RiTx; Integrating among Field Monitoring System (FMS), Internet of Things (IOT) and agriculture for precision agriculture

B D A Nugroho¹,² and H K Aliwarga¹

¹ Department of Agriculture and Biosystem Engineering, Universitas Gadjah Mada, Indonesia, e-mail: bayu.tep@ugm.ac.id

Abstract. As developing country with industrial revolution 4.0, agro-technology, Internet of Things (IoT), E-Commerce and logistics technology is an important point in Indonesia. Although there has been many agro-knowledge and information systems for farmers, but a little information in integrating among agriculture, IoT and field monitoring systems (FMS) technology for farmers in Indonesia. RiTx or Agricultural Technology is one of application for farmers with integrating among agriculture, IoT and field monitoring system technology. RiTx provides real-time, localized soil and weather data and field-level agronomic intelligence, which support farmers to decide their decisions during planting until harvesting, so failure during planting season can be eliminated. The province of East Nusa Tenggara (NTT) is cluster of islands located in the south – eastern part of Indonesia. The monsoon season stretches from October to March each year. Outside of the monsoon season, the climate of NTT is relatively dry. This study focuses on applying FMS technology with IoT for agricultural precision. For this study, field monitoring system was set up in the field since 26 July 2017 in Kupang, NTT Province that is consisted of three main components, i.e., FieldRouter, Datalogger and the sensors. Here, there are several sensors that have been installed in the field, e.g., solar radiation, rain-gauge and soil moisture. As the results, the IT field monitoring system showed good performance and reliable for precision agriculture. The actual field conditions were monitored well in term of image, numeric, and graphical data acquisition. Based on monitored data, plant growth can be well monitored. In addition, dynamic changes of environmental parameters can be monitored as well. Finally, it can help farmers in the future, not only in Indonesia or South-East Asia but also in the world, so prosperity for farmers can be granted.

Keywords: field monitoring systems, internet of things, precision agriculture

1. Introduction

East Nusa Tenggara (NTT) is a province with typical monsoon climate with low annual rainfall and relative dry. Increasing population and reducing arable area have increased the challenges to raise rice productivity. Furthermore, climate change has affected on any sectors including agriculture, forestry and fishing (Bayu, 2016). During El Nino years, the start of the monsoon is often delayed and the amount of rainfall reduced, exacerbating the vulnerability of communities in the province (IRI-Columbia, 2013). The increasing variability of weather, attributed to climate change, has also affected farming in NTT, in particular affecting the start and duration of wet seasons (Montgomery et.al, 2010). This uncertainty contributes to the food security households. In contrast, La Nina cycles often lead to high rainfall and flooding, also contributing to crop failures. These climatic factors are the major causes of food insecurity in NTT, along with other factors such as pests and plant diseases (Muslimatun and Fanggidae, 2009).
Sustainability of rice farming is depending on water resource. When its scarcity became increasing due climate changes, water saving technology for rice farming is essential. In the other hand, industrial revolution 4.0 in agricultural sector is increasing in recent years (Gardjito et al. 2008). Many companies have been developing agricultural application based on android platform. But, the agricultural application still in specific feature; e-commerce, agro-knowledge and market place, not yet any integrating feature in one application, especially in agricultural technology application. RiTx or Agricultural Technology is one of application for farmers with integrating among agriculture, IoT and field monitoring system technology. RiTx provides real-time, localized soil and weather data and field-level agronomic intelligence, which support farmers to decide their decisions during planting until harvesting, so failure during planting season can be eliminated.

However, to test the FMS and IoT, we have set up FMS in the field in Kupang, East Nusa Tenggara Province. To provide for this investigation, we needed data on rice field environment such as soil and meteorological data through continuous measurements. Soil moisture data are important to identify water availability in the field. Meanwhile, information on meteorological data such as precipitation, air temperature, relative humidity, solar radiation and wind speed are required to consider natural environmental effect in determining water availability in the field.

Aims of this research is application of Information Technology (IT) Field Monitoring System in providing precise environmental data to support precision agriculture in Indonesia and can be monitored with RiTx Apps. The output of the application is expected to be used by farmers and increase the land and water productivities under the climate change situation.

2. Materials and methods

2.1. Study area
This study is located in 8° – 12° S dan 118° – 125° E, East Nusa Tenggara Province (Figure 1). The province is divided into 20 district and one municipality, Kupang, which had the highest population density in the province in 2012 (around 2,496 people per km²) (BPS, 2010). Outside of the monsoon season, the climate of NTT is relatively dry. Inter-annual climate variability is caused by El Nino Southern Oscillation (ENSO) that affects the start and end of the monsoon as well as the amount of rainfall.

Figure 1. The newest regencies of East Nusa Tenggara showing borders, capital cities and regency names (ANU, 2015).

2.2. Methods
The field monitoring system was set up under natural environment in Tarus sub district, Kupang, NTT since 26 July 2016. Rice plant was planted on 29 July and harvested on 22 November 2017. The schema of IT field monitoring system was figured out in figure 2.
Figure 2. Scheme of Field Monitoring System (FMS).

There were 5 sensors that have been installed in the field, i.e., solar radiation, rain gauge, anemometer humidity and air temperature, and soil moisture sensors. All sensors were connected by cable to data logger. All measurement parameters were stored in that logger every 5 minutes. Then, FieldRouter will accumulate the data and send them using internet connection to server. The server realtime will received the picture of field condition. User can access the data through the RiTx Apps publish the data in term of numerical and graphical data.

3. Results and Discussions

3.1. Developing Field Monitoring System (FMS)

Developed field monitoring system, all monitored data including numerical, graphical and images can access data through RiTx apps in real-time data every 5 minutes update. For this monitoring, RiTx apps can be downloaded, and was prepared to present 5-minutes update monitored data. The interface of the RiTx Apps can be seen on figure 3.1) In that app, all data were updated real-time, and early warning system for field condition also available. So, if any low or high weather and soil condition in the field, the farmer will get notification and they can anticipate the condition based on recommendation from the apps.

Figure 3. (a) Interface of RiTx Apps based weather and soil data and recommendation; (b) data presented in website based system information: a) daily image during one month, b) graphical data, c) numerical data.

In addition, there are two more types data, i.e., numerical and graphical data. Numerical data represented environmental data measured by the sensors every 5 minutes update. Graphical data represented the dynamic changes of each environmental parameter. The sample both numerical and graphical data can be seen in figure 3.2). Based on this data, farmers can be estimated next conditions in the field, so failure of planting and harvesting can be avoid.
3.1.1. Dynamic changes of environmental parameters. On the RiTx Apps, dynamic changes of environmental parameters can be monitored. Figure 4a shows dynamic changes of daily solar radiation. Solar radiation was fluctuated. During August to September, the higher solar radiation was occurred during August 28 to September 7. The lowest solar radiation occurred on October when their values reached 60 MJ/m2/day.

![Figure 4a](image1)

Figure 4a shows dynamic changes of daily average solar radiation.

![Figure 4b](image2)

Figure 4b shows dynamic changes of precipitation during planting season. Precipitation had fluctuated trend with in the beginning of planting (August 27-September 3), precipitation was less, and then the trend was increased from September 4 to 24. But, during September 24 to October 7, the trend was decreased again. The high precipitation occurred on October 27.

![Figure 4c](image3)

Figure 4c shows dynamic changes of solar temperature and air temperature. Dynamic change in solar radiation and air temperature was fluctuated, which is air temperature range around 25°C during planting season.

4. Conclusions

In this study, the IT field monitoring system showed good performance and reliable for monitoring in the field. The soil and weather data can be monitored in real-time 5 minutes update. The real field conditions are well monitored, in term of images, numerical, and graphical data. Based on monitored data, dynamic changes of environmental parameters can be monitored as well. These results can be proved that agro-technology can be applied to support precision agriculture in Indonesia. In the future, it will be useful for farmers to avoid failure in planting and harvesting due to climate change conditions.

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Acknowledgements
This research was part of a research project entitled “Climate Projection and Adaptation Strategy of System of Rice Intensification (SRI) Cultivation against Regional Climate Change by integrated climate-crop-soil-water model approach in East Nusa Tenggara” funded by Indonesian Climate Change Trust Fund (ICCTF) during March 2016 to March 2018 (2 years).