

UTILIZING CROPPING CALENDAR IN COPING WITH CLIMATE CHANGE

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(Diterima tanggal; Disetujui tanggal)

ABSTRAK

Salah satu implikasi dari perubahan iklim adalah pergeseran waktu tanam yang tentunya mempengaruhi pola tanam dan produktifitas, terutama tanaman pangan. Untuk memandu petani menyesuaikan pola dan waktu tanam, maka analisis kalender tanam sangat diperlukan. Tujuan study ini adalah untuk mengembangkan peta kalender tanam tanaman padi di Jawa berdasarkan keragaman iklim (tahun basah, tahun normal dan tahun kering). Peta kalender tanam dikembangkan beberapa tahap, yaitu: (a) analisis waktu tanam eksisting, (b) analisis waktu tanam potensial, and (c) pembuatan peta kalender tanam. Analisis dilakukan dengan menggunakan data curah hujan harian dari tahun 1983 sampai dengan 2006, dan data realisasi tanam padi bulanan dari tahun 2003 sampai dengan 2005 untuk seluruh pulau Jawa. Hasil penelitian menunjukkan bahwa terdapat perbedaan waktu tanam pada kondisi basah, normal dan kering. Waktu tanam tertinggi untuk musim tanam pertama (MT I) pada tahun basah hampir sama dengan kondisi normal yaitu pada Okt 2/Okt 3, sedangkan pada tahun kering terjadi pada Des 2/Des 3. Intensitas tanam juga bervariasi antar provinsi. Kondisi ini mengakibatkan distribusi input pertanian seperti benih dan pupuk harus dijadwalkan sesuai kondisi setempat. Agar perencanaan waktu tanam dapat dilakukan dengan mudah, informasi peta kalender tanam telah dipetakan dalam skala 1:250.000 pada skala kecamatan. Peta kalender tanam selanjutnya dikompilasi menjadi satu atlas yang dapat digunakan sebagai pedoman bagi penyuluh dan petani di dalam penentuan kalender tanam.

Kata kunci: waktu tanam, tanaman pangan, pulau Jawa.

ABSTRACT

One implication of climate change is shifting of the onset and the end of the season that has adverse impacts on cropping pattern and crop productivity, particularly seasonal crops. To assist farmers in adjusting cropping pattern and planting time, produced of cropping calendar maps is imperative. The objective of this study was to develop new cropping calendar map for seasonal crop, principally paddy rice field in Java based on climate variability (wet, normal and dry years). The cropping calendar map was developed through several steps: (a) actual planting time analysis, (b) potential planting time analysis, and (c) completion of cropping calendar map. The analyses were made by using climatic data from 1983 to 2006 and rice planted area period data from 2003 to 2005 in Java Island. The results showed that there was a considerable different of cropping calendar among wet, normal, and dry climate conditions. The peak of cropping calendar of first crop (MT I) in wet year are almost the same within normal year i.e. on Oct 2/Oct 3.

For dry year, the peak of cropping calendar is on Dec 2/Dec 3. Analytical results also show the intensity of cropping practices in Java differ among provinces particularly West, Central and East Java. The differences indicate the season onset in each region varies significantly. This condition implies to the agricultural inputs distribution schedule. Hence, untimely distributions of seed, fertilizer and other inputs can be avoided, because the proper time of germination the seed can be expired, cost of storing fertilizer and degradation of fertilizer quality. For a better planning of cropping time and pattern, these cropping calendar maps were developed at the scale of 1:250.000 at the sub-district level and furnished with a detail description of cropping time. Those cropping calendar maps which were compiled in an atlas can be used as a guideline for extension workers and farmers in exercising their farming practices.

Keywords: cropping calendar, food crop, Java

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INTRODUCTION

Climate dynamics materializes in the spatial and temporal (seasonal, intra-seasonal, annual, inter-annual) are one of the challenges in increasing agriculture production. These challenges will become harsher when the global temperature keeps increasing as the main driver of climate change(1). The rising trend of air temperature in Jakarta during the period of 1880-2000 with mean increase of 1.4°C in July and 1.04°C in January (Figure 1) (2). Because of the lack of long historical data, the increasing temperature in archipelagic tropical country like Indonesia is difficult to quantify (3, 4).

Climate change can be observed in increasing frequency and intensity of climate anomaly, exceedingly wet during La Nina phenomenon or dry during El Nino phenomenon (5, 6, 7). The uncertainty of rainfall with the changing climate causes not only the change in the

rainfall(8) but also the shifting of the onset of rainy or dry seasons(9). The increasing frequency and intensity of variability and climate change has significant effects on rice production due to decreasing planted and harvested areas as well as the yield (10, 11).

Climate anomaly also affects cropping pattern both in irrigated and rainfed areas. Therefore, climate change is a grave challenge to national food self-sufficiency and security including the implementation of National Rice Improvement Program through increasing productivity and expansion of the planted areas (12).

Climate anomaly has been observed during the last several years has caused natural disaster El Nino events of 1972/1973, 1976/1977, 1982/1983, 1986/1987, 1991/1992, 1994/1995, 1997/1998, 2002/2003, 2006/2007, and 2009 in decreasing national rice and secondary crops

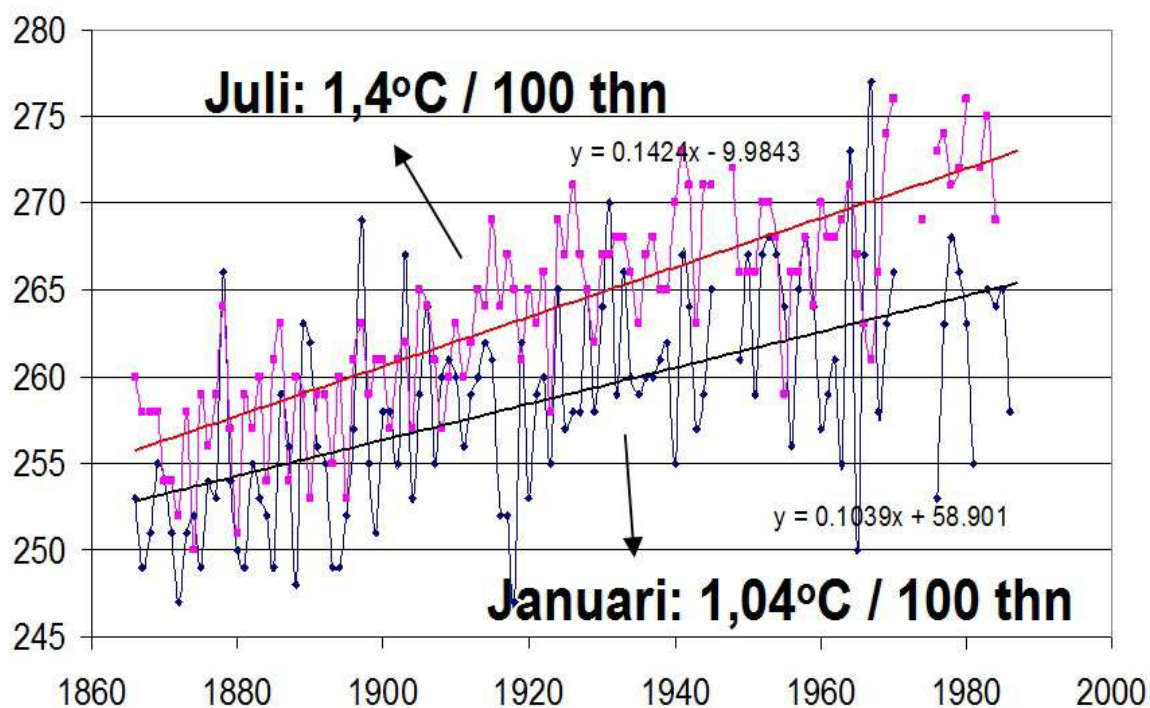


Figure 1. Trends of increasing air temperature in Jakarta during the period of 1860-2000 (Boer, 2007)

production. Therefore, in order to strengthen food self-sufficiency and security the climate change has to be anticipated by adjusting cropping pattern and planting time for each agro-ecology based on climate condition (13).

Traditionally the farmers in West Java use Pranatamangsa, in Bali use Kertamasa, and in South Sulawesi used Palontara in planning crop cultivation as an indigenous knowledge, inherited from generation to generation(14). Presently the indigenous knowledge are not applicable anymore because change in the irrigation and the farmers' farming systems, and the lost fauna and flora used as indicators.

Considering that condition, it is necessary to adjust cropping pattern and planting time that are appropriate for condition affected by climate variability and climate change. Therefore, a more comprehensive guideline that based on rainfall is imperative.

This study attempts to develop the new cropping calendar map for paddy rice field in

Java Island that are appropriate for condition affected by climate variability and condition (wet, normal, and dry years).

Cropping calendar atlas was compiled at technical scale of 1:250.000, to be used as guideline in determining the commencement of planting season at sub-district level in different climate conditions.

MATERIAL AND METHODS

Cropping calendar maps were delineated based on the actual field condition and its potential based on climate analyses (Figure 2). Cropping calendar delineation was compiled started by spatial analysis of the actual time of planting practiced by the farmers based on monthly planted area from 2003 to 2005 compared to paddy field area at sub district level. The monthly planted and paddy area data was supplied by Badan Pusat Statistik(15).

Considering the dynamics of climate cropping potential is also determined for wet (WY), normal (NY), and dry years (DY), by using

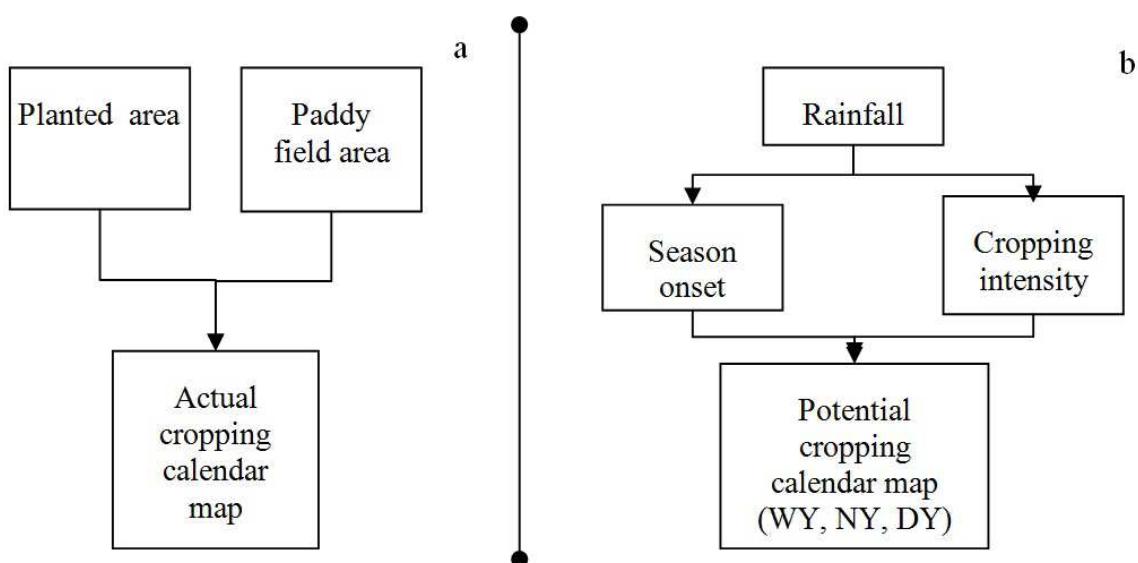


Figure 2. Flow chart of (a) actual and (b) potential cropping calendar map delineation. WY is wet year, NY is normal year, and DY is dry year.

Table 1. The criteria of climate variability

Climate Variability	Class	Note
Wet Year (WY)	>115%	Comparison with long term average rainfall
Normal Year (NY)	85-115%	
Dry Year (DY)	<85%	

Source: BMKG (2006).

daily days rainfall data from 1983 until 1996 of more than 500 stations over Java that supplied by Badan Meteorologi Klimatologi dan Geofisika (BMKG) and Ministry of Agriculture. Peta Rupa Bumi Digital Maps scale 1:250.000 for whole Java Island published by Badan Koordinasi Survei dan Pemetaan Nasional from 1990 to 2002 along with paddy field digital map of Java Island published by Pusat Penelitian dan Pengembangan Tanah dan Agroklimat on 2002 have been used together for mapping.

Analysis of Actual Cropping Calendar

Actual cropping calendar information described the actual time of planting practiced by the farmers based on monthly planted area from 2003 to 2005 compared to paddy field area at sub district level. Season onset actual for first crop (MT I), second crop (MT II), and third crop (MT III) was determined when 8%, 6%, and 2% respectively of paddy area has been planted. In order to get more accuracy result, the time planting was determined in ten days period.

Analysis of Potential Cropping Calendar

The main components of potential cropping map are rainfall. The first task are managing climate resource data, and then analyze to determine the rainfall characteristic such as variability, the season onset as eventually planting time potential, and cropping intensity.

Climate Variability

Rainfall characteristic used as the primary variable in differentiating the climate variability is based on BMKG criteria(16). Based on the criteria there are three classes of climate variability i.e. dry (mainly El-Nino), normal, and wet (mainly La-Nina), Table 1. These criteria are very helpful to show the variation of rainfall spatially.

Season Onset Potential

Rainy season onset characterizes the time of planting for the first crop. The onset of rainy season begin when the rainfall exceeding 50 mm/dekad (1 dekad = 10 days) consecutively in three dekads. With the criteria starting September (First Crop, MT I) until February the following year divided into eight zones of cropping calendar onset, Table 2.

Table 2. The eight zones of cropping calendar onset of first crop (MT I)

Zone	Onset
1	SEP 1/2
2	SEP 3/OCT 1
3	OCT 2/OCT 3
4	NOV 1/2
5	NOV 3/DEC 1
6	Dec 2/Dec 3
7	Jan 1/Jan 2
8	Jan 3/Feb 1

Note: Roman 1, 2, and 3 indicate date 1-10, 11-20 and 21-30 of each month

Table 3. The classes of LGP and crop rotation

NO	LGP Class	CI	Crop rotation
1.	LGP < 120 DAYS	0	FALLOW
2.	120 < LGP < 170 days	1	Paddy - Fallow - Fallow
3.	170 ≤ LGP < 300 days	2	Paddy - paddy/Secondary crop - Fallow
4.	LGP ≥ 300 days	3	Paddy-paddy/ Secondary crop - Secondary crop

Notes: LGP is Length Growth Period; CI is cropping intensity

Cropping Intensity (CI)

Cropping intensity is informing how many crop rotations can be executed in one year based on rainfall data, Table 3. This is closely related the number of dekad within a year with rainfall more than 50 mm/dekad (LGP, length growth period). The LGP of cropping season will start with the same time of cropping calendar (Table 2) and end when the rainfall below than 50 mm/dekad.

Data Processing

The climate data are of the particular points where the weather stations are located. Therefore, it is necessary to upscale areas represented by the stations spatially. Spatial delineation was done using three the climate classes' i.e. wet, normal and dry condition. Each layer was then overlaid with administration boundary. The results are the database for the cropping calendar to be used to determine the onset of the seasons in each sub-district using the highest intensity of time of the onset. Further, to be more informative the maps are overlaid again with land use map particularly rice fields in each sub-district.

Completion of Cropping Calendar Map

Geographic information system (GIS) was applied to facilitate analyses and the completion of spatial information of the cropping calendar maps. The final map was overlaid among four layers i.e. paddy field distribution, administration boundary, rupa bumi map, and cropping calendar layers.

RESULTS AND DISCUSSION

Distribution of Actual Cropping Calendar

The present cropping calendar is what being currently practiced by the farmers in the field. Analytical results show the intensity of cropping practices (%) in Java (Figure 3) differ among provinces particularly West, Central and East Java.

The difference indicates the season onset in each region varies significantly. This condition implies to the agricultural inputs distribution schedule.

Hence, untimely distributions of seed, fertilizer and other inputs can be avoided, because the proper time of germination the seed can be expired, increase cost of storing fertilizer and degradation of fertilizer quality.

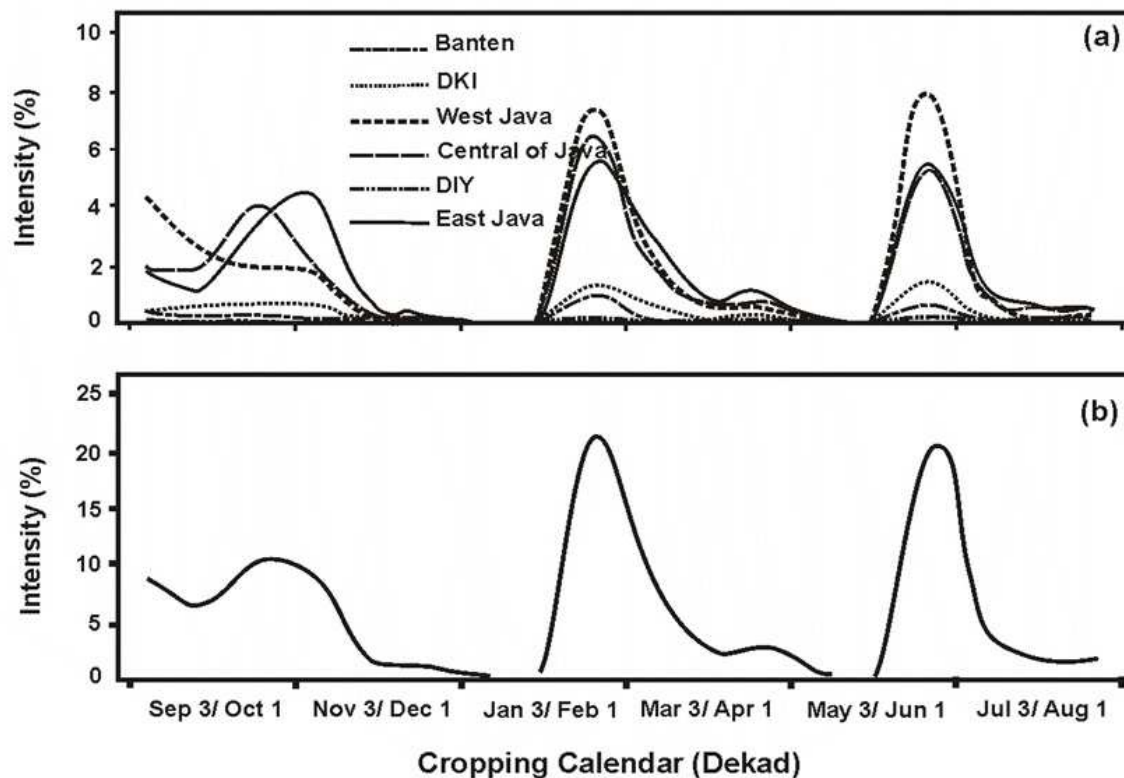


Figure 3. Temporal distributions of the peak actual rice planting times in (a) each provinces and (b) the whole Java.

Distribution of Potential Cropping Calendar based on Climate Events

Wet Year

When considering the percentage of planting area in Java Island, the provinces of East Java, West Java and Central Java have the largest area. Provinces of Banten and DIY have paddy field area but not as large as other provinces in Java.

Distribution of planting time based on climate events, shows the times in three different climate conditions namely wet, normal and dry years. In wet year the peak of planting season for the first crop in West and Central Java is

two dekads earlier compared to the present condition with similar pattern (Figure 4).

However, there was no significant different in East Java. Stark difference found in the second and third crops where the peak of planting time differs among provinces. West Java (March 1/2) 4 to 8 dekads earlier than Central Java (April 2/3) and East Java (May 1/2).

In East Java in the second crop there are two peaks of planting season with similar distribution pattern of West and central Java. This means that in wet year there is opportunity to plant crop any time in all provinces.

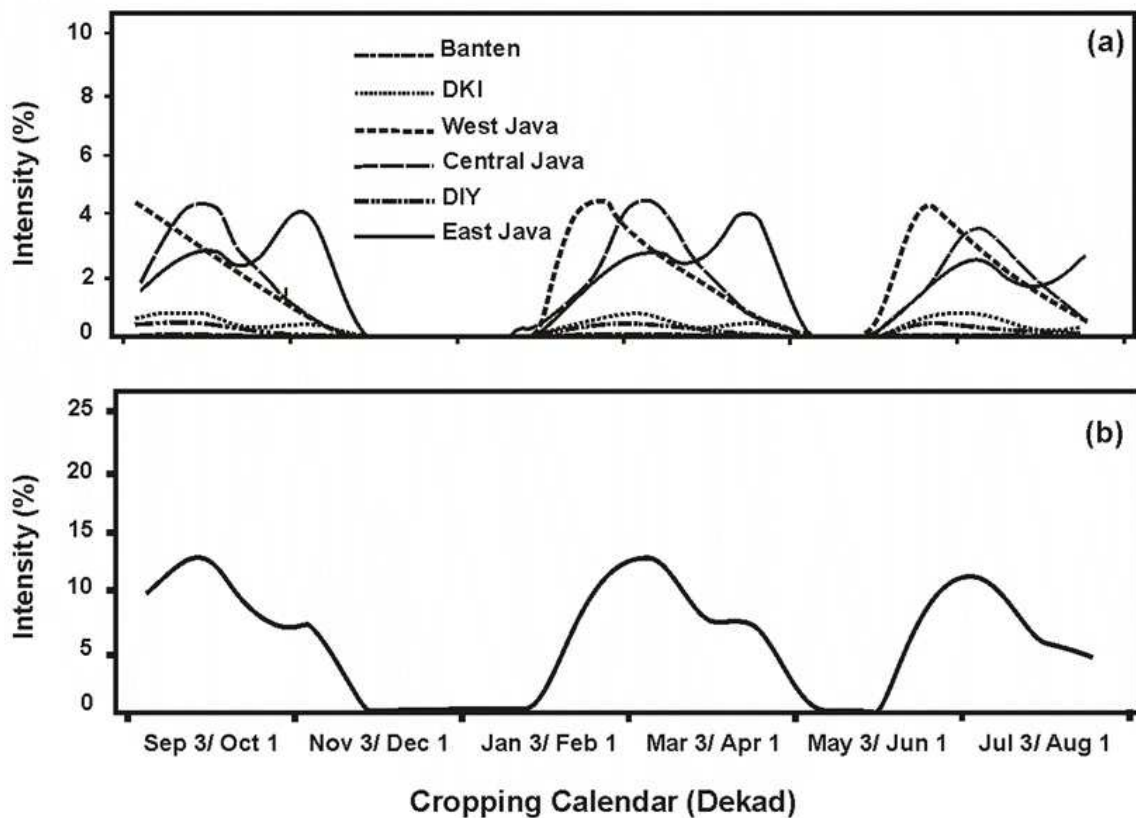


Figure 4. Peak of distribution pattern in wet year in different seasons in (a) each province and (b) the whole Java.

Normal Year

The peak of planting time in normal year is similar to the wet year, where in West Java 4-8 dekads earlier than Central and East Java either in the first crop, second and third crops. The peak planting time in Banten is almost similar to Central Java, particularly the second and third crops.

In normal year the peak time of planting of the first crop was 2-4 dekads earlier for both Banten and Central Java compared to those practiced by the farmers (Figure 5a). Even in normal year planting time practiced by the

farmers is later than the onset of rainy season. This among others is the inadequate water from the only rainfall for land tillage. Farmers usually wait until high rainfall for consecutive three days.

On other hand in the second and third crops the peak planting time practiced by farmers in Banten, Central Java, Yogyakarta, and East Java was 1-3 dekads earlier than normal year. This is because the farmers try to utilize the remaining rain in the transition period for second and third crop planting. Earlier planting in the second and third crops is practiced in the whole Java (Figure 5b).

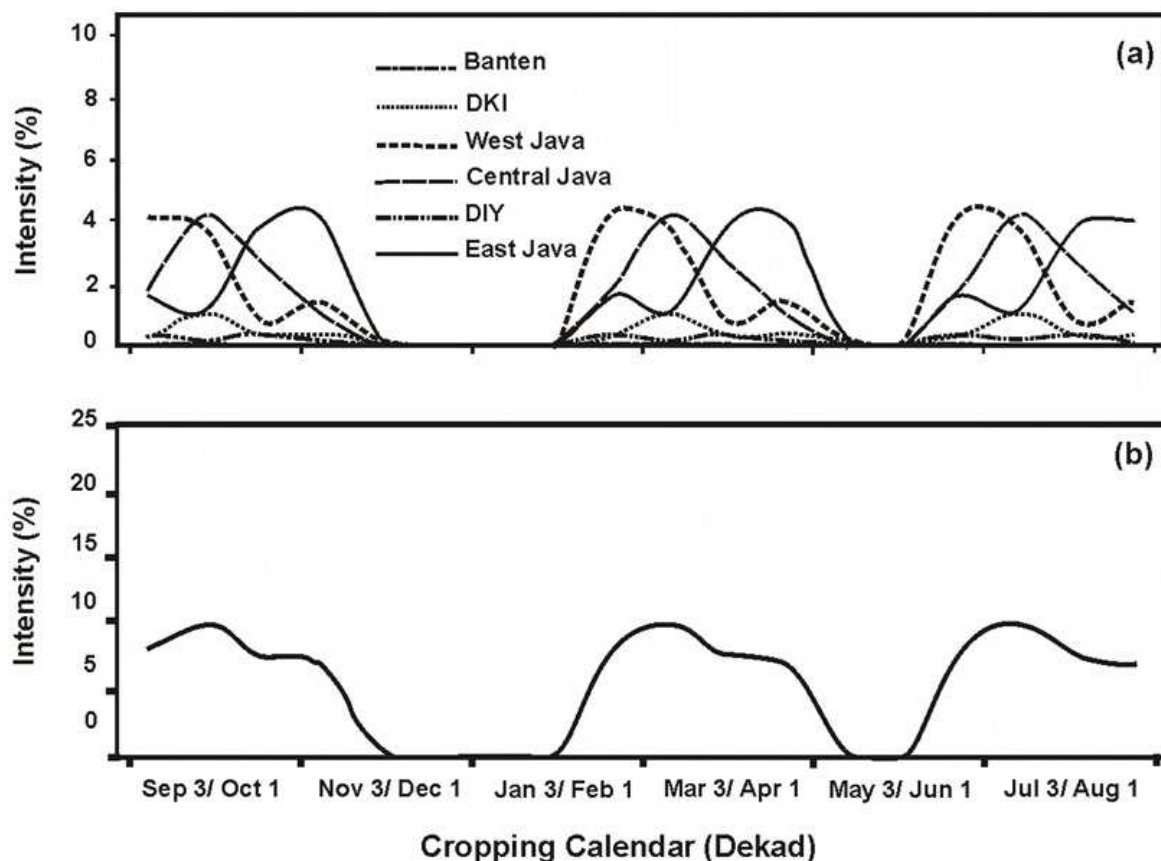


Figure 5. Peak of distribution pattern in normal year in different seasons in (a) each province and (b) the whole Java.

Dry Year

Differs with distribution in wet and normal years, peak planting time in dry year in each province is almost similar either in the first crop in December 1/2. Advanced planting time was practiced in all provinces except in East Java because of its dryer climate (Figure 6a).

The shift in the peak planting season of 6-8 dekads happened in all provinces for second and third crops from March 1/2 to May 1/2. Because of the delay in the peak planting time in dry year, it is vulnerable of losing the opportunity to have the third crop because it

already the beginning of the coming rainy season. West Java with relatively more humid climate has two peaks where the third crop can compensate the earlier loses although with slightly less areas (Figure 6b). The delay of planting time during dry year was observed during field verification in all the provinces of Java. The rice fields that are far from irrigation canals or other water sources are risking of the opportunity to plant rice or losing the season. One attempt that was done to cope with dry years is new high yielding crop varieties improvement that adapt to drought, for instance Dodokan and Silugonggo (12).

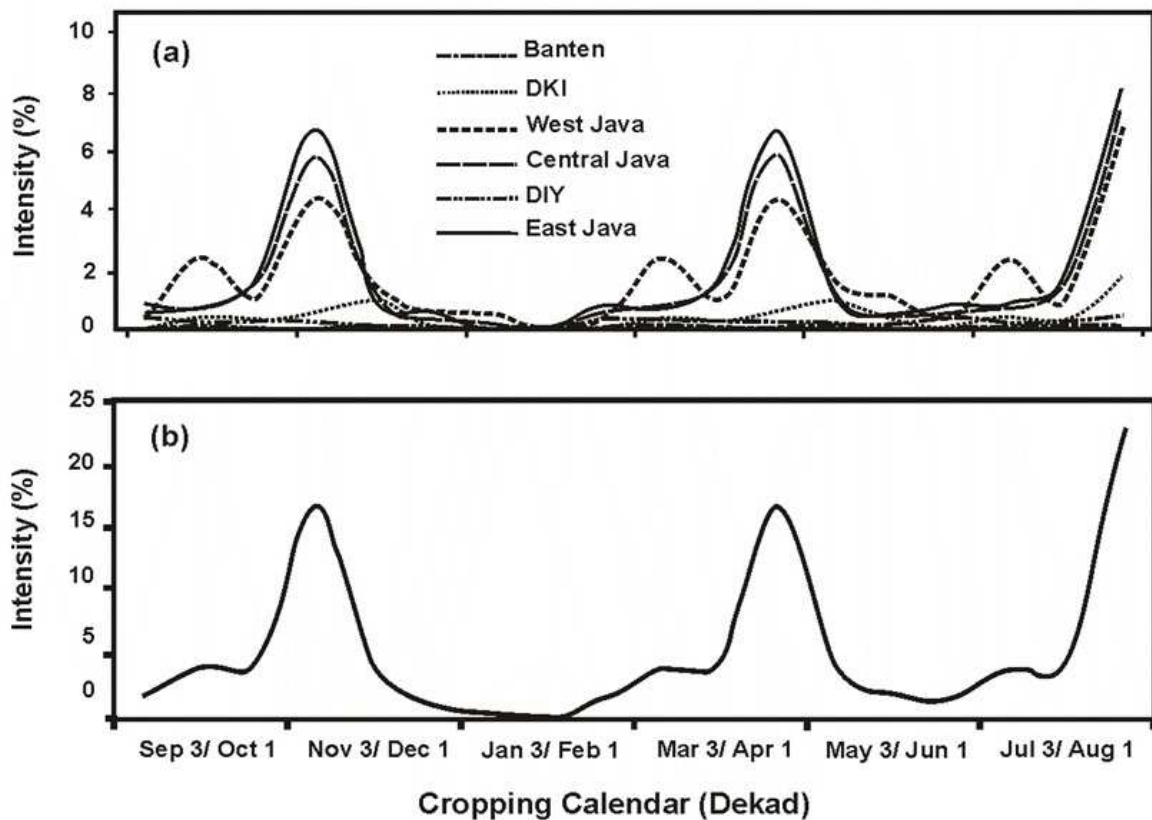


Figure 6. Peak of distribution pattern in dry year in different seasons in (a) each province and (b) the whole Java.

Cropping calendar map

The legend of cropping calendar maps is divided in 8 season onset potential (zone). The maps are furnished with legends providing information on cropping calendar potential and crop rotation in each sub-district.

For a better planning of cropping time and pattern, these cropping calendar maps were delineated at the scale of 1:250.000 and furnished with a detail description of cropping time at the sub-district level for the whole Java Island as shown in Figure 7 and Table 6.

Those cropping calendar maps which were compiled in an atlas can be used as a guideline for extension workers and farmers in exercising their farming practices of Java(17).

Besides that, the research results are the

database for the cropping calendar to be used to determine the onset of the seasons in each sub-district using the highest intensity of time of the onset. Further, to be more informative the maps are overlaid again with land use map particularly rice fields in each sub-district. The area without paddy field area will fill up by agroclimatic zone.

CONCLUSIONS

We have developed new cropping calendar map for seasonal crop, particularly paddy rice field in Java based on climate variability (wet, normal and dry years). The maps of cropping calendar in this atlas were arranged in a simple way to be easily understood by extension workers, technical staff of agricultural offices, farmer groups, and farmers.

There are several expediencies of cropping calendar atlas: (1) providing spatial and tabular cropping pattern at the sub-district level, (2) determining cropping rotation in each sub-district based on the existing climate and water resources, and (3) supporting the planning of cropping season and pattern for seasonal food crops. In utilizing the cropping

calendar maps on the future, a reliable seasonal climate forecast from BMKG is becoming very essential. Both are complementary tools in the planning the cropping time and pattern for annual crops adjustable to the climate conditions in minimizing losses. Therefore, it is necessary to disseminate this information along with climate forecasting.

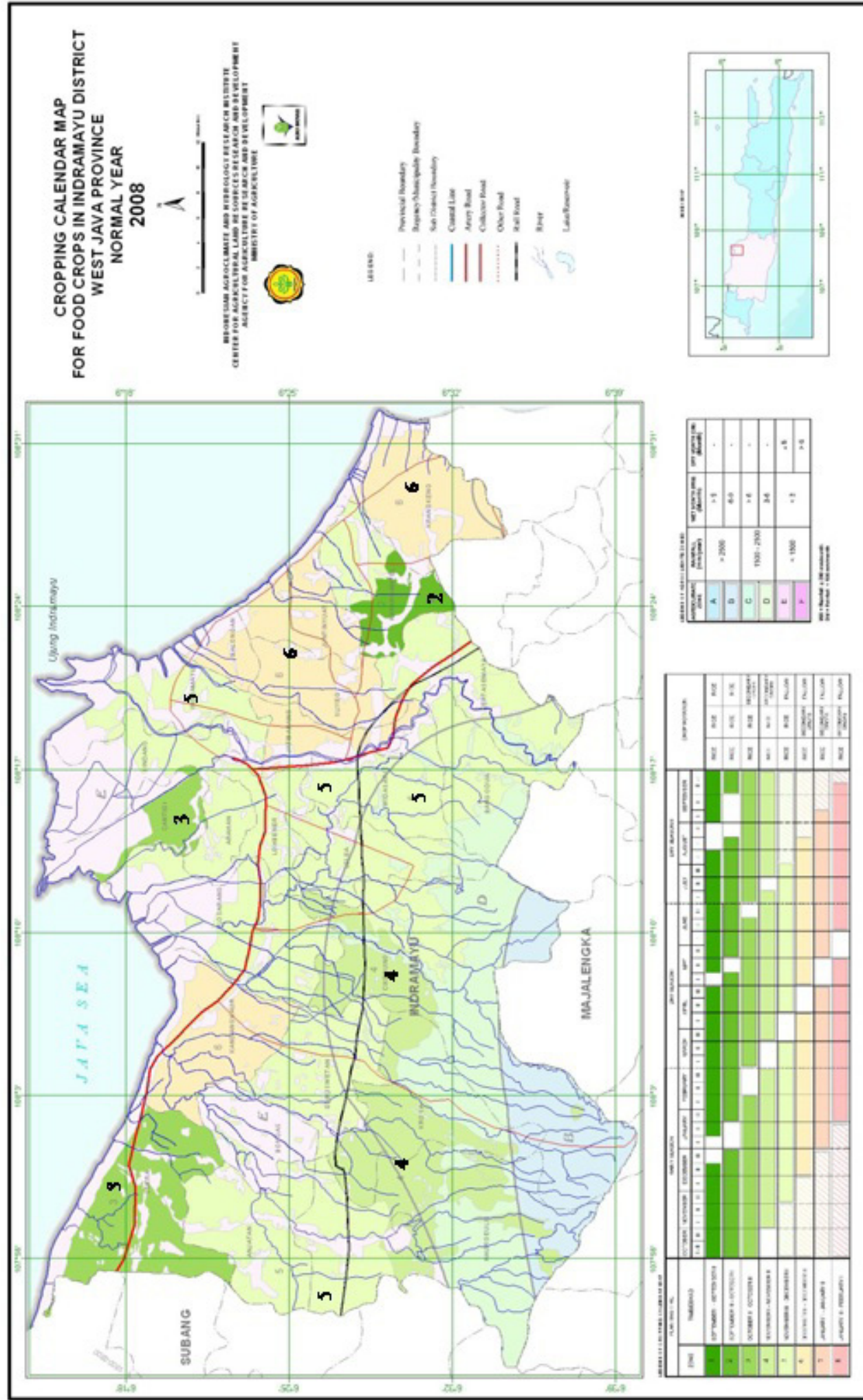


Table 6. Food Crop Calendar of Indramayu District, West Java (Normal Year)

NO	SUB DISTRICT	CODE NUMBER	RICE FIELD AREA (HA)	AREA PLANTED						CROPPING INTENSITY (%)			
				FIRST CROP		SECOND CROP		THIRD CROP		FC	SC	TC	TOTAL
				PLANTED TIME (DEKAD)	AREA (HA)	PLANTED TIME (DEKAD)	AREA (HA)	PLANTED TIME (DEKAD)	AREA (HA)				
1	ANJATAN	3212210	6.800	NOV 3/DEC 1	6.086	APR 2/3	4.708	AUG 2/3	2.413	90	69	35	149
2	ARAHAN	3212171	2.418	NOV 3/DEC 1	2.230	APR 2/3	1.502	AUG 2/3	556	92	62	23	177
3	BALONGAN	3212140	938	DEC 2/3	825	MEI 1/2	718	SEP 1/2	265	88	76	28	193
4	BANGODUA	3212060	4.500	NOV 3/DEC 1	4.067	APR 2/3	3.003	AUG 2/3	1.782	90	67	40	197
5	BONGAS	3212200	3.930	NOV 3/DEC 1	3.560	APR 2/3	2.668	AUG 2/3	987	91	68	25	184
6	CANTIGI	3212161	1.121	OCT 2/3	1.088	MAR 1/2	848	JUL 1/2	314	97	76	28	201
7	CIKEDUNG	3212040	3.681	NOV 3/DEC 1	3.341	APR 2/3	2.545	AUG 2/3	942	91	69	26	185
8	GABUSWETAN	3212030	6.100	NOV 3/DEC 1	5.470	APR 2/3	4.680	AUG 2/3	2.40	90	77	39	206
9	GANTAR	3212011	3.821	NOV 1/2	3.464	MAR 3/APR 1	2.105	JUL 3/AUG 1	779	91	55	20	166
10	HAURGEULIS	3212010	3.978	NOV 3/DEC 1	3.925	APR 2/3	3.063	AUG 2/3	1.804	99	77	45	221
11	INDRAMAYU	3212150	2.601	NOV 3/DEC 1	2.195	APR 2/3	2.002	AUG 2/3	741	84	77	28	190
12	JATIBARANG	5212130	2.999	DEC 2/3	2.741	MEI 1/2	1.812	SEP 1/2	671	91	60	22	174
13	JUNTINYUAT	3212110	4.059	DEC 2/3	3.674	MEI 1/2	2.844	SEP 1/2	1.723	91	70	42	203
14	KANDANGHAUR	3212190	6.250	DEC 2/3	5.602	MEI 1/2	4.827	SEP 1/2	2.457	90	77	39	206
15	KARANGAMPEL	3212100	2.290	Nov 3/Dec 1	2.117	APR 2/3	1.446	AUG 2/3	535	92	63	23	179
16	KEDOKANBUNDER	3212101	2.117	SEP 3/OCT 1	1.965	FEB 2/3	1.804	JUN 2/3	667	93	85	32	210
17	KERTASEMAYA	3212080	2.860	NOV 3/DEC 1	2.671	APR 2/3	1.896	AUG 2/3	701	93	66	25	184
18	KRANGKENG	3212090	4.621	DEC 2/3	4.119	MEI 1/2	3.597	SEP 1/2	2.002	89	78	43	210
19	KROYA	3212020	4.050	NOV 1/2	3.666	MAR 3/APR 1	2.997	JUL 3/AUG 1	1.780	91	74	44	208
20	LELEA	3212050	4.800	NOV 3/DEC 1	4.326	APR 2/3	3.418	AUG 2/3	1.936	90	71	40	202
21	LOHBENER	3212170	2.554	NOV 3/DEC 1	2.458	APR 2/3	2.441	AUG 2/3	903	96	96	35	227
22	LOSARANG	3212180	7.329	NOV 3/DEC 1	6.552	APR 2/3	5.066	AUG 2/3	2.545	89	69	35	193
23	SINDANG	3212160	1.813	NOV 3/DEC 1	1.589	APR 2/3	1.339	AUG 2/3	495	88	74	27	189
24	SLIYEG	5212120	5.300	DES II/III	4.766	MEI 1/2	2.800	SEP 1/2	1.707	90	53	32	175
25	SUKAGUMIWANG	3212081	2.532	NOV 3/DEC 1	2.238	APR 2/3	1.830	AUG 2/3	677	88	72	27	187
26	SUKRA	3212220	6.550	OCT 2/3	5.534	MAR 1/2	5.125	JUL 1/2	2.567	84	78	39	202
27	TERISI	3212041	4.199	NOV 1/2	3.797	MAR 3/APR 1	3.575	JUL 3/AUG 1	1.994	90	85	47	223
28	WIDASARI	3212070	5.517	NOV 3/DEC 1	4.962	APR 2/3	3.714	AUG 2/3	2.045	90	67	37	194
	TOTAL		109,728		99,028		78,373		38,391				

Note: Roman 1, 2, and 3 indicate date 1-10, 11-20 and 21-30 of each month. FC: first crop, SC: second crop, and TC: Third crop.

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