APPLICATION OF ICT TOOLS IN FOOD CROPS MONITORING IN INDONESIA

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ABSTRACT

*Indonesian "Working Cabinet" 2014-2019 is placing more attention to the agricultural sector, particularly its self-sufficiency program for major food crops such as rice, corn/maize and soybean. The government has been planning to achieve self-sufficiency in rice production by 2016, corn production by 2017 and soybean production by 2018. The Indonesian government has also inspired to have renewed enthusiasm in using new information and communication technologies (ICTs) for agricultural services. Driven by significant roles of ICT, research institutes, universities, and related associations have been actively involved in ICT application in agriculture in the recent years. The aim of the paper is to review/analyze the roles, potentials and contributions of ICT to agriculture and to explore opportunities for its use in IT in various fields of agricultural sector in Indonesia. The paper reviews and analyzes various ICT-based information dissemination models application in agriculture. In addition, success stories of ICT applications in agriculture are presented i.e. Application of Standing Crop for Rice Monitoring, Modeling of maize self-sufficiency in Indonesia, KATAM: Cropping Calendar, Android based Tani Hub Application, Pantau Harga: Android application for agricultural prices monitoring, SMS based cropping area monitoring, e-Rice consultation services version 1.0, and e-IRKB: Online based Indonesia Rice Knowledge Bank. The findings provide a useful direction for researcher and practitioners in developing future ICT based information dissemination systems. ICT tools ensure farmers and increase their capacity to make effective and informed decisions.*

Key words: Information and communication technologies, food crops, agriculture information, e-service

INTRODUCTION

Information and communication technologies (ICTs) have transformed lives across Indonesia. ICTs have been widely used in information related fields and their use has been received and adopted within agricultural informatics studies as well. According to the census of 2015, 56% of the population in Indonesia is considered rural whereas 44% belongs to the urban area. However, according to projections, in 2017, about 56% of Indonesia’s population will be considered urban and the remaining 44% will be living in rural areas (CBS 2016). The development of modern agriculture techniques and human resources, are the two main priorities in agriculture under the new “working cabinet” of 2014-2019. These have been found to boost agricultural production in Indonesia.

During 2015-2016, the government had achieved its irrigation rehabilitation target of 3.2 million hectares and built 1,235 reservoirs. The government had also provided 180,000 units of agriculture machineries, which consisted of tractors, water pumps, together with harvesters and rice transplanters. The government had also distributed US$4.49 billion in fertilizer subsidy and 527 organic fertilizer processing units. The government had also granted agricultural insurance to protect 373,000 ha of land from crop failure risks (Ministry of Agriculture, 2016).

ICTs have become an important part to the progress of rural and semi urban in Indonesia. Kimeyi and Moyo (2011) stress that technological innovation and the adoption of new technologies provide great opportunities for growth in the service sectors such as agriculture, health, education, banking and insurance. Many countries have identified ICT as an important component in moving their countries’ subsistence-based economy to a service-sector driven, high value-added information and knowledge based economy, that can compete effectively in the global market (Ansoms, 2008).

After the introduction of ICTs in the agricultural sector, the traditional agriculture has been reformed, thus significant improvement in agricultural productivity and sustainability has been reached. Over the last two decades, the Indonesian government has invested substantial amount of efforts to develop ICT-based agriculture information...
dissemination system (Ministry of Agriculture, 2016). As a result, various innovative and effective information dissemination channels (called Multi channel dissemination system) have been emerged and widely used (Haryono, 2012).

This paper will review food crops production in Indonesia including the application of ICTs for agriculture, particularly for food crops monitoring and dissemination. In the last part we will discuss the challenges and opportunities to increase food crops production in Indonesia by using ICTs to meet the increasing demand for food.

Overview of Food Crops Production System in Indonesia

Indonesia is the third largest producer of rice in the world after China and India (FAO 2017). Over the last three decades (1993-2015), rice production in Indonesia has increased from 45 million tons in 1993 to about 75.4 million tons in 2015. Rice productivity has also increased significantly in the last three decades from < 4.3 t/ha in 1993 to 5.3 t/ha in 2015. In addition to rice area, the last three decades remained almost stagnant i.e. 11.4 million ha in 1993 to 14.1 million ha in 2015 (CBS 2016). Rice production is still rising in the future to meet rising demand for various purposes (Figure 1).
Maize production in Indonesia has contributed approximately 2% of the global maize production. In Indonesia, maize is grown all-year round i.e., rainy season and dry season. Among these two seasons, nearly 65% of the production occurs during the rainy season while the remaining 35% occurs during dry season. Since the maize is rain dependent, it is mainly grown during the rainy season. Maize area, production and yield in Indonesia have seen a phenomenal growth over the last three decades and Indonesia has emerged from being an importer to levels of self-sufficiency. Over the last four decades (1971-2015), maize production has increased from 3 million tons in 1971 to about 19.6 million tons in 2015. Maize productivity has also increased significantly over the last three decades from < 1 t/ha in 1971 to 5.2 t/ha in 2015. In contrast, maize area over the last three decades remained almost stagnant i.e. 2.8 million ha in 1971 to 3.8 million ton in 2015 (Figure 1). Maize production is still rising in the future.
to meet the rising demand for various purposes. Diversified uses of maize also prompted higher production in Indonesia. Presently, maize is mainly used for the feed industry while the remaining is used for food, starch, etc. (Adnyana et al. 2001).

Maize, like any other cereal, is grown across all the provinces in Indonesia, and in some provinces such as East Nusa Tenggara, West Nusa Tenggara, Central Sulawesi, South Sulawesi, Central Java etc., East Java, Central Java, and Lampung are the leading producers of maize in Indonesia while South Sulawesi, North Sumatera, West Java and Gorontalo are the other important producers. Among the major producing provinces, East Java tops the list which contributes around 30% to the total national maize production. Other producers are Central Java (16%), Lampung (10%), South Sulawesi (7.5%), North Sumatera (7%), West Java (5%) and Gorontalo (4%). High maize production in East Java was mainly due to the wide-spread use of hybrids, especially in rainfed and irrigated lowlands as well as good transportation network.

Role of ICTs in Agricultural Sector

The ICT sector has had a significant impact in developing countries, as they are being utilized in the agricultural sector through ICT-enabled solutions for agricultural production. Milovanovi (2014) divided the contribution of ICT in agricultural sector in two ways: 1. Directly, where ICT is used as a tool that contributes directly to productivity of agricultural production and 2. Indirectly, where ICT is used as a tool that provides information to farmers enabling them to make quality decisions in the efficient management of their respective enterprises.

Furthermore, Mehar (2015) categorized the mechanism of agricultural information service systems into three types: Government-led, market driven and community self-support. The government-led mechanism normally follows a top down approach to disseminate innovation technology. The initiatives are developed from MOA and promoted through the management systems from agricultural departments in provincial cities, agriculture bureau or agricultural promotion centers in counties (Zhang et al. 2016). The marked driven mechanism is the development of information services to individual farmers by commercial enterprises. The community support mechanism refers to the development of information services organized by local communities.

Currently, the agricultural information dissemination models in Indonesia include Websites, voice information delivery services, SMS based agricultural information services, radio and television broadcast, extension services based on mobile phones and database monitoring, and e-learning for agricultural information services. In order to determine the most appropriate dissemination channels, farmers’ capability and behavior, operating costs and local context should be taken into consideration (Zhang 2007).

SUCCESS STORIES ON AGRICULTURAL INFORMATION SYSTEM

SIMOTANDI: Rice Standing Crop Monitoring System

The Indonesian government is recently moving quickly to create a big impact in the agricultural and food sectors. The first target is to boost rice production to achieve self-sufficiency by 2017. The second is to be a rice exporting nation in the near future. To achieve these targets, since 2015, the Agriculture Ministry has been adopting Rice Standing Crop Monitoring System (SIMOTANDI). SIMOTANDI is a collaboration project among the Ministry of Agriculture, the Indonesian National Institute for Aeronautics and Space (LAPAN), the International Rice Institute for Climate and Society (IRI) and the Ministry of Public Work.

The SIMOTANDI project aims to develop a monitoring and information system for rice production in Indonesia. SIMOTANDI’s main purpose is to gather and organize information on rice area, rainfall monitoring, reservoir water level monitoring and open camera application to provide information to the stakeholders for policy support. The project mission is to support the Ministry of Agriculture with the capacity and infrastructure to use information technology for food security secure.

SIMOTANDI also directed to revolutionize the way data and information on how rice is collected and used. SIMOTANDI gathers information on rice such as where it is grown, when it is grown, standing crop status, and how the water availability status through integrating remote sensing and information and communication technology. SIMOTANDI is developed by using web based GIS, high resolution Landsat-8 image derived from National Aeronautics and Space Administration in collaboration with United State Geological Survey (USGS). The resolution of the image is 30 x 30 m with accuracy prediction between 88-92%. All available information is made accessible to stakeholders and decision makers anytime and anywhere using website and android application.
KATAM: The Integrated Crop Calendar (ICC)

The integrated crop calendar (ICC) is a project of the Indonesian government in response to the effects of climate change for farmers and thus, agricultural production. The Indonesian government is looking for a way to keep the production of rice high since it is the most important staple food in the country. The ICC is produced thrice a year, at the start of the rainy season, transition season and dry season. The calendar is published a few weeks ahead of the start of the season, usually in early September, January and May.

The research Institute for Agro-climate and Hydrology in Bogor is responsible for the production and publication of the calendar. The calendar is built in two parts, the rainfall prediction/start of the season and an advisory part with regard to crop variety and fertilizers. The calendar’s main information is the planting time for the upcoming season, indicating the decadal to start planting and the potential area in hectares that could be planted in the current season. The calendar also indicates if maize or soybean can be planted. The calendar not only shows the planting time for the coming season but also the seasons after that. This information is later updated but is meant for the farmers and the government’s long-term planning. Further the integrated crop calendar contains advice on fertilizers, including their proper combination and amount. ICC also provides information on how much agricultural machines are available in the area and what would be needed if planted according to the calendar.

The ICC is available on different policy levels, from sub-district to the national scale. In Indonesia there are 6911 sub-districts, 510 regency/district/cities, and 34 provinces. Looking into the constraints of effective climate information used by Patt and Gwata (2002) and the way in which the integrated crop calendar developed, we see that the government has clear goals. The calendar is developed to guide farmers in their farming practices in order to increase production and food security for Indonesia. The ICC is published thrice a year and gives a prediction for the whole season and is not updated in between. All available information is made accessible to stakeholders and decision makers anytime and anywhere using website and android application.
Since 2014, the Ministry of Agriculture has been implementing self-sufficiency acceleration program called UPSUS. The UPSUS program involves all extension staff in Indonesia, the Indonesian army, researchers and farmers. UPSUS program allows members of its extension staff to monitor the rice crop status including the reports about the coordinates of the rice crops. Using android phones is an obligation for all extension services and army Liaison Officer. Android cellular allow UPSUS involved staff to real time rice standing crop monitoring coordinates through open camera and is reported to the UPSUS center through the Whatssup application. Standing crop of rice should be reported daily from 7,071 sub districts, 514 Districts/Regency and 34 Provinces to the data center located in the Ministry of Agriculture office, Jakarta. Open camera application allows the staff to monitor the standing crop status of rice field including identification of un-used lands so that action plan can be further developed.
TANI-HUB: Android Based Shopping of Fruits and Vegetables

Mobile communication technology in general and mobile application for agricultural development in particular, hold significant potential for advancing development of product marketing Tani-Hub software is designed to take advantage of mobile technology and can be developed for other technologies besides mobile phones. The framework is designed to help consumers understand how android application can be used to improve services and support enabling environment for innovative m-Tani-Hub application.

Tani-Hub is the largest online shopping for fruits and vegetables in Indonesia. Tani hub focuses on improving agriculture supply chain integration and has a wide range of functions, such as providing information on organic and non-organic products, price information and facilitating market links. Users are diverse including produce buyers, cooperatives, input suppliers and other stakeholders who demand useful and affordable services. Tani-Hub has an advantage by taking fruits and vegetables directly from the farmers, so that the freshness and quality is guaranteed. Tani Hub application has been successfully applied for online product sell particularly for big cities in Indonesia such as Jakarta, Surabaya, Bandung, Tangerang and Bekasi.

![Tani Hub interface for online agricultural sales in Indonesia](image)

Indonesia’s Rice Knowledge Bank

Indonesia’s Rice Knowledge Bank provides up-to-date information on rice and rice-based cropping systems for farmers and extension workers in Indonesia. Indonesia’s Rice Knowledge Bank was developed in close partnership with the Indonesia Center for Agricultural Library and Technology Dissemination (ICALTD) under the Indonesian Agency for Agricultural Research Development (IAARD). The Indonesia Rice Knowledge Bank is a treasure of rice knowledge. It is a dynamic source of knowledge in rice and rice production technology. It is a repository of rice knowledge and online rice and rice based knowledge hub prepared and maintained by scientists of the Indonesia Rice Research Institute. Most materials- fact sheets, training manuals, booklets, leaflets, brochures, posters, videos have been prepared in Bahasa, which are easily understandable to farmers and extension workers.

The main contents of Indonesia Rice Knowledge Bank are the following: 1) Cultivation method of rice in Indonesia; 2) Variants of seasonal rice and its cultivation method; 3. Rice and its production method; 4) Agronomy and rice production method; 5) Fertilizer and soil management; 6) Rice insects and their management; 7) Rice diseases and their management; 8) Quality rice seed production and preservation methods; 9) Post harvest handling; 10. Environment and policy on rice distribution and marketing; etc. (Pustaka, 2008).
Application of System Modeling

The Indonesian Agency for Agricultural Research and Development (IAARD) has been applying dynamic approach through system modeling in order to design the strategies for achieving the maize self-sufficiency program in 2017. Maize production system is interrelated and supported by many factors such as seeds, farmers, postharvest system, mechanization in maize production, pests and disease control, level of fertilization, water, land, incentive, supply chain, and the feed industry. Each system is interrelated and is to be formulated so that the prediction system is acceptable. Input-output diagram of Indonesia maize production system is shown in Figure 6.

![Input-output diagram of Indonesia maize production system](image)

As shown in Figure 6, maize production system and supply chain system is affected by three inputs, one expected output and one unexpected input. The environment inputs affecting maize production and supply chain are climate, water availability, land and natural disaster including pests and disease outbreaks. The controllable inputs include fertilizers, seeds and pesticides, irrigation, land conversion, farmer motivation, post-harvest handling and distribution channels. In addition, uncontrollable inputs including number of population, market price/ﬂuctuation and maize supply. The expected outputs are classified into five outputs i.e. sufficient level of production, sufficient level of supply, meeting the demand, efficient maize supply chain and affordable investment cost. Meanwhile unexpected outputs are high fluctuation of market price, high investment cost and high impact.
As shown in Figure 6, the existing production area in Indonesia in 2012 is approximately 3,996,973 ha with average productivity is 5.45 t/ha. The existing production is about 21,770,088 tons. Based on the existing calculation, sensitivity analysis was performed in order to identify the most affecting parameter to enhance the production to 29,000,000 tons in 2017. Among the parameters tested, it was found that water availability, seeds and fertilizer use are among the three most affecting parameters, and by increasing the leverage of those parameters into a certain value, will sharply increase the production. Based on the simulation result using Powersim Software, in order to achieve maize self-sufficiency in 2017, the government has to increase the area production to about 4,999,000 ha and also increase the productivity to 5.82 t/ha. The overall policy recommendation of dynamic modeling of maize self-sufficiency is shown in Figure 8.
CI-Agriculture

CI-Agriculture was established in 2015 to harness the power of big data technology to solve challenges in agriculture in Indonesia. CI agriculture is aimed to benefit the whole ecosystem including smallholder farmers, agriculture companies, microfinance institutions and agricultural producer supplier. CI- agriculture is built using Smart Farming Platform that enhances the productivity of agricultural companies that works with smallholder farmers, giving insights on field potential, farm inputs management, anticipation of pests and diseases. CI-agriculture has been empowering thousands of farmers in Sumatra and Papua islands to improve land productivity by using smart farming and precision agriculture solution.

![CI-Agriculture Platform](image)

Figure 9. CI-agriculture platform

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