

The critical review of agriculture technological transfer in the era of decentralization

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Abstract. The progress of agricultural technological transfer in accordance with socio-economic conditions has long been recognized as an obstacle in accelerating agricultural development. After two decades of implementing decentralization, Indonesian agricultural technological transfer has become more complex. The purpose of this study is to identify the performance of the agricultural technological transfer after two decades of implementation of the decentralization in Indonesia. The lack of collaboration between the various agriculture institutions, as well as a centralistic approach in agricultural development for more than three decades considered to be the main inhibiting factor of the effectiveness of technological transfer. The implementation of the decentralization policy in early 2001 has affected in changes fundamental of the organizational structure and management of government institutions that carry out extension functions in agriculture. This fundamental change has implications in the performance of most agricultural sector's organizations and personnel. Developing agricultural sustainable development requires collaboration between local, regional and central levels. In creating decentralized agricultural policy, including the technology transfer and innovation, it will be effective when they have commitment to a mutually support between related institutions. Pentahelix synergy among stakeholders in local level will be substantial for maintaining long term agricultural sustainable development goals.

1 Introduction

The implementation of the decentralization era in Indonesia has affected in changes fundamental of the organizational structure and management of government institutions that carry out extension functions in agriculture. These fundamental changes bring the consequences in the performance of most agricultural sector's organizations and personnel in both national level and local level. The progress of agricultural technology transfer in accordance with the bio-physical and socio-economic conditions has long been recognized as an obstacle in accelerating agricultural development, especially in the rural level where technology adoption are less developed.

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The process of technological transfer, which aims to bring research to a commercial product, is an substantial step of innovation [1]. It is crucial to close the gaps between research and industrialization to increase competitiveness in the industry. There are three main steps of technology transfer, firstly, research that produces technology, secondly assessment to develop site-specific technology and thirdly, counseling to apply technology in the field [2]. After two decades implementing decentralization, Indonesian agricultural technological transfer has become more complex. Industry 4.0 has adapted and transformed to agriculture 4.0 in order to analyse the characteristic and performance in this specific domain. Industry 4.0, it is generally knows as integrating, accomodating and including the latest developments based on digital technologies in all sectors. This allows agripreneur, including farmers, to transmit real-time information in terms performance and latest progression of the plant development. [3]

Innovations produced by the Research and Development Agency of Agriculture consists of two forms, namely innovation technology and institutional innovation. Innovation institutions is an effort to disseminate the results of the technology that has been generated through the formulation of the model and application in the field to farmers, with involving field officers, researchers, extension workers and local government officials. In applying innovation, Agricultural Research and Development Agency has initiated some models which have been recognized by other parties. Some of the models have been widely applied and adopted by various ministries, for example development capital with Business Credit management Independent (KUM) and field schools. While, several models developed by Agricultural Research and Development Agency has also been adopted with some improvements especially in within the Ministry of Agriculture. [4]

This article aims to identify the performances of the agricultural technological transfer after two decades implementation of the decentralization in Indonesia. The lack of collaboration between the various institutions carrying out agricultural technological transfer, including farming institutions, as well as a centralistic approach in agricultural development for more than three decades considered to be the main inhibiting factor of the effectiveness of technological transfer. Analysis focused on the approach used from transfer technology to innovation systems, as as well as developments in science and programs dissemination of agricultural technology innovations developed internationally during this time. This scientific review is compiled from various materials namely reports on various activities in the scope of Agricultural Research and Development Agency and literature study which is relevant. The analysis was carried out with delineation by time and scientific development.

The structure of this study is presented as follows. At the beginning, we will explain the background and objectives of technology transfer in agriculture along with some studies related to this topic. In the second part, this paper describes the critical review method explained in this paper. Then in the results and discussion section, we elaborate the recent development of technology transfer in decentralization era. Then, according to some literature findings, we propose and discuss technology transfer schemes in the agricultural 4.0 era which can be an important focus for future research agenda.

2 Methods

This critical review identifies main problem about how could existing trends in agricultural advisory service structure and the influence of potential digital developments on agricultural transfer organization in the future. The two components of the review are:

1. A review of the recent development of Agriculture Technology Transfer Agency in Indonesia

2. A conceptual framework of major trends in the digitalisation of agriculture which transform the way technological transfer can move rapidly through online platform adopted by farmers in their farming activity.
3. An observation of recent digital agriculture learning platform provided by some provider in Indonesia, including government, university and general public where farmers can independently learn, practice and increase their technology and new knowledge adoption.

In contributing the following section, both the review are explained in our conceptual mapping (Figure 1, 2 and 3). In the last section of discussion we provide the future agenda which can be essential for Indonesian Agency for Agriculture Research and Development in facing agriculture 4.0 era.

3 Result and discussion

3.1 Agricultural technology transfer

In a centralized regime, with the presence of massive state-owned, it is unnecessary for agriculture organization for technological transfer from center of agricultural research and development to rural communities, including farmers, cooperative and village government. The role of technology transfer in those centralized system was accomodated by their management bodies [5]. Unfortunately, when the decentralisation was implemented the flow of technological transfer was only in one direction. In this system, farmer was the object of dissemination, and had no opportunity to give feedback.



Fig 1. The agricultural technology information in one way system [6]

Agricultural extention body, in early decentralized system, obtained knowledge from agricultural research organization, where was implemented in a pilot project farm and then transfered to other farmers. Indonesian Agency for Agricultural Research and Development recently has 33 Agricultural Technology Assessment Centers (BPTP) which have purpose to accelerate technology transfer to farmers. The Center focuss on three main steps of technology transfer, namely research that produces technology, studies to develop site-specific technology and counseling to apply technology in the field.

In addition the Center has also set up field laboratories in various locations to bring technology closer to farmers. In recent development, they established the development of an Agro Techno Park and an Agro Science Park where is currently being planned to address various problems faced by farmers in the field. By 'serving' technology directly to the farmer's table, hopefully agriculture technology transfer can be adopted more quickly.

In this agriculture 4.0 era, farmers use many information source, as knowlegde and information are no longer the domain of agricultural research center. The information is rapidly moved using more complex digitalized platform, for instance online course platform, social media or Youtube which can be accessed using mobile device.

3.2 The future of agriculture technology transfer

Digitization often refers to the increasing intensity of human-computer or human-information and communication technology (ICT) interactions. Digitization is different from digitalization, which can mean changing component parts from manual to digital. Agricultural digitization involves the development, adoption and improvement of digital technologies in the agricultural sector. Fielke et al. [7] stated that the impact of digitization in agriculture tends to refer to precision agricultural technologies that broadly reduce input costs in one hand and increase yields or sustainability values on the other hand.

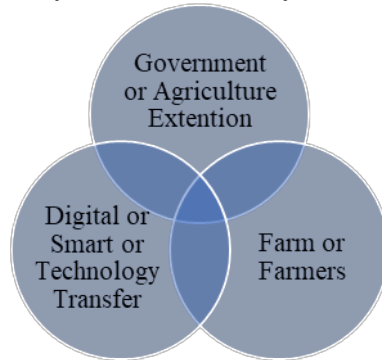


Fig 2. Intersection of Farmers, Agriculture Agency (Government) and Digitalization Process [7]

The rapid and massive development in the agricultural era 4.0 needs to be prepared by all stakeholders (Figure 2). This is because the accelerated development of new digital technologies, including, for example, the use of sensors in monitoring agricultural land, drones technology, big data, machine learning, Internet of Things, and cloud have become a necessity in future agriculture [8]. Such rapid changes can cause digital disruption, a term commonly used to denote drastic changes in a system, where incumbent players, such as individuals, organizations, companies and technology that used to be market leaders have been redesigned by the digital disruption [9].

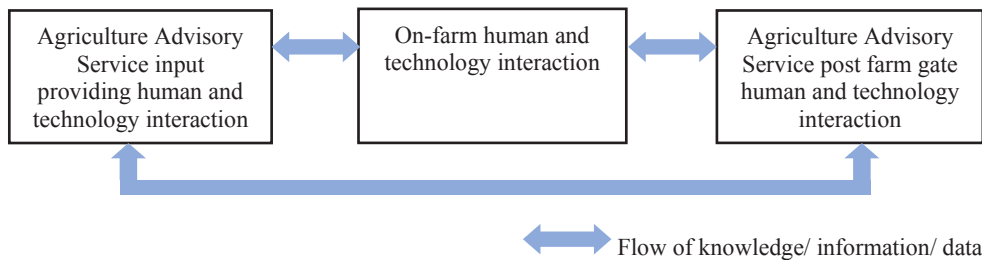


Fig 3. Digitalisation of the agricultural knowledge, information and data feedbacks through agricultural advisory agency and farming actors.

Knowledge networks are crucial in terms of disseminating data, information and knowledge related to the latest agricultural methods. The knowledge network can be applied continuously with the placement of knowledge proportionally. This network can perform transformation by converting raw data and information into knowledge and then applied to the planted area [10]. In the era of agriculture 4.0, private and public advisors can have the same role as intermediaries in transferring knowledge to farmers through two-way consulting services. In the international context, various knowledge transmission processes that are applied, for example advisors who provide advice on improving management or

improving agricultural land management procedures, are often referred to as agricultural consulting services [11]. The process of innovation in agricultural research has taken place globally. The development of knowledge transfer technology ranging from automatic supply chain management to processing data and information that is used as a basis for decision making in agricultural management has been widely applied [12]. The addition of interaction between humans, computers, before, during and after farming has been visualized in Fig. 3.

In Indonesian context, farmers can independently learn by themselves how to farm efficiently through several digital learning platform. For instance, the Ministry of Agriculture of the Republic of Indonesia has developed iTani, a social media-based digital library application that is equipped with an eReader to read ebooks. With social media features, readers can connect and interact with other users, provide recommendations for books being read and submit book reviews. Towards the era of Agriculture 4.0 in addition to the iTani application, the Indonesian Ministry of Agriculture's Balitbangtan also developed the TAKESI Application (Android Technology for Cow Health), KATAM (Planting Calendar) and myAgri (an application that supports IPM). Besides this application, millennial farmers can also access various Balitbangtan innovations through social media of various UK/UPT within the scope of Balitbangtan and the Ministry of Agriculture. Another digital transformation in agriculture extension is cybex.pertanian.go.id. This is also a government-owned site that contains information about plant cultivation counseling which is certainly very helpful for those who are just learning on how to farm properly.

From private sector, farmers can learn using start up is "pak tani digital". Pak Tani Digital is a "Farmers Social Startup" whose vision is to empower Indonesian millennial farmers to become main players in the Society 5.0-based Agricultural Industry in the future. The startup has becoming agent of agriculture technology transfer through their website and Apps which contains agricultural information, tips, and inspiration from successful farmers. In addition, this website also contains information on agricultural commodity prices which is sometimes become 'a mystery' for farmers.



Fig 4. Indonesian Digital Learning Platform for Millenials Farmers

Various agriculture-based digital startups have started to emerge in the value chain system in agriculture, starting from learning, financing, and e-commerce. In the field of financing, there are five financial technologies (fintech) that provide loan to farmers, namely iGrow, TaniFund, Crowde, Vestifarm, and Tanijoy. In the e-commerce sector, at least TaniFund competes with nine other players in Indonesia. They include HappyFresh, Sayurbox, Brambang, Tukangsayur.co, 8Villages, Chilibeli, Kedai Sayur, Etanee, and Kecipir. Based on the official iGrow website, the total funding disbursed reached IDR 251.7 billion [13]. Loans that are still running or outstanding IDR 139 billion. Agricultural startups also seem to attract investors to invest. Startup in the field of agriculture, TaniHub Group received funding of USD\$ 65.5 million or around IDR 942 billion [14]. In the e-commerce sector, at least TaniFund competes with nine other players in Indonesia. They include HappyFresh, Sayurbox, Brambang, Tukangsayur.co, 8Villages, Chilibeli, Kedai Sayur, Etanee, and Kecipir.

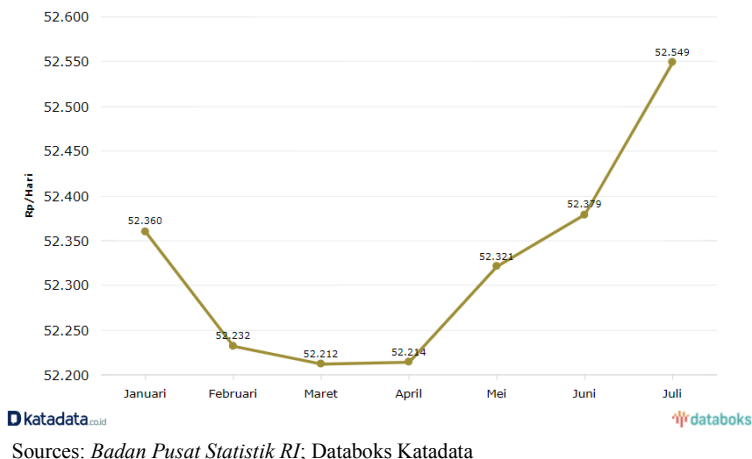


Fig 5. National Real Wage for Farmers (January-July 2020)

Digital-based agriculture is a new hope in improving the welfare of farmers. Farm-based startups claim to have an impact on increasing farmers when they join. The real wages of farm labors also decreased at the beginning of 2020 and began to increase in May by 0.21% compared to the previous month and continued to increase until July 2020 to IDR 52,379 per day (Figure 5). The collaboration of agriculture-based startups and the government is believed to increase the competitiveness of agricultural products. They give the new approach in farming process especially focusing on competitive improvement. They connect between farmer and digital platform in farming process and distributing to customers.

In the future, the transformation of agricultural digitalization will run in two directions. In addition to the opportunity to change agricultural consulting services to become fully digital and automated, it is also possible that disruptive digital technology will be taken over by human workers manually. In general, the prediction of agriculture 4.0 in the future is fully autonomous agriculture managed by robotics and agricultural block chain technology has been tested to replace traditional farmers who currently still produce inefficiencies [15]. The rapid development of digital technology will continue to enhance the capabilities of existing agricultural consulting services to provide added value to the agriculture sector in a more accurate and efficient manner [16].

4 Conclusion

In beginning era of decentralization, agriculture technological transfer in Indonesia is closely related to the implementation of extension services. Agriculture advisors used to play an important role in introducing agricultural technology innovations to farmers. In recent development, the role of advisor is not only to introduce technology to farmers, but also to increase the capacity of farmers to be able to run their businesses independently. In Agriculture 4.0, farmers can use many information source. Knowledge and information are no longer the domain of agricultural research center, as the information is rapidly moved using more complex digitalized platform. In addition, developing agricultural sustainable development requires collaboration between local, regional and central levels. In creating decentralized agricultural policy, including the technological transfer and innovation, it will be effective when they have commitment to mutually support among related institutions. Pentahelix synergy between academics, government, business, media as well as

communities in local level will be substantial for maintaining long term agricultural sustainable development goals, including long term technological transfer.

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