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Introduction Technology of Cropping Calendar-Information System (CC-IS) for Rice Farming as A Climate Change Adaptation in Indonesia

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Abstract*— Challenges in food production in the future are becoming more complex. Factors affect food production includes climate variability and climate change. To adapt the impact of climate change, Indonesia Agricultural Research and Development has designed a Crop Calendar-Information System. This technology contains recommendation on planting time, cropping patterns, and adaptive technology with Integrated-web-based according to climate prediction and season-to-date. Although it has been launched officially since 2011, the uses as consider for farming in sub-districts are remain low. This paper aims to present the process of designing the CCIS, the dissemination activities, and process of getting feedback to improve the CCIS implementation. Survey was done using a mail survey in 33 provinces for a year during January–December 2014. The data was collected three times for a year covered 32 provinces. The data collected consist of primary and secondary data.. Observations were carried out to determine the role of CCIS provider. Methods of data analysis use descriptive qualitative method through tabulation, data summary, data reduction, data display, then conclusion and verification. Result shows that on average, there was 10 socialization held in 10 sub-districts with 200 extension officers attend the session. The most common dissemination methods use printed media and direct communication (70-88%) and the least use visual communication-radio/television (12%) and field demonstration (6%). Furthermore, feedback of the CCIS dissemination shows that hardly any sites implement the CCIS recommendation because of unavailability of recommended variety and water availability (43,25%), whereas 52,75% said that the recommendation was less suitable with their condition and less frequency in doing socialization. According to the validation activities done in 16 provinces, the suitability of planting time vary compared to the actual planting time. In rainy season (MH), 37.5% of the sample district had the accurate prediction range from 64% up to 90%. Although the technology is widely spread, it still needed effort to ensure farmers and local stakeholders to use the CCIS as a recommendation technology to minimize the impact of the climate change.

***Keywords*— crop calendar information systems; dissemination; feedback**

I. INTRODUCTION

Challenges in food production in the future are becoming more complex. Factors affect food production includes climate variability and climate change. The climate also impact to the availability of water. In addition, water availability and food production are very vulnerable to climate change. As well, prolonged droughts and increased flooding can disrupt food production. One of the recorded drought happened in 1997. It was the heaviest droughts in the last 20 years. At that time, 500 thousand hectares of rice fields experiencing a period of drought, which cause lost in yield for one season. Another heavy drought happened in 2006, where 260 thousand hectares of paddy fields have failed harvests.

In the same time, flooding and explosions pest organism also become another risk of climate changes. Based on data reported in Deslnventar [1], 58 million hectares of crops damaged and 11 million livestock died due to natural disasters occurred between 2003 and 2013. This damage is equivalent to 11 billion US dollars. According to results of the research related to this issue indicate that agricultural sector is the most severe in facing of the climate change. Therefore without attempt of anticipation, agriculture will face a problem that extends to production and socio-economic conditions [2].

Efforts are being made to anticipate those impacts such as adjustment the most appropriate cropping patterns with low-risk threat to climate variability and climate change. The use of ICT to broaden the dissemination of information and technologies is commonly done [3]; [4]. Furthermore, dissemination of information and technologies of climate change adaptation is a collection concept of diffusion process, behavior of the resources and the recipients in the system, perceptions, capacity, and participation [4], [5].

For those adaptations, Indonesia Agricultural Agency for Research and Development (IAARD) has designed a Cropping Calendar Information System (CCIS) Technology. In detail, the technology contains recommendation adaptive technology with Integrated-web-based according to climate prediction and season-to-date. Information in the CCIS consist of (1) time planting and cropping patterns; (2) potential planting area for each season on rainy, normal, and dry conditions; (3) adaptive technology on varieties, fertilization systems, and control of plant intruder organism. The recommendation is available up to sub district levels to reduce the risk of decline and failure in rice production due to flood, drought and pest attack.

The CCIS is designed in a simple format to be easily understood by users such as extensions and farmers in setting up the calendar and rice-crop pattern (irrigated, rain fed and swamps) in accordance with the climatic conditions. The CCIS version 1.4 was released in 2013, which first launched in 2011. The current version is completed with technology information for adaptation in national level up to districts [6]. Although it has been launched officially since 2011, its usage for farming planner still remains low. Therefore, efforts are needed to accelerate the dissemination of CCIS. This paper aims to assess the dissemination of CCIS and its feedback.

II. Methodology

A. *Framework for the AIAT's Task Force in supporting the dissemination of CCIS*

In preparing the CCIS for each planting season, there are two task forces has been designed, namely National Task Force (Nat-TF) and Provincial Task Force (Prov-TF). The Nat-TF consists of experts on climatology and information technology (IT) to create and maintain the CCIS. The Nat-TF will set up a planting recommendation based on data from National Climate Center and National Statistics Agency. Furthermore the CCIS then be launched before each planting season to inform a suitable planting time and technology recommended regarding to the existing climate condition in each sub-district.

In provincial level, the task force is done with Agricultural Institute for Assessment Technology (AIAT) in 32 provinces. They have roles to verify the recommendation on CCIS as an improvement for the next CCIS' edition. As well, AIAT have works to disseminate the information on CCIS and collect feedback in each province/district. Verification in the first growing season is very important because it is sequentially for the next growing season. The data to be verified includes rice fields areas, planting time, fertilizer type and dosage, possibility of the flooding, drought and pest attack. Validation is done through interviews focus group discussion with farmers.

As shown in Fig.1, socialization (step 6) and verification/validation (step 7) is done by the Prov-TS. Whereas, step 1 until 5 is done by the Nat-TF. Detail of the cycle is as shown in Fig.1. There are seven activities in preparing the CCIS. First, Collecting and updating database in national level is organized by Agroclimate and Hydrology Research Center (IAHRC) and supported by Center for Rice Research (ICRR), Center for Agricultural Engineering (IACAE), Indonesian Agency for Meteorological Climatological and Geophysics (IAMCG), and statistics Indonesia Agency (SIA).

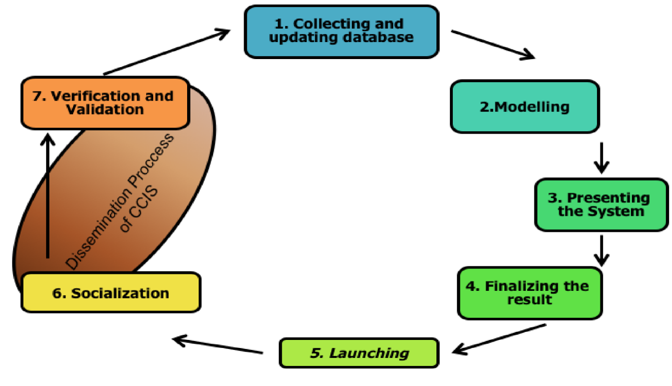

Fig. 1 Role of Task Force in National and Provincial Level in CCIS Cycle

Furthermore, IAHRC processes the data through modeling, presenting the system, and finalized the result. After the process is successful, the CCIS ready to be launched. Lastly, the information is socialized and verified by BPTP through collaborating with local government and BBSDMP (extension officer). Resume of activity and Organization in charge is as the following table.

TABLE I

ORGANIZATIONS INVOLVED IN THE PROCESS OF CCIS SYSTEM

No	Activity	Organization	Other Supporting Organization
1	Collecting and updating database	Balitklimat	BB Padi, BB Mektan), BMKG *), BPS *) (data)
2	Modelling	Balitklimat	
3	Presenting the Sysytem	Balitklimat	
4	Finalizing the Result	Balitklimat	
5	Launching	BBSDLP	
6	Socialization	BPTP	BBP2TP, Local Government, BBSDMP (coordination),
7	Verification and validation	BPTP	BBP2TP, Local Government, BBSDMP (coordination)

B. *Time and Place*

The survey was done by a mail survey in 32 provinces during January– December 2014. The data was collected three times (MT-I; MT-II; MT-III), based on the launching periods of CCIS.

C. *Data Collection*

The data collected consist of primary and secondary data. Methods of data collections are through literature study, observation and questionnaires. The questionnaires were distributed by mail survey through 33 provinces. Observation was carried out to determine the role of the CCIS' provider. In doing this, the researchers involved as an observer by utilizing coordinator the CCIS in 33 provinces. Therefore, researchers can directly interact with the provider of CCIS.

D. *Data Analysis*

Methods of data analysis use descriptive qualitative through tabulation, data summary, data reduction, data display, conclusion and verification. (1) Tabulation of the data is the process of integration data and information obtained from each target research into one unified list to be easily read or analyzed; (2) Data Summary is the sum of each target group research that has similar character based on certain criteria; (3) Data reduction is a process of reducing less necessary and irrelevant data or adding the lack-data; (4) Presentation of the data is the process of gathering information, sorted by categories or groupings required and (5) Interpretation of the data is the process of understanding the meaning of data presented.

III. Results and Discussion

A. *Designing and Development the CCIS by IAARD*

Terminology used for the CCIS is planting calendar or cropping calendar. The cropping calendar is defined as a schedule of rice or other crops growing season from the fallow period and land preparation; crop establishment and maintenance; harvest and storage. In general, using cropping calendar or planting calendar has a purpose for better planning of all farm activities and the cost of production [7].

The early stage design of the cropping calendar is in the form of atlas in printed and CD. This form later developed into the CCIS in 2010. The Cropping calendar contains a collection of maps planting calendar per district, issued yearly with a series of the wet, normal and dry year. According to FAO (1996), the cropping pattern consists of three major parts, namely the calendar cropping, cropping intensity and cropping rotation. Reference [5] state that the Ministry of Agriculture uses the term Planting Calendar Atlas, which contains information on initial estimation of the planting time, the potential acreage, crop rotation, and crop intensity in each district for each season during one-year cycle, based on scenarios on wet year (La Nina), normal year and dry year (El Nino). Planting Calendar Atlas is based on the existing condition of cropping patterns in the field and its potential conditions by using climatological analysis. Furthermore, IAARD develop the atlas gradually for (1) Java, (2) Sumatra, (3) Kalimantan, (4) Sulawesi, and (5) Bali, Maluku, Nusa Tenggara and Papua. For simplify, the flowchart of designing the CCIS is as in Figure 3.

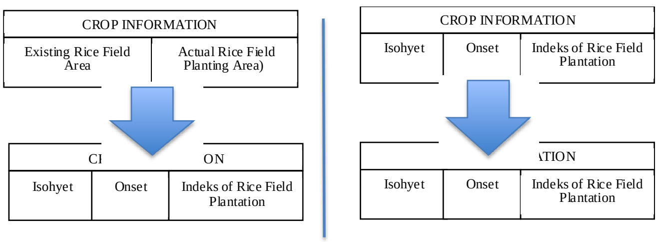

Fig. 2 Flowchat on Preparation of Crop Calender (a) Existing and (b) Potential [5]

The benefits of planting calendar atlas are [8]: (a) determining the cropping pattern in spatial and tabular mode in the district level, (b) determining crops rotation in each district based on potential climate and water resources, (c) supporting the planning crops, especially food crops annuals, and (d) reducing the adverse impact of the shift in the planting season on farmers losses. The planting calendar also dynamic - as compiled by some climatic conditions; operational in scale of local climate and water resources; easily understood as it is made in spatial and tabular structured with a clear description.

However, some limitations are encountered during the preparation of the planting calendar, especially relating to: (a) dynamics of development of new districts so that the atlas have to adjust with the new list, (b) availability on time series data of rice planting area varies between districts, and (c) limited availability of climate data, especially outside Java Province. This affects the quality of climate information in spatial and tabular. Examples of the planting calendar map as in Fig 4.

Fig. 3 Left: Planting Calender Map of Java Island, Wet Season, 2007; Right: Planting Calender Atlas

An accurate information and broad scale of recommendation, is a challenge while preparing information in the Cropping Calendar. In 2011, begins with the realization that the assumption of static nature of the climate throughout the year needs to be corrected, the information is then combined with the results of climate predictions from the IAMCG. With this approach, each zone of the season shows different results between seasons. Therefore, information on climatic characteristics that were assumed indifferent throughout the year has been identified different according to three distinct seasons based on predictions of climate characteristic. This improvement ensures users get the latest information [9].

The additional information apart of the initial planting in each sub-district level has change the “dynamic cropping calendar” into “integrated planting calendar”. To accelerate dissemination information all over the nation, the CCIS is presented in the form of “web-based information system”. This new form of the Cropping Calendar renamed “Integrated CCIS”. The CCIS is interactive format that simplify and accelerate users in accessing the information. Development of CCIS is based on three major subsystems, namely database, model, and search (query). The software used in the development of the CCIS are ArcGIS Desktop 10, Visual Basic Studio .NET 2010, ArcGIS Server10, Microsoft Server 2010, Microsoft SQL Server 2010, and DXperience Enterprise [7].

The database contained in the CCIS consists of: (1) general information, (2) Cropping Calendar and estimation of planting area with supported of water resources. The information of CCIS is updated at least three times a year at the beginning of each growing season for all districts in Indonesia. The information vary depend on pattern of rainfall. In general, growing season (MT) are grouped as follows: (1) MT I: 3rd week of Sept/1st week of Oct - 3rd week of January / 1st week of February; (2) MT II: 2nd/3rd week of feb/3rd - 3rd of May/1st June; (3) MT III: 2nd/3rd June - 1st/2rd Sept [8].

B. Dissemination of the CCIS

The CCIS is published three times a year before the beginning of the growing season (MT I, MT II, MT III). Socialization is done after the CCIS has launched. Socialization activities can be done more than once per growing season according to the resource availability of each Prov-TP and the needs of the information. During 2014, the most number of socialization activities was in MT I, which held 226 times accounted for provincial, district and sub-district level. The least number of those activities was in MT III, held only 65 times. Whereas, the socialization held in MT II approximately half number than those in MT I.

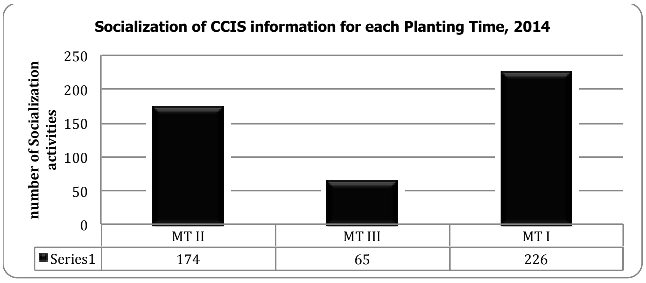

Fig. 4 Number of Socialization Activities in MTI-III, 2014

At the district level, the socialization activity such as meetings or regular extension held in the AEA. Every month usually the district extension officer takes their monthly incentive payment in the AEA. In the same time, the Prov-TF disseminating CCIS' recommendation in printed material. In the sub-district level, the socialization can be performed in conjunction with Extension activities and simultaneously distributing the CCIS information in poster. The posters then have to be posted in BP3K. Socialization was done to farmers and extension workers. In some locations, the dissemination of the CCIS use banner or billboard. This was done to shows districts resident the planting schedule. In a farmer level, socialization was done through group meetings and field activities.

Participants of the socialization comprise of extensions, farmers, local governments, institutions or organizations in the non-agricultural related, as well as private and local agriculture. On average, socialization conducted during 2014 was 10 locations in the sub-district level. While the average agents attend the activities were 200 people and 50 people for the agency attendance in average.

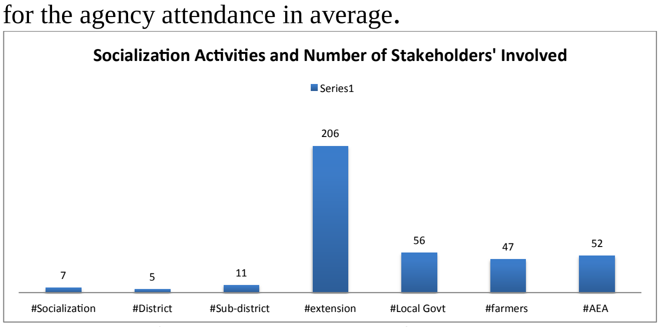

Fig. 5 Number of Location and Participants of CCIS's Socialization, 2014

Methods used for socialize the CCIS consist of face-to-face meetings, demonstration or field trials, manufacture and distribution of print media, and radio or television. The least Method of dissemination was done through radio or television (12%) and field demonstration (6%). In contrast, the face-to-face meeting, leaflet, and synergy dissemination with other party are dominant methods for dissemination. The CCIS range between 70-88%.

The most dominant methods of dissemination ware face-to-face activities (88%). This was done through: (a) coordination meeting with local government to advocate CCIS; (b) training for capacity building of extension workers in CCIS;(c) Extension, field practice, and demonstration site to increase the ability of farmers to understand and implement the CCIS recommendations; (d) Socialization by utilizing local institutions.

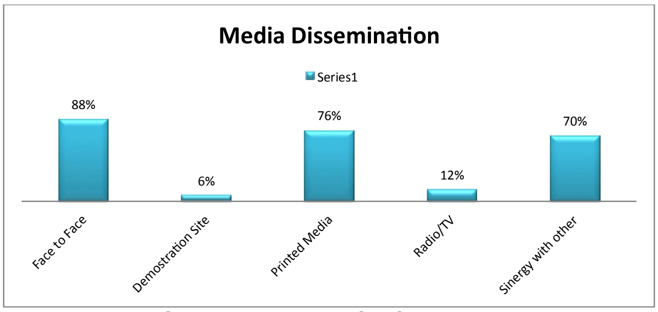

Fig. 6 Media Dissemination Used in the CCIS, 2014

The second most dissemination method is distribution in printed media (76%). The printed materials include magazine, leaflets, posters, brochures, and CDs. Furthermore, the electronic media or digital include web, text message, android, email, television, and radio. For those areas not covered by direct socialization, socialization was done in CD format and text message. Media dissemination with the most produced is a leaflet (13 811 shares), followed by posters as much as 7608 pieces. Whereas the least media produced was booklets (only 1215 pieces).

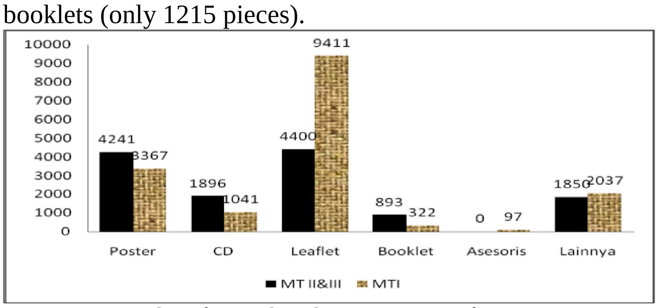

Fig. 7 Number of Printed Media Dissemination for CCIS, 2014

C. Feedback on Utilization the CCIS

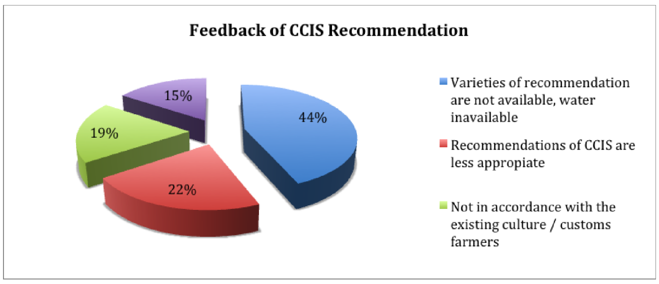

Fig. 8 Feedback of CCIS's Information, 2014

Regarding to the CCIS utilization, result shows that information from the CCIS still less utilized by the stakeholders. The most reason was there is no availability of recommended varieties (44%). The others had response that the CCIS recommendation is not suitable for their condition (22%). Another reason is about the limited information on CCIS and unsuitable with usual existing farming culture, range from 15-19%.

D. Result on Validation and Verification of the CCIS

In the cycle of preparing the CCIS, validation and verification is part of the activity to get feedback from the implementation of the CCIS. Verification of the CCIS aims to evaluate existing planting season done by farmers compared with those recommended. According to the validation activities done in 16 provinces, the suitability of planting time vary compared to the actual planting time. In rainy season (MH), 37.5% of the sample district had the accurate prediction range from 64% up to 90%. Whereas, majority of the validation shows that the existing planting time are less suitable in MH. Furthermore, for dry season (MK), the percentage of % Suitability of planting as recommended versus planting existing shows indifferent with those in MH. In MH, around 37.5% 37.5% of the sample district had the accurate prediction range from 64% up to 100%. Some interesting data shoes that 37.5% location had very different existing planting time, compared with those recommended. In general, the differences between existing planting time and its recommendation are for three *dasarian* or about one month backward or forward in MH or MK.

TABLE II
VERIFICATION THE CCIS IN SOME AREAS IN INDONESIA, 2014

No	Province	Verification			
		No of sampling dictricts	% Suitability of planting as recommended vs planting existing		Explanation
			Rain Seas. (MH)	Dry Seas. (MK)	
1	East Kalimantan	3	0%	67%	Planting time in rain season (MH) backwards 3 dasarian
2	West Sulawesi	6	90%	90%	-
3	Bali	53	42%	19%	Majority of planting time in rain season (MH) and dry season (MK) backward. There are four districts had forward planting time.
4	Central Sulawesi	11	79%	na	Verication done only in MH
5	Central Jawa	8	60%	na	
6	Banten	7	14%	0%	Majority of planting time forward 3 dasarian
7	West Java	2	90%	90%	-
8	East Java	81	90%	90%	-
9	West Sumatera	14	64%	64%	Some district had backward or forward planting time in MH and MK for 3 dasarian.
10	South Sumatera	10	0%	0%	Backward planting time in MH and MK for 3 dasarian Two location in idle period
11	North Maluku	6	17%	0%	Most of the district had backward for 3 dasarian
12	Papua	3	0%	0%	-
13	West Kalimantan	4	25%	50%	Most of the district had not planting during MH. In MK, some of location had forward planting time.
14	South Kalimantan	11	na	18%	Most of the district had backward for 3 dasarian in MK
15	Maluku	2	0%	100%	Some district had forward planting time in MH
16	Central Kalimantan	8	50%	na	Some district had backward/forward 3 dasarian

Source: Annual Report, 2014

Validation of the CCIS aims to examine rice production by using recommended technology and compare the result with those applied in existing farming. Validation is done through a field site. According to the data taken from eight locations, the average district to be validated is two locations in each province with area of the field experiment range from 0.5 to 6 ha. The majority recommendation technology implementing by users are planting methods, fertilizer, and variety(s). Rice production in the filed site had 7.4 t/ha in average, higher one ton compared with those in unapplied.

TABLE III
VALIDATION OF THE CCIS IN SOME AREAS IN INDONESIA, 2014

No	Province	Validation				
		No of District validating	Experimental field site (ha)	Recommendation Technology of CCIS implementing	Rice Production (t/ha)	
					No of Applicants	No of Un-Applicants
1	East Kalimantan	1	0.5	Planting method, variety(s)	Na	na
2	Southeast Sulawesi	2	2	Planting method	11.9	10.4
3	Bali	2	2	Planting method, fertilizer, variety(s)	7.8	7.3
4	Central Sulawesi	6	6	Planting method, fertilizer, variety(s)	7.02	5.9
5	Central Java	2	2	Planting method, fertilizer, variety(s)	7.08	6.45
6	West Java	1	1	Planting method, fertilizer, variety(s)	8.84	6
7	East Java	1	5	Planting method, fertilizer, variety(s)	6.34	4.48
8	West Kalimantan	1	0.25	Planting method, fertilizer, variety(s)	3.12	4.28
	Average	2	2.3		7.4	6.4

Source: Annual Report, 2014

IV. CONCLUSIONS

The CCIS cover a wide range of areas in all over Indonesia with different types of climate. Therefore, the technology can give a wide range of recommendation regarding to the suitable technology to adapt the climate change. In addition, its delivery mode is available through Internet, atlas, CD, or any printed material. This leads to easiness of the CCIS to be disseminated. However, more efforts are still needed to ensure farmers and other users to adopt the recommendation from the CCIS. This is due to availability of supporting innovation and current farming pattern

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