Application of ICT tools in food crops monitoring in Indonesia

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Abstract. Indonesian “Working Cabinet” 2014-2019 is placing more attention on agricultural sector, particularly 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. Indonesian government has also inspired to renewed enthusiasm to use new information and communication technologies (ICTs) for agricultural services. Driven by significant role of ICT, research institute, universities, and related associations have actively involved in ICT application in agriculture for recent years. The aim of the paper is to review/analyze role, potential and contribution of ICT in agriculture and to explore opportunities for use of 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 story 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 ensuring farmers and increases their capacity to make effective and informed decisions.

1. Introduction

Information and communication technologies (ICTs) have transformed lives across Indonesia. ICTs have been widely used in information related field 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 rural whereas 44% is urban. However, it is projected that in 2017, about 56% of population in Indonesia is urban and the remaining 44% living in rural areas. Under the new “working cabinet” of 2014-2019, the development of modern agriculture techniques and human resources, the two main priorities in Indonesia’s agriculture program, have managed to boost the agriculture 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 also had provided 180,000 units of agriculture machinery, which consisted of tractors, water pumps, combine harvesters and rice transplanters. The government had also distributed US$4.49 billion fertilizer subsidy and 527 organic fertilizer processing units. The government had also granted agriculture insurance to protect 373,000 ha of land from crop failure risks [1].
Information and communication technologies have become an important part to the progress of rural and semi urban in Indonesia. [2] Stress that technological innovation and the adoption of new technologies provide great opportunities for growth in service sectors such as agriculture, health, education, banking and insurance. This being the case, countries have identified ICT as an important component in moving the country subsistence-based economy to a service –sector driven, high value added information and knowledge based economy, that can compete effectively on the global market [3]. After the introduction of ICTs in agricultural sector, the traditional agriculture has been reformed, thus significant improvement in agricultural productivity and sustainability has been reached. Over the last two decades, Indonesian governments has invested substantial amount of effort to develop ICT-based agriculture information dissemination system [4]. As a result, various innovative and effective information dissemination channels (called Multi channel dissemination system) have been emerged and widely used.

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

2. Overview of Food Crops Production System in Indonesia

Indonesia is the third largest producer of rice in the world after China and India [5]. For the last three decades (1993-2015), rice production 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 in the last three decades remained almost stagnant i.e. 11.4 million ha in 1993 to 14.1 million ha in 2015 (Figure 1). Rice production is still rising in the future to meet rising demand for various purposes.
Maize production in Indonesia contributing approximately 2% of the global maize production. In Indonesia, maize is grown in all the seasons i.e., rainy season and dry season. Among these two seasons, nearly 65% of the production is from rainy season and 35% during dry season. Since the maize is rain dependent, it is mainly grown during 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 importer to levels of self-sufficiency. For 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 in the last three decades from < 1 t/ha in 1971 to 5.2 t/ha in 2015. In contrast, maize area in the last three decades remained almost stagnant i.e. 2.8 million ha in 1971 to 3.8 million ha in 2015 (Figure 1). Maize production is still rising in the future to meet rising demand for various purposes. Diversified uses of maize also prompted higher production in Indonesia. Presently, maize is mainly used for feed industry and the remaining is used for food, starch, etc.

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, maize is one of the important staple foods. 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 with the contribution of about 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.

3. 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. [6] 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 for making quality decisions in efficient management of their enterprises.
Furthermore, [7] categorizing mechanism of agricultural information service systems into three types: Government-led, market driven and community self support. The government-led mechanism normally follow 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 [8]. The market 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 phone and database monitoring, and e-learning for agricultural information services. In order to determine the most appropriate dissemination channels, farmer’s capability and behavior, operating cost and local context should be taken into consideration [9].

4. Success Stories on Agricultural Information System

4.1 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 Ministry of Agriculture, Indonesian National Institute for Aeronautics and Space (LAPAN), and International Rice Institute for Climate and Society (IRI) and Ministry of Public Work.

The SIMOTANDI project aims to develop a monitoring and information system for rice production in Indonesia. SIMOTANDI 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 crop 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 any time and any where using website and android application.
4.2 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 of the country. The ICC is produced three times 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 build up in two parts, the rainfall prediction/start of the season and an advisory part with regard to crop variety and fertilizer. 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 this 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 on updated but meant for the farmers and governments long term planning. Further the integrated crop calendar contains advice on fertilizers, the combination and amount to use. ICC also provide 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 until the national scale. In Indonesia there are 6911 sub-district, 510 regency/district/cities, and 34 provinces. Looking into the constraints of effective climate information used by [10] 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 3 times 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 any time and any where using website and android application.
4.3 Realtime Crop Monitoring Through Open Camera
Since 2014, Ministry of Agriculture has been implementing self-sufficiency acceleration program called UPSUS. UPSUS program involving all extension staffs in Indonesia, Indonesian army, researchers and farmers. UPSUS program allows extension staffs to monitor the rice crop status and reporting including coordinates of the rice crops. Using android phone is an obligation for all extension services and army Liaison Officer. Android cellular allow UPSUS involved staffs to real time rice standing crop monitoring coordinates through open camera and reported to the UPSUS center through Whatsup application. Standing crop of rice should be reported daily from 7071 sub districts, 514 Districts/Regency and 34 Provinces to the data center located in the Ministry of Agriculture office, Jakarta. Open camera application allows staffs to monitor the standing crop status of rice field including identification of un-used lands so that action plan can be further developed.

4.4 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 designed to take advantage of mobile technology and can be developed for technology 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 focus on improving agriculture supply chain integration and have 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.
4.5 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 maize self sufficiency program in 2014. Maize production system is interrelated and supported by many factors such as seed, farmer, postharvest system, mechanization in maize production, pest and disease control, level of fertilization, water, land, incentive, supply chain, and feed industry. Each system is interrelated and is to be formulated so that the prediction system is acceptable.

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 pest and disease outbreak. The controllable inputs are including fertilizer, seed and pesticide, irrigation, land conversion, farmer motivation, post harvest handling and distribution channel. 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 4, 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 ton. 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 ton in 2014. Among the parameters tested, it was found that water availability, seed 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 sufficient 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. 5
Figure 5. with the policy recomendations to achieve maize-sufficiency in 2014.

4.6 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 institution and agricultural producer supplier. CI-agriculture is built using Smart Farming Platform that enhances the productivity of agricultural companies that work with smallholder farmers. giving insights on field potential, farm inputs management, anticipation of pest and disease. 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.

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