Agri-Tech and Agribusiness Integration to Support Agricultural Ecosystem in Indonesia

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ABSTRACT
Indonesia's farmers face many challenges, from low productivity, pest attack, uncertainly commodities price, unscrupulous off-takers to difficulties in getting loans. One of the biggest challenges right now, however, is climate change. Speaking of weather conditions, level of weather predictions covers too wide area (per district or subdistrict). Meanwhile, micro-climate in village or land area is specific, sometimes every 2 or 3 km has different rainfall condition. Therefore, localized technology assuring precise weather prediction by installing localized weather station is needed. From technical innovativeness perspective, not only provide the current and raw data of what is happening on the farm to the farmers but notifications and recommendations precisely on what to do is more important because the conditions of Indonesian farmers that mostly are having low literacy capability, to give them precise and simple information is very beneficial for them. Access to the market is not the only problem that farmers have to face in terms of economic challenge. Farmers find it difficult to apply loan in the bank, thus they have to borrow the money from middlemen, which has the contract farming that farmer have to sell their product in a low price to them. So, not only technology but also ensure that farmers have access to the market by building agricultural ecosystem project. Agricultural Ecosystem project is a collaborating project among government, bank, insurance, agriculture inputs supplier, off-taker and also agri-tech start-up. By using technology and included in the agricultural ecosystem project, farmers can improve their productivity also certainty to market their products with fair price to a certain off-taker. Farmers also can be assured that if their production is damaged by natural disaster, they can claim to agriculture insurance provider. They also don't have to worry about the agriculture input supply because they can obtain high quality products from the trusted supplier that collaborating in agricultural ecosystem project. Lastly, farmers also can receive micro financing from bank with low interest. Then, to help farmers gain higher sale price through using traceability feature. It can help them export their products and obtain more funding for their business since product transparency is presented. In a nutshell, implementing this project can solve four main problems within small holder farmer community: improving yield and productivity, gaining wider access for the right financing, obtaining higher value of product and also access to the market.

Keywords: *digitalization agriculture, farmers, from land to table, smart agriculture.*

1. INTRODUCTION

Indonesian agriculture has high potential to growth and develop. Its climate is conducive to grow not only food crops but also all tropical agricultural commodities. Farmer is the most relevant profession determining the success of agricultural development [7]. However, the interest of being farmer tends to decline gradually. Agricultural Census by Indonesian Statistic [9] shows that majority of farmers are elderly, aging from 45 to 54 years old. Interestingly, farmers above 65 years old is higher compared to the youth below 34 years old. Young generation prefers to move to urban areas for a living. Under the scope of economy, Indonesian smallholder farmers are dealing with poverty. According to Indonesian Statistics [10], family living under poverty is dominated by farm household which was 29.16% or 18 million. They are trapped in the circle where they face harvest failure, financial access difficulty and commodity's fair price. These problems are elaborated in

A. D. Saputro et al. (Eds.): ICOSEAT 2022, ABSR 26, pp. 576–581, 2023.
https://doi.org/10.2991/978-94-6463-086-2_78

this paper. By these phenomena, the availability of farm employment could face uncertainty. Later on, it could degrade the sustainability of agricultural sector.

Agriculture is seen as a high-risk business, when climate change is happening and brings more harm than good for agricultural practices. The change in crop calendar and fluctuated trend in temperature makes crops difficult to adapt [6]. Moreover, it interferes pest life cycle, and then emerges pest and disease attack uncontrollably. Thus, the impact of climate instability causes tangible harm for farmer and food security [6]. The main solution for it is that farmers have to improve their adaptability. Importantly, they have to acquire enough information about the real time situation of climate and its prediction. Here, technology application is the only way to provide access such information rigorously.

In digital era, numerous types of technology have been developed, especially those connected to internet. In agriculture, the term "precision agriculture" has been introduced to bring the future of adaptive agriculture. It aims to assist farmers in cultivating their field by adjusting the real-time situation of the nature. A high-tech approach using Internet of Things (IoT) is innovated to help farmers receive quick access of information using internet [8]. It can be functioned for on-farm management (including agricultural resource use), traceability and monitoring [4]. Unfortunately, this technology has not yet well-developed in Indonesia. Manual farming is still the majority but many developed countries have innovated IoT for precision farming such as USA, China and European Union countries [3].

The other problems appearing in smallholder farmers are related to the loan and market price. Farmers have some options to propose funding such as bank, farmer association, local kiosk, microfinance institution, trader and other financing (family). Majority of those services need requirements in which farmers do not understand and perceived as complicated [12]. At the end, the easiest way to access is loan through the trader or middleman. However, there is a consequence for farmers where they have to agree joining contract farming. Their products have to be sold to the trader. In fact, they cannot control market prices as the chain is too complex. Furthermore, they have to receive low price for their products, and it leads to lower income [1].

From the above problems, it is important to understand that farmer's problem is complex. Providing high-tech technology can help farmers improve their production and prevent harvest loss. However, if at the end farmers still cannot attain higher price, the role of technology will have no significant impact to boost farmer's income. Without sufficient funding, farmers cannot afford enough input and labour. Therefore, end-to-end solution needs to be emphasized in the implementation of agrotechnology 4.0 with agricultural ecosystem.

1.1. Product in the Form of Ecosystem

The partnership's theory of change represents the dynamic source of problem-solving method. Thus, it would be great to involve relevant stakeholders dealing with relevant problems [11]. Here is the picture describing ecosystem:

Figure 1 Ecosystem Model

a) Technology

Precision Farming requires exact measurement on agricultural practices. Within it, prediction and prevention are the main components to optimize on-farm activities. There are four main technologies to help farm grow as expected, namely drone surveillance, drone sprayer, soil and weather sensor and water debit sensor. Drone surveillance is functioned as agro-mapping tool to identify land fertility and to determine the spots for soil and weather to be installed. Enhanced with NDVI technology, drone surveillance can generate 3D image to present the updated condition in the farm field, including the fertile and infertile areas in the farm overlay. After receiving and analyzing the data, the map is sent to drone sprayer. Here, with autonomous system, drone sprayer is capable of spraying agricultural land automatically based on the field need. For example, the drone spray fertilizer or pesticide to the spot which needs special treatment. Its capability is to bring 20 Litres of liquid and able to spray 1 Ha of land within only 10 minutes. The second technology is soil and weather sensor. It is used to understand real-time situation on in the context of agro-climate aggregate. Using Internet of Things (IoT), the information is updated every five minutes. Smallholder farmers will receive notification and recommendation on what to do via apps. Thus, when the field is not fertile and in need of certain fertilizer, farmers will be notified and suggested to add relevant fertilizer with certain amount of dosage to the soil. The other example is rainfall warning. When tomorrow is going to be raining, farmers will be notified and recommended not to fertilize their field. By doing that, fertilization can be applied efficiently.

As a matter of fact, some cases occur in our pilot study are related to inefficient use of fertilizer. Firstly, as farmers do not know when it will rain exactly, they use their own instinct to predict. As a result, when they spread fertilizer on their farm, rain falls and bring the mineral in fertilizer away from the soil. This phenomenon is called as run-off. Consequently, farmers have to repeat fertilization activity by spreading more fertilizer, in which, it increases the input cost. Secondly, farmers are not capable of identifying the precise need of their field to be fertile. They use their own intuition to discover the need of fertilizer. It cannot be the basis of measuring the soil's need. Furthermore, farmers often fertilize imprecisely. In other words, they spread excessive or too little amount of fertilizer. Later on, it can damage the soil.

All problems above happen due to the lack of information on farmers. The precise situation is the only solution to achieve efficient and effective farming. This is the technology which farmers inevitably need to access. Through ecosystem concept, we work with stakeholders to ensure that farmers can enjoy the technology feature with affordable price (rental).

b) Ecosystem Sustainability Guarantor

The ecosystem is a committed ecosystem, meaning that the implementation is planned for long time period. Therefore, it has to be sustainable. The guarantor usually local government within regional level who can work with local farmers closely. Their main duty is to decide the project areas in the regency including the farmers involved. They set up the plan and organize farmer group to unite and join the precision agriculture project. After undergoing the project in the first crop calendar, big possibility to expand in the larger areas.

c) Ecosystem Facilitator

The second important stakeholder for this ecosystem is the facilitator of ecosystem. Cooperating with farmer is not a simple matter. Strategic approach is required, especially in involving the extension officer, a party who has the closest relationship with farmers.

As committed partner in the ecosystem, both ministries play a role as ecosystem facilitator. Ministry of Village works for disadvantage regions, recommends the specific areas for project's concentration. Meanwhile, the Ministry of Communication and Informatics can involve in areas not limited to marginalized region. The contribution of both ministries is mainly in terms of operational facility. They cover the socialization event on farmer level including the cost and guidance book of on-farm activities.

Applying technology through internet access requires proper signal in the field. Meanwhile, all the projects are located in rural areas, meaning that signal plays a pivotal role on the technology performance. Here, Ministry of Communication and Informatics provides signal access in the blank spot areas through program so called Bakti Negeriku. At the end, the risk of signal instability can be minimized.

The role of Ministry of Agriculture is in crop calendar collaboration and Good Agricultural Practices (GAP). The ministry has historical data of regional weather which can be linked to our soil and weather sensor capacity. It will improve the validity of crop calendar, especially for food crops and horticulture. For specific commodities, we determine the GAP by our experts from universities. It is then compiled with the existing GAP recommendation from Ministry of Agriculture to form a better GAP. On the other hand, BMKG helps us improve weather content (forecasting) in the apps for farmers with no weather sensor on their field. In other words, those who install our sensor on their field will enjoy the facility of real-time soil and weather information from the device, but those who do not have access on our localized soil and weather sensor may enjoy weather prediction feature in our apps from BMKG.

Actually, ecosystem facilitator is open for private institutions as well. For example, off-taker (industrial scale) who already has farmers can also facilitate the ecosystem by providing the technology on their contracted farmers. It can be happened when off-taker wants to improve their farm productivity which can increase their supply capacity.

d) Finance Institution and Insurance

Other than technology access, farmer is facing difficulties in obtaining fund. It can be said that farming business is not bankable. The main reason for it is because crops cultivation has a high risk. Climate change increases uncertainty on the field. It means, once farmers have to deal with natural disaster or pest attack, big possibility that harvesting failure can occur. Unfortunately, this disaster will make farmers unable to return the fund.

By involving technology, farmers can prevent their work from uncertainty since they have device which allow them to predict agro-climate condition nearby their field. For example: farmers can forecast when to fertilize according to the weather prediction provided in the apps. Also, through recommendation and notification, early warning system is developed to curtail unwanted event such as soil mineral insufficiency and pest attack. Furthermore, it can provide harvesting guarantee for farmers. By this, farmers will be able to return the loan. Therefore, bank is convinced to contribute in delivering Kredit Usaha Rakyat (KUR), a type of loan for rural society.

Other than harvest guarantee, this ecosystem involves agri-insurance. When farmers face a dramatic agro-climate anomaly, natural disasters such as drought and hurricane can happen. This insurance can cover the risk of these damaging events. Furthermore, farmers can propose an insurance premium to the insurance company in the ecosystem. The budget can be used to replace the loss of harvesting those farmers will be able to pay the credit. Therefore, the involvement of agri-insurance also makes bank convinced to accommodate farmer with KUR program.

KUR helps farmers attain low interest compared to when they borrow the money from other sources. Having interest of 7% per year, KUR supports farming business with lower burden for farmers. For financial institutions, this is one the strategies to expand their market penetration in the project locations.

e) Local Farm-shop

Agri-input is the main production function variable in agriculture. It includes fertilizer, pesticide and other materials boosting the harvest result. Farmers commonly buy it in the local farm-shop or kiosk. They type of this shop can vary such as individual ownership and group cooperative. Through this ecosystem, the kiosks can have coordination function with startup or private sector and other stakeholders. Their task is to make sure that agri-input is sufficient for farmers to take.

f) Off-taker

When farmers can improve their productivity, it means higher production and higher income. However, when farmers cannot enter the market, their sales cannot be optimized and it is potential to attain lower price. To avoid market failure, off-taker has a big part in providing market. Categorized as industrial market, off-taker needs to be existed in the ecosystem, to absorb all farmer's products with premium price.

1.2. Agriculture Ecosystem with Asian Development Bank

We are currently working with Asian Development Bank (ADB) to improve small holder farmer's prosperity. The number of beneficiaries is 50,000 small holder farmers for three commodities: paddy, corn and chili. It takes place in Sukabumi and Pasaman Barat Regency covering up to 50,000 Ha of coverage area.

This project aims to improve farmer's welfare sustainably. As represented by the type of stakeholders joining, improving farm productivity will be the first social impact. The use of technology helps farmers grow their crops precisely as the tools can provide real-time information and recommendation on what-to-do for farmers. Anticipating unwanted harvest failure by following real-time information is supported by technology which is more precise and up-to-date. Successful production affects income growth. The second impact is related to the market. As we involve off-taker in the ecosystem, all the farmer's products are absorbed by them having better price is a positive sign to gain higher profit for farmers. It reflects as the third impact, which is accessible financing for farmer. And then, as we use group approach in this project, farmer group empowerment can be considered as the other social impacts. In this context, having farmer group working together in the technology implementation can revitalize the role of this group.

1.3. Social Impact for Farmers

The use of precision agriculture technology could benefit farmers in diverse ways. It consists of several points below:

a) ***Farmer Group Revitalization***

Social capital is important in Indonesian farming since farmers work in group. This concept is encouraged by the government. Farmers work together, especially in terms of labor. because it is hard to find farm laborer. Thus, they often hire their own neighbors to cultivate their land. It is inevitable that sometimes farmers work alone and the spirit of farmer group only for labor matter. By using technology, 10 ha is organized by more than 10 farmers. One sensor can be installed for 10 ha, meaning that farmers have to cooperate to maintain the sensor. They have to secure the tool collectively. It will increase the interaction between farmers and intensify their social capital. By this, farmers will involve in the group more frequently. They can discuss the problems on their field more actively especially after being notified on their smartphone about the most current situation of their field. They can determine the strategy for pest anticipation together. This communication is essential to build stronger farmer group [5].

RiTx Bertani apps records farmers activities from planting to harvesting. This record will be the basis of GAP. Every farmer will create GAP on their own. It can be seen in the apps. Whose GAP generates the highest yield, he or she will receive reward. This situation will encourage farmers to have the best GAP.

b) Financial Inclusion

The involvement of KUR in the ecosystem indicates that the farming is bankable. Here, farmers can access the loan along with agri-insurance. The funding can help farmers boost their on-farm productivity and fulfil the need of farm management. Importantly, KUR provides low interest (7% per year). Equal opportunity for fund access is created through the ecosystem.

c) Farmer Revenue Improvement

MSMB has done pilot studies in some areas such as: Wonogiri and Malang. The result shows that farmers of onion in Malang experience a dramatic increase of production from 7 ton/ha to 12 ton/ha. Besides, Wonogiri farmers also gain higher productivity of rice by 20% because following the recommendation from soil and weather sensor, posted by the apps. The improvement of productivity indicates increasing income. However, it still depends on the price. MSMB builds an ecosystem involving off-taker. By being the off-taker aggregator, MSMB buys all the harvested products from farmers and directly linked to the off-taker. Thus, farmers can attain better price, which can lead to increasing revenue.

d) Easing Social Conflict

The other case happened in East Nusa Tenggara where Public Works Agency install water debit sensor. Irrigation is sensitive for farmers as it relates to water supply. Farmers are suspicious each other on the water insufficiency issue. They think that insufficient irrigation is caused by dishonest behaviour of other farmers, in which, some farmers were seen to leak the irrigation stream. Social conflict occurred. Actually, it is due to the lack of information on water division. Using water debit sensor is proven to ease social conflict as it informs farmers about the water stream division based on debit data updated every five minutes. For example, water debit shows that today's irrigation only can cover 50 ha of rice field, meanwhile usually it can cover 120 ha. By this condition, farmers with the field above 50 ha will be notified the information and understand that the water is not sufficient to irrigate their land.

e) Female Empowerment

Females in here refer to farmer's wives and daughters The purpose of involving them is to empower them in gaining additional income from post-harvesting. MSMB designs the scheme to process the waste of harvesting to become silage, which can be sold for livestock feeding. Within 10 ton of waste, we can produce 9-ton silage with 80% of profit margin. Besides that, the wives will be trained on financial literacy, which is useful for their financial management.

2. CONCLUSION

To deal with climate change and its impact on the crops, farmers demand technology. However, it is not enough to assist farmers only from technological perspective since the other problems are significantly appearing such as funding access and fair price on the market. MSMB forms an integrated and committed ecosystem inviting government, financial institution, agri-insurance, off-taker and local kiosk. Proven to successfully increase the yield, MSMB's technology is perceived as the pioneer of precision agriculture in Indonesia. By using RiTx Bertani Apps, farmers not only can monitor their field but also record their activity to result GAP. This model of agricultural ecosystem can be replicated in the other areas in Indonesia but customized with characteristics and local wisdom in each area.

ACKNOWLEDGMENTS

The title "ACKNOWLEDGMENTS" should be in all caps and should be placed above the references. The references should be consistent within the article and follow the same style. List all the references with full details.

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