegetable growers: With the hydroponic vegetable growth model, the company aims at providing a comprehensive automated control solution for vegetables, including a cooling system, automatic nutrient supply solution, nutrient pumps, and a seedling system. The system operates fully automatically according to the schedule already installed.

Building the loT (Internet of Things) platform for agriculture has initially achieved very positive results, creating a foundation for digitization in agriculture and collecting big data in agriculture. To apply IoT solutions effectively to agricultural production will take much more effort and be time consuming due to the low fundamental

development of the agricultural sector in Vietnam. However, establishing the loT of platform for agriculture will help Vietnam's agriculture sector to be less dependent on foreign technology and develop more sustainably in the future.

3. 2 Farms Applying Technology 4.0

3.2.1 OFP Company

OFP Company was established on 12/03/2015 in Lien Chau Commune, Yen Lac District, Vinh Phuc Province, with an area of 4 hectares. The main products of OFP are spinach, broccoli, Chinese cabbage, gourd, zucchini, and melon. The company operates according to the VietGap standard with 12 employees (10 regular employees and 2 temporary employees). Currently, the farm is applying automatic irrigation and QR code labels on each product (traceability). However, the application of ICT in the cultivation process is still limited. Soon, OFP intends to use chips to measuring humidity, the temperature at the irrigation points, and the standard procedure evaluation system (pH level of soil, water, organic fertilizer etc.).

OFP is cooperating with the Vinacert Certification and Inspection Joint Stock Company to deploy specific software to assess and monitor the cultivation process. OFP will participate in Hanoi's network of traceability for agriculture, forestry, and food and foodstuffs in order to meet the standards of special customers in the Hanoi market area. Ownership of the data collected by the farm will be contracted to a software service provider with the right to access the data belonging solely to OFP. The ICT application supplier is not allowed to use or disclose OFP's data under the terms of the contract.

OFP's major market is in Hanoi, in the form of contracts with Big C, Aeon, MegaMarket, Coop Mart, some elementary schools, Vietnam Agricultural Products Import Export Joint Stock Company, and the Green Star Joint Stock Company.

From the early stage until now, the company has faced many difficulties selling the products because the consumers do not have adequate information and knowledge to compare normal products and OFP's qualified vegetables, except by the packaging. The price of products that apply ICT or partial automation is often more expensive than the same types sold in street markets. Therefore, raising awareness for individuals about food safety and traceability plays a key role to develop Agriculture 4.0 in Vietnam. Besides that, the company also faces difficulties in sourcing capital for the operation and recruiting enough high-skill workers from the local community.

In the next stage, OFP is aiming to use domestic ICT services that have lower

operating and maintenance costs. In addition, it is much more convenient to get advice or maintenance service from such local suppliers.

3.2.2 Phung Gia Mushroom Company

The scale of the factory is 2,000 m2 in Tam Hop Commune, Binh Xuyen District, Vinh Phuc Province with a total investment of VND 20 billion. The company applies Korea's mushroom production technology to produce high quality mushrooms for the market in Vinh Phuc and the neighboring provinces and cities. Its current capacity is 150 tons/year, and this is expected to reach 600 tons/year by 2020. The company started operating in February 2017 and introduced its chicken drumstick mushroom to the market in December 2017.

The Director of Phung Gia Mushroom Company formerly worked as staff in a big mushroom farm in Korea for 7 years. During that time, he has learnt mushroom cultivation techniques, especially chicken drumstick mushrooms. After finishing his labor contract with the Korean company, he returned home and invested money in building up his mushroom farm because at that time there was no high-tech company of a small to medium-size involved in mushroom growing production. Therefore, he could see a promising opportunity in terms of growing mushrooms, because high-quality mushrooms are always in huge demand by the market, especially in Hanoi. In addition, the preeminent characteristics of Korean mushroom production technology allow proactive quality control from seedling to packaging. The mushroom production cycle is double sealed and automated through a quality assurance system.

After more than a year in operation, the company's products have been well received by consumers. One of the main obstacles for the company is the high production cost. The technique to produce mushrooms requires a controlled low temperature, but the cost of the building and cooling the production base is very expensive. Therefore, the mushrooms sell at relatively high prices. The company hopes to access the preferential credit terms offered by the government, but so far it has not been successful. In addition, they also expect to receive some professional advice on management and marketing their products.

3.2.3 Delco Company

Delco Investment and Construction Joint Stock Company (Delco Company) is one of the most experienced construction contractors with FDI investors. Established in 2007, Delco is well known as a pioneer in high-tech agriculture in Vietnam. The Delco Farm project

commenced in December 2017 and has been in mass production since mid-2018. Currently, Delco Farm covers an area of about 6 hectares located in Thuan Thanh District (Bac Ninh). At the same time, it is considered to be one of the smartest farm models in the north, with 100% information technology application on vegetable production and other clean agricultural products (eggs).

At Delco Farm, 100% of the design, construction, installation, monitoring software, automatic control and the Internet connection (IoT) were all developed by Delco's engineers and its partners. As a result, Delco's ICT solutions (both hardware and software) are installed with very reasonable costs in comparison with the same imported technology. Currently, Delco Farm has two chicken houses for egg laying housing over 40,000 chickens, 1 hydroponic vegetable house, with an area over 1,000 m2, and 4 Kimoji melon gardens, each garden has an area of over 1,700 m2. Recently, the products launched to the market have received positive responses from partners and customers in terms of quality and price. Thanks to that, Delco Farm's 2018 revenue is over VND 30 billion. The advantage of Delco is that, thanks to its network of customer in the construction business, the company can easily find customers to distribute their products on contract.

Delco's main goal is to develop and provide ICT application models for agricultural production. Delco's farm in Bac Ninh was built to test the IoT technology developed by Delco's engineering team and its partners. Since the technology has been successfully applied, it will be promoted and marketed through two ways: direct transfer to companies and organizations wishing to develop Technology 4.0 agricultural methods, or collaborating with neighboring households and cooperatives who want to apply ICT technology on their farms, and Delco will collect and sell all the products from these farms. Delco's success is due to its large capital (the head company is a general contractor specializing in the construction), so Delco's agricultural project does not have the same financial constraints as similar projects.

Delco's current flagship products are hydroponic vegetables and chicken eggs, which are only available at Delco's stores or sold online through the company's website. To achieve Delco's success, it is necessary to have a good foundation in terms of capital, human resources, and at least partly master the technology. In addition, combining development and transferring technology is a comparative advantage for Delco. When establishing the investment project in Bac Ninh, the company received much support from the local government. In the company's evaluation, access to a large area of land for production is not a problem. However, during the Delco development process, it also encountered difficulties because consumers did not have a clear basic knowledge to

distinguish between ordinary products and of smart technology products (QR codes are not popular in Vietnam). The living standard is relatively low, so people are not ready to pay higher prices for good quality and environmentally friendly products.

3.3 Some remarks from Case Studies Analysis

This section describes the business models of five companies of technical solution providers to farms applying modern production techniques. Overall, the prospects for Agriculture 4.0 in Vietnam are quite promising, with a growing interest from the domestic sector to invest in agriculture.

Companies like Nextfarm and AgriConnect are actually very successful in adapting and developing the available technology from developed countries for use in Vietnam. With such adaptation and development, they are able to provide technical solutions at much lower prices, creating a considerable comparative advantage compared to providers from other countries. They also have advantages in lower labor costs, local knowledge, flexibility, and after-sales services. These companies are also good at collaborating with other technical partners (such as Viettel in the case of Nextfarm) and agricultural experts from specialized universities to complement their products and services. Most of their capital funds are provided by the founders. In general, they have no access to the many supporting programs, especially the VND 1,000 billion credit package designed to lend to high-tech agricultural enterprises. As emphasized in Sakata (2019), most of the government's support goes to large farming projects invested by large corporations, like the Vin Group, which require a huge amount of capital to fund building, machinery, and equipment. Almost all start-ups and technical solution providers have very little access to these programs. As stated by these companies, they are expecting the government to ease access to such credit programs, or to provide some venture funding for companies to implement their innovation ideas and solutions.

A number of farming projects are applying modern techniques, especially Technology 4.0 (precision and automation, QR code). Many of these farms are medium scale enterprises (less than 10 hectares). These projects require a large initial investment fund, and are most often run by investors who have some knowledge of agriculture and the relevant technology. This is one important factor explaining their success so far. In addition, these models are successful because they have good experience in farming contracts with their customers. Their regular customers are supermarkets, factories, hospitals, and schools. While selling in large volume creates advantages to lower prices

to the final customer, these companies need to apply more effort to standardize the quality of their products and build strong brands for recognition by a larger number of customers.

4. Prospects and Policy Implications for Vietnam

4.1 Prospects for Agriculture 4.0 in Vietnam

Uwe et al. (2016) argue that it is not easy for developing countries to promote Technology 4.0 in agriculture. Even if a growing share of the rural population with access to the Internet is high, the lack of access to information and lack of connection capability are only two among many obstacles that the farmers are facing. These include the fragmentation of many markets and the shortage of financially sustainable business models to attract private investors in providing technical solutions for small scale production. Currently, precision agriculture is mainly adopted on large scale farms with financially strong investors. In another aspect, even when the farmers are able to access to the Internet, there is still a lack of reliable market information providers. Therefore, they might not be able to benefit from the modern technology.

Many experts of Vietnam also highlight the obstacles to adopt Technology 4.0 in agriculture. Le Tat Khuong et al. (2014) list out some major difficulties, such as access to credit, small scale farms, slow progress in land consolidation, poor infrastructure, lack of market information, and lack of well-organize distribution channels. Do Kim Chung (2018) points out other challenges, such as application of Technology 4.0 in Vietnam is still limited, partly because the low overall technological level of the country, and inappropriate investment in research and development. Technology such as automation systems will lower the demand for labor, which poses a threat to a large percentage of low-skilled workers in the agricultural sector.

However, there are still good prospects for application of Technology 4.0 in Vietnam. This is evident by the increasing, although modest, number of firms providing digital and technical solutions for farming. Such start-up enterprises like Nextfarm or AgriConnect set quite high targets for their future. Nextfarm is even aiming at providing solutions for farmers of small and medium scale farms. From the demand side, there is a new wave of private investment in agriculture for medium and large-scale farms (Hoang and Do, 2019). Given the fact that, in many areas, farming alone does not provide enough income for the households, many are leaving agriculture to seek non-farm income sources

of income. To a certain extent, land transactions are more active, giving opportunities for agricultural projects on a larger scale and for a longer duration (Tarp, 2017).

Prospects for Technology 4.0 in Vietnam is further confirmed by the fact that more than 54% of the population has access to the Internet. The percentage of the population using broadband internet mobile phones (3G) had reached nearly 40% by 2017. In addition, almost all households (98%) have access to electricity (MIC, 2017). Another advantage is that the population of Viet Nam is relatively young, and thus they are more dynamic and ready to absorb new knowledge. In fact, the ICT industry of Vietnam is out-performing other sectors, and attracts thousands of students each year. Further, the rising middle-class and population growth are placing a greater demand than ever on agriculture products, both in volume and quality.

4.2 Some Policy Implications for Viet Nam

Many studies have shown that Agriculture 4.0 will be an irreversible trend in the coming decades. Developing countries like Vietnam should take it as an opportunity and solution to improve its agricultural sector's productivity and efficiency. Although the technological level of agriculture in Viet Nam is low, there appears to be a growing trend to apply modern techniques by this sector.

The current approach of Viet Nam to the new trend can be described as quite conventional. According to Matthieu et al. (2018), in this approach, the government acts like "the enabler of an ecosystem with targeted initiatives, creating a positive environment for the players to participate in". In order to boost investment in agriculture, the government provides a series of supports, from financial incentives, infrastructure upgrading, trade promotions, to training programs. However, investment in agriculture are still quite modest (the investment in agriculture is equivalent to around 2% of total investment in the economy (GSO, 2019).

Matthiew et al. (2018) suggest a more targeted, goal-oriented approach, which is also applicable for Vietnam. Accordingly, the government has set clear goals and seeks measures to achieve these goals. The funding should be based on problem-solving methods to attract the best partners. Instead of building a good environment and expecting investors to come, they should shift to a demand focus, i.e. make investors come first and then build with them. The recommendation by Nextfarm is a good measure. Besides making credit access easier for entrepreneurs, the government should fund more innovative ideas although the failure rate is high. In addition, the government should be

more active in promoting public-private partnership in agriculture in order to share the burden with the enterprises.

Given the fact that the cost to implement Agriculture 4.0 is too expensive for small-scale farmers, promoting land consolidation and farmers' cooperatives are necessary. Only when farmers are organized together can they share the cost of investment and achieve the benefit from economies of scales in production and commercialization.

There are also many other emerging issues from the evolution of Industry 4.0 that the government needs to pay more effort to in order to more effectively adjust the strategies and policies to avoid any potential negative side of this revolution. Issues like data privacy and cyber security are amongst the biggest challenges in the era of digitization.

References

Do Kim Chung, 2018, "Agriculture 4.0 and some policy implications (in Vietnamese)" viewed on 01/10/2019 at http://ktptnt.vnua.edu.vn/Portals/0/Documents/Tin%20tuc%20KTPTNT/2018/NN%204.0Bao%20NN%209%20Dec%20chinh%20thuc.pdf.

EU. 2014. "Precision agriculture: An opportunity for EU farmers – potential support with the CAP 2014-2020", viewed on 01/10/2019 at http://www.europarl.europa.eu/RegData/etudes/note/join/2014/529049/IPOL-.AGRI_NT. (2014) 529049_EN.pdf.

EU. 2018. "Farming 4.0: The future of agriculture", viewed on 01/10/2019 at https://euagenda.eu/upload/publications/untitled-62960-ea.pdf.

Gebbers, R. and V.I. Adamchuk. 2010. "Precision agriculture and food security", *Science*, vol. 327 (5967), DOI: 10.1126/science.1183899.

GSO (General Statistics Office). 2019. "Brief on the Socio-economic Conditions of Vietnam in 2019", viewed on 15/01/2010 from www.gso.gov.vn.

Hoang, X. D. and T. T. T. Do. 2019. "Investment in agriculture in recent times: The case of Vietnam", Chapter 5 in Sakata, S. (ed). *New trends and challenges for agriculture in the Mekong region: From food security to development of agri-business*, BRC Research Report, Bangkok Research Center, JETRO Bangkok/IDE-JETRO.

Le Tat Khuong, Tran Anh Tuan and Ta Quang Truong. 2014. "Study to Propose Some

Recommendations on Policies to Encourage High-tech Agriculture towards Commercialization in Vietnam" (in Vietnamese), JSTPM, vol. 3 (no. 3).

Matthieu, D. E, Anshu, V. and B. Alvaro. 2018. "Agriculture 4.0: The future of farming technology", viewed on 01/10/2019 at https://www.worldgovernmentsummit.org/api/publications/document?id=95df8ac4-e97c-6578-b2f8-ff0000a7ddb6.

MIC (Ministry of Information and Communications). 2017. *Vietnam information and communication technology*, White paper 2017.

PRD (The Government Public Relation of Thailand) 2017. "Intelligent SMES and smart agriculture in response to Thailand 4.0 policy", viewed on 01/10/2019 at https://thailand.prd.go.th/main.php?filename=index.

Sakata, S. 2019. "The application of information and communication technologies in agriculture: Present status, opportunities and challenges in Vietnam", Chapter 6 in Sakata, S. (ed). *New trends and challenges for agriculture in the Mekong region: From food security to development of agri-business*, BRC Research Report, Bangkok Research Center, JETRO Bangkok/IDE-JETRO.

Tarp, F. ed. 2017. *Growth, Structural Transformation, and Rural Change in Vietnam*, Oxford University Press.

Uwe, D., G. Aparajita, and M. Deepa. 2016. "Will digital technologies transform agriculture in developing countries", *Agricultural Economics*, vol. 47.

WEF and ADB. 2017. "ASEAN 4.0: *What Does the Industrial Revolution Means for Regional Economic Integration*, white paper, viewed on 01/10/2019 at <https://www.adb.org/sites/default/files/publication/379401/asean-fourth-industrial-revolution-rci.pdf>.