The application Of Fourier Prediction Models To Schedule Paddy Growing Season With High Resolution For Upgrading Farm Capacity Building (Case Study in Indramayu Regency)

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Abstract. Indonesian government still has obstacles in the production of annual paddy harvest and planting which causes a decrease 20 percent drop in National production. The failure of one of them caused by weather patterns and climate change that makes farmers difficult to plan future activities with good crop calender. That is because the coming of the rainy season at this moment cannot be predicted precisely. To that end, the role of technology in model and estimate the precise rainfall (high resolution) becomes very important. The developing Fourier prediction models to become agriculture information system was user friendly for instructor/extension officers and farmers who can overcome this problem. The agriculture information models are developed to determine the time of crop calendar weighted maps with rice terraces whom government services, scout and farmers at Indramayu regency easily wears it. The sum of sinus models is used alternatively to predict deciles futures and monthly rainfalls for one year ahead produce a 0.97 correlation with the observed data in Indramayu region. The residue of the sum of sinus models became anomalous rainfall for instan ENSO can cause forward and late in rainfall season. Basically by using a method of curve fitting Sum of Sine results turned out to be related to the monsoon event and climate classification that indicate to distribute annual. While residue model shows cycles of 28.89,61.79 and 80.9 months. These frequencies are related to ENSO event. The Schmidt & Ferguson climate classification of rainfalls and wind monthly conclude Indramayu Regency dominate by type of wet and dry monthly. Map early in the season prediction and map early the planting of rice that have been tested since the start built 2008 is currently being updated with a system software, so that will make it easier for farmers and extension officers as well as related service to apply it on crop calendar.

Keywords : crop calendar,sinus,fourier,climate and Monsoon.

1. Introduction
The Impact of climate change is affecting development and human life becomes complex to be studied, one sector that is experiencing this development is agriculture. Most of Indonesian farmers are distributed in central of agriculture producing regions had to be difficult to set up crop planting when condition of rainfall patterns change are frequently. According to report study of The Inter-Center Working Group on Climate Change had stated that paddy production decreasing at the Indonesia are caused by wet season shifting are amount 20 %. To help this problem than a government role to give information services crop calendar are very important. By integrating most of stakeholder in agriculture sectors to develop a crop calendar are still needed for accurate increasing that it will be used to predict
rainfall season arriving to do crop planting. So that, role of crop calendar information is hanging to a rainfall event than climate model rule will help to set up crop planting exactly in central of agricultural production regions.

To study of Indramayu Regency areas, West Java Province are very important caused in this regions have three sector field economic activities include ocean, agriculture and forestry. On the agriculture sector are still relying on cultivate paddy and palawija. This regency is also central to paddy domain production at West Java Province and beside Karawang Regency that it gives production around 35% of total production of West Java, but this region is very vulnerable to drought and flood event that special case of the flood tide and El Niño Southern Oscillation (ENSO) event. In general, the percentage of accuracy of the results forecast in early the season DPM (a part of area forecast) 6 reached 57.1%, while the DPM 7 reached 50 to 85.7%. For the season the nature, accuracy of forecasts was between 43.6% to 44.8%. The low percentage yield forecast is caused by two main factors. First, the division of the territory into two DPM Indramayu, namely DPM 6 and 7, seemingly still too rough where DPM 6 represents an area of 122,025 ha and DPM 7 covering 81,986 ha, while the diversity of rain between stations in the same DPM still high. The second is a statistical model (ARIMA) which is used to forecast early the season or the nature of the season is still not in accordance with the nature of the data so that the resulting models have not been able to properly forecast conditions ahead (Suciantini, R. Boer and R. Hidayat, 2006).

The definition of the early wet season in Indonesia based on the provisions made by the BMKG that marked the early wet season with rainfall amounts ten average days has more than 50 mm and a minimum of two deciles followed next, otherwise the beginning of the dry season is characterized by deciles rainfall amounts of less than 50 mm and followed by at least two subsequent deciles. The onset of the wet season is characterized by precipitation during the deciles amount is more than or equal to 50 mm, and is followed by the amount of rainfall greater than or equal to 50 mm in the next few deciles. While the beginning of the dry season is characterized by rainfall during deciles amount is less than 50 mm, and the next few deciles amount of rainfall is less than 50 mm. When the initial calculations were performed BMKG wet season usually after September 1st. The early wet season is important in determining the future and crop patterns. This definition used in agriculture in Indonesia, where rainfall was recorded after August 1> 40 mm in 5 consecutive days followed by 10 days without a cleaning spell or rainfall <5 mm in a period of 10 days (Moron et al., 2008). The Tropical regions, wind patterns are dominated by a belt Intertropical Convergence Zone (ITCZ), the monsoon and buffer systems resulting from the cross equatorial motion of the Sun 23.5 ° North and South. Tropical conditions different from that in the sub-tropics and the polar regions, in the region of atmospheric patterns and the important role that Rossby waves that winds around the earth, moving from West to East and resulted in furthering of moisture from the Atlantic Ocean. In addition, factors that differentiate the definition of the early wet season is the location of the sea and the land that has implications for the general wind pattern, such as monsoon activity that only occurs around the waters of the Indian, Pacific, Asia and Australia (Graham et al. 2010). A Clustering of BMKG rainfall, which DPM existence can still be divided into several groups of smaller regions with rainfall patterns are different from each other. So the climate information that has been shown globally can be lowered with an area smaller area. (Haryoko, Urip, MSI., 2004).
The specific aim of this study is designing and implementing a harmonized series model to forecast by the *Sum Of Sinus* to the dominant pattern of rainfall deciles and *Fourier method* to forecast the its residue, so output can be used as the foundation for determining the crop calendar in the level district of Indramayu at a high resolution or upper districts or villages after initial forecast maps packed in a season that began on September 1 every year to forecast one year ahead. Selection of the method the sum of sin and this because of the behavior of their Fourier iteration and the similarity to solutions of the atmosphere dynamics based on the *laws of physics* are used to extract the parameters of wind, pressure, air temperature and precipitation so that this method will contain a dynamic addition to the statistical interpretation.

2. Literature Study

2.1. Influence of Rainfall on Rice

It is known that weather and climate are factors that determine the crop growth and productivity. The crops are very sensitive to changes in weather and climate drastic nature. Increasing and decreasing precipitation drastically influence on plant physiology. The water for the plant has six functions, namely (i) the solvent and the medium for chemical reactions, (ii) medium for the transport of dissolved organic and inorganic substances, (iii) medium to provide the plant cell turgor, (iv) hydration and neutralization of the charge on the molecule colloid, (v) the raw material for photosynthesis and other chemical reactions, (vi) water evaporatranspiration) to cool the plant surface. The water requirements for rice is 150 mm per month while for crops is 70 mm/month, with the assumption that the same chance of rain is 75%, then to meet the water requirement of rice plants of 150 mm/month needed rainfall of 220 mm/month. Meanwhile, to meet the water needs of the crops needed rainfall of 120 mm/month, so according Oldeman a wet month when the monthly is said to have monthly rainfall greater than 200 mm and said dry months when monthly rainfall less than 100 mm.

2.2. Rainfall

The amount of rainfall in the deciles (the time span for 10 days) more than 50 mm and followed by several subsequent deciles defined as the early wet season. While the comparison between the amount of rainfall during the validity period (one period of the wet or a dry season) with a normal amount of rainfall (average for 30 years) referred to as the *nature* of the rain. Season forecast area (DPM) is an area with the type of rain that has a clear distinction between the period of the dry and the wet season pattern is seen from the monthly rainfall for one year. The nature of rain is divided into three categories, namely: a) the nature of rainfall above normal/AN( if the value of rainfall> 115% on the average), b) the nature of normal rainfall/N (if the value of rainfall between 85% - 115% of the average) and c) the nature of rainfall below normal/BN ( if the value of rainfall <85% on the average). The nature of rain is accumulated rainfall is expected to occur during the period of the season. Rain nature considered normal, if the accumulated rainfall occurs during the period of the season is around the average of 30 years (e.g., 1961-1990 normal period) or the ratio of 85-115%. If the accumulated rainfall is lower than the lower limit of normal, or has a ratio smaller than 85%, then the nature of said under normal rain. Conversely, if the accumulated rainfall is higher than the upper limit of normal values or the comparison of more than 115%, then the nature of rain is said to be above normal. An analysis and determination of the start of the wet
or dry season made by the BMKG are divided into three deciles, namely: a) deciles I, is the period from the first day until the tenth day of January, b) deciles II, is the period from January the eleventh day until twentieth day and c) deciles III, is the period of January twenty-first day to the end of the month (Nuryadi, 1998).

2.3. Climate Affects Phenomenon Or Season In Indonesia

El Nino is a global phenomenon of ocean-atmosphere interaction system marked warming of sea surface temperatures in the Nino 3.4 or sea surface temperature anomalies in the area of positive. Meanwhile, the extent of influence of El Nino in Indonesia, depends on the condition of Indonesian territorial sea. El Nino phenomena that influence in the region followed by Indonesia with drastically reduced rainfall, will occur when the conditions are cold enough temperature Indonesian waters. However, if the condition of Indonesian sea is warm enough temperature has no effect on the lack of significant rainfall in Indonesia. In addition, given the vast area of Indonesia, not all areas of Indonesia affected by the El Nino. While La Nina is the opposite of El Nino is characterized by a negative sea surface temperature anomaly in Nino 3.4. A La Nina phenomenon in general cause rainfall in Indonesia increased when coupled with the warming of sea surface temperatures in the sea of Indonesia. Similarly, El Nino/La Nina effect to the entire territory of Indonesia. A symptom of ocean-atmosphere interaction in the Indian Ocean that is determined from the difference between the sea surface sea temperature anomaly of the east coast of Africa in the sea west of Sumatera. The difference value above the sea surface temperature anomaly is known to be a Dipole Mode Index (DMI). For positive DMI, generally impacting the lack of rainfall in western Indonesia, while the value of DMI negative, impact increased rainfall in parts of western Indonesia. Madden Julian Oscillation (MJO), observation of the MJO activity, related to the vertical movement of the air condition while in Indonesia due to the arrival of the propagation it. MJO about 30-50 days (intra seasonal) indicates growth in activity oscillations clouds along the path starting from the upper waters of East Africa to the western Pacific waters.

2.4. The Components Affecting Accuracy of Weather Forecast and Climate

In the preparation of weather forecasts and climate information must involve some aspect of science as the basis of meteorological knowledge, such as physics, mathematics, statistics, geology and chemistry. So, weather and climate forecasting system is a complex process that involves, among others: a forecaster expertise (skills and experience), availability of data, methods of analysis and data processing and Information conditions globally and regionally. Attempts to exploit the regularity of a return period or cycle is widely used by practitioners of a particular field to predict upcoming weather conditions still needs to be well considered, because of the diversity of different weather from time to time. The dynamic model, this method is more analysis of the dynamics of the atmosphere which is then used for prediction. Analysis made include analysis of wind currents and sea surface temperature that analysis of sea surface temperature (SST). Most of the water vapor in the atmosphere comes from the evaporation of sea water. As an indicator evaporation of sea water used sea surface temperature as a predictor (Dodo Gunawan et.all, 2000).

2.5. Development Analysis And Method Of Harmonic Series
This research will use a method that is a harmonious series to the main pattern with
the method **the Sum of sin** and **Fourier method** of identifying periods of oscillation based
on the data of precipitation residue. Fitting parametric used to find the coefficients
(parameters) for one or more models that are more suitable and appropriate to the nature
assumed data. Data divided into two important components, namely components are
deterministic and undeterministic. The components are given by the parametric model and
random component is interpreted as data anomalies. About Sum of sines Models, the sum of
sine model fits periodic functions, and is given by

\[
y(x) = \sum_{i=1}^{n} a_i \sin(b_i x + c_i) \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdot (1)
\]

Where \( a_i \) is the amplitude, \( b_i \) is the frequency, and \( c_i \) is the phase constant for each sine wave
term. \( n \) is the number of terms (1 \( \leq \) \( n \) \( \leq \) 8) and \( x \) are deciles of rainfall. In this study, the sine
function used \( n = 3 \) and the results have error of 5 percent. About Fourier Series Models, the
Fourier series is a sum of sine and cosine functions that describes a periodic signal. It is
represented in either the trigonometric form or the exponential form. The model provides this
trigonometric Fourier series form

\[
y(x) = a_0 + \sum_{i=1}^{\infty} a_i \cos \left( \frac{2\pi n x}{c_i} \right) + b_i \sin \left( \frac{2\pi n x}{c_i} \right) \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdot (2)
\]

Where \( a_0 \) is a constant (intercept) term in the data and is associated with the \( i =0 \) cosine term,
\( a_i \) is the amplitude, \( b_i \) is amplitude, \( c_i \) is period and \( n \) is the number of terms (1 \( < \) \( n \) \( < \) \( \infty \)).

3. Data and Methodology

The data used in this study is the rate of rainfall in 36 points in the Indramayu region
with a daily TRMM source (3B42 V7 derived) with a spatial resolution 0.25°x 0.25° and time
resolution January 1,1998 to August 31,2014. TRMM constitute means of satellite
observations for suspected daily weather data, then weather data is converted into the rate of
rainfall (mm/h) and when multiplied by 24 hours, then generates daily rainfall (mm/day).
Other supporting data taken from 36 observation posts surface rainfall for 31 years from 1981
to 2012 in the regency of Indramayu. Data sourced various agencies that Climatological
Station Pier, Bogor; Irrigation Department and Perum Jasa Tirta Section 3 Patrol Indramayu.
In addition to rainfall data used topography height data and coordinate observation post rain.
The wind data u and v are derived from an average monthly wind surface obtained from the
NCEP/NCAR reanalysis. Data zonal and meridional wind field will could easily be obtained
free of charge/free through a NOAA website. Temperature data used in this study are the
monthly average of data from the NCEP / NCAR reanalysis. Data were used from 1981
to 2014 with a spatial resolution of 2.5 °. Geographically Indramayu district is in a position 107°
52 ' -108° 36 ' E and 6°15' -6°40 ' S with an area of Indramayu regency of approximately 209,
942 ha, with a length of approximately 147 km beach that stretches along the northern coast
of Java Sea between Cirebon than Subang regency, which as far as four miles from the coast .

4. Results and Analysis

4.1. DPM Clusters of the Indaramayu Regency

The regional grouping of DPM must have a type clear difference between the period
of the dry and the wet season. Other terms of the DPM are ZOM (zone season). According to
BMKG, based on the data on 1961-1990, DPM to Indramayu before 2002 is divided into two,
namely DPM 6 (Indramayu northern) with an area of about 122,025 ha and DPM 7 (Indramayu southern) with an area of about 81,986 ha. The idea would be changes in zoning new rainfall has resulted in as many as six new zoning DPM (Haryoko, 2004).

![Figure 1. Monthly distribution of rainfall pattern in the Indramayu regency](image)

For Indramayu regency in figure 1, bar show monthly rainfall when peak rainfall there in January with a value of 365.55 mm and the smallest rainfall there in September with a value of 34 mm. The average rainfall is 1962.6 mm a year and reach the highest rainfall and the lowest rainfall is 331.48 mm. The bold line is monthly temperature that have highest temperature there in April with a value of 26.54°C and the lowest in August with a temperature of 25.74°C. The range of the highest and lowest temperature was 0.8 ° C. Climate Schmidt and Ferguson are based on a comparison of the average dry month for one year in a minimum period of 10 years. Criteria used to determine in dry, wet, and humid, as follows: in dry, if rainfall amounts of less than 60 mm, in humid, if the amount of rainfall of 60 mm–100 mm and in the wet, when the amount of rainfall over 100 mm. To determine the value of Q climate type used, as follows: Q = average number of dry months during the year / average number of wet months during the year x 100%. The Indramayu regency has 114 dry, 44 humid and 202 wet during 1998-2014 year, the climate type category is C (Q=56.44 %) and monsoon area by Ramage requirement, see figure 2. Winrose then this region concludes that climate type is dry wet tropical climate.

![Figure 2. The Indramayu regency wind rose](image)

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Monsoon in various parts of Indonesia is the primary factor determining the intensity and pattern of rainfall are global climate phenomenon causes the movement of the sun to the earth. The movement of intra-seasonal variability is brought as a result of the high rainfall areas of the region in its path. Intra-seasonal variability or oscillation is known as the MJO by
name originates. In the Indonesian maritime continent area, wave propagation to the east of these symptoms occur in the Indian Ocean and the events that began in the ocean will result in rainy areas where the rain will move to the east entrance of the Indonesian archipelago through West Sumatera province and continue to move to the East (Aldrian 2008). This resulted in the movement of intraseasonal variability of rainfall so that the time lag wet (wet spell) or time lag dry (dry spell), will impact the loss occurs in the wet or the dry months between 20-50 days (Benjamin & Pierre 2006).

![Figure 3](image.png)

Figure 3. Matching the data with a sinusoidal function that shows the amount of average rainfall along the 400 months (1981-2010) for the Indramayu regency.

The precipitation anomalies/residues figure 3 above in periodicity identification using Fourier methods of curve fitting functions and then to do an analysis of the residue by periods that have common or typical known mechanism in the weather and climate of regional and global influences that are seasonal, inter annual or decades. From the results obtained residue during 1981-2010 years of fitting, period the incidence of rainfall anomalies following Indramayu region 12.59, 28.89, 61.79 and 80.9 months or about five years, known as ENSO events. During the phase of El Nino events, drought tends to be drier (the magnitude of rainfall under normal conditions) and the longer time it happened. The opposite occurs in La Nina where wetter season than normal and longer duration rainfall event. Indonesian region is in a strategic position, located in the tropics, between Asia and Australia, between the Pacific Ocean and the Indian Ocean, as well as passed the equator, consists of islands and the islands stretching from west to east, there are many straits and bays, causing the region Indonesia is vulnerable to climate change/weather. Phenomena that affect climate in Indonesia: ENSO, Dipole Mode, Asia–Australia Monsoon, MJO, Regional meeting of the Inter-Tropical winds (Inter Tropical Convergence Zone / ITCZ) and Sea Surface Temperature in Indonesia regions. ENSO causes annual climate variations in Indonesia, delay planting season occur in the years ENSO than normal. When the water management is not considered properly allow food production will decline so destabilize national food. Currently ENSO years resulted in a longer dry and the wet season is shorter. ENSO effects of drought years in Indonesia recorded almost felt mostly in eastern Indonesia, but in Sumatra (due to the influence of a stronger dipole mode index) except for a few places equatorial stronger influences.
The Relations between El Nino / La Nina than dry month number In Java Island, the drought in Indonesia related to El Nino and the Southern Oscillation Index Negative. The years where there is a strong El Nino in 1982 and 1997, El Nino was in 1987 see in figure 4, while year of a strong La Nina was in 1988 and La Nina weak in 1998. The drought event and natural disaster drought caused by the low amount of precipitation. Beside elements rainfall, high temperatures also affect drought. The rainfall in the Indonesian maritime continent has enormous variety both in temporal or spatial. Variations in rainfall tend to the time controlled by factors that are changing, mainly dominated by monsoons, El Nino Southern Oscillation, movement of the intertropical convergence zone (ITCZ), and local onshore wind circulation-the ocean. The Monsoon blows in steady in the summer and blowing the opposite in winter. Hal season indicates a change in the pressure gradient direction and major weather changes (Ramage, 1971). The ratio amount of rainfall in the monsoon western and eastern greater than one to ten times. Sometimes monsoon circulation reinforced by local circulation like a sea breeze, in such case, the amount of rainfall is abundant. El Nino is a quasi-periodic disruption to the climate system that occurs every few years (about 5 years). Activities center located in the Pacific Ecuadorian but their influence on the climate system extends beyond the pacific. Drought in Indonesia related to El Nino and the Southern Oscillation Index Negative (Bayong, 1992;1996).

4.2. Early Season Forecast Method Using Total Sine and Fourier method.

Use of the method of sum of sin to predict early in the season in DPM 1 was performed using training data to predict the length of the year 1998 to 2012 in 2013 with 36 deciles.

**Figure 5.** The running of the sum of sin for DPM 1, the dominant factor in rainfall patterns interpreted by ITCZ and monsoon dynamics (annual iteration), while residual models interpreted by ENSO.
From figure 5 seen that there is a negative predictive value, this happens due to the effects of mathematical and numerical, while rainfall may not be negative, if the value is recombined with the prediction residuals will be the lowest value is zero. DPM results forecast for 2, 3, 4, 5 and 6 can be seen in appendix-1, all of DPM has shown the same dominant factors, namely the control ITZC and monsoon, but the area of DPM 6 (Indramayu southern), the average period of drought about 17 deciles or nearly 6 months starting in May deciles III. Normal amount of precipitation during the period of about 292-394 mm. While the rainy period of about 19 deciles or more than six months, namely from November deciles II until May deciles II. Normal precipitation for the period of about 1157-1565 mm. For DPM 4 (Indramayu northern), the average period of drought about 25 deciles or eight months, i.e. from April to Dec first deciles I. Normal amount of rainy during the period of about 522-706 mm. While the rainy period of about eleven deciles or four months starting in Dec deciles II until March deciles III. Normal precipitation for the period of about 821-111 mm. Indramayu northern region (influenced by the sea) is relatively drier than the southern part (influenced by mountains).

4.3. Forecast Evaluation beginning of the season and the nature of the rain.

Based on a preliminary analysis of the results forecast BMKG when compared to the evaluation shows that for DPM 4 (Northern Indramayu) forecasts of approaching 44.8%. This value is obtained from the results of the evaluation of the same forecast on AN, N and BN are respectively 2.45%, 27.61% and 14.72%. While DPM 6 (Indramayu Southern), or accuracy of 43.6% or see Table I.

Table I. The forecast and evaluation on the nature BMKG monthly rainfall of the year 1987-2014

| Forecast | EVALUATION (Monthly) | Percent | Forecast | EVALUATION (Monthly) | Percent |
|----------|----------------------|---------|----------|----------------------|---------|
| DPM 4    |                      |         | DPM 6    |                      |         |
| AN       | 4 (2.45 %)           | 7 (4.29 %) | 6 (3.68 %) | 10.43 | AN       | 4 (2.45 %) | 8 (4.91 %) | 5 (3.07 %) | 10.43 |
| N        | 26 (15.95 %)         | 45 (27.61 %) | 43 (26.38 %) | 69.94 | N        | 22 (13.49 %) | 45 (27.61 %) | 48 (29.45 %) | 70.55 |
| BN       | 3 (1.84 %)           | 5 (3.07 %) | 24 (14.72 %) | 19.63 | BN       | 2 (1.23 %) | 7 (4.29 %) | 22 (13.50 %) | 19.02 |
| Total    | 20.24                | 34.97   | 44.78    | 100   | Total    | 17.17    | 36.81    | 46.02    | 100   |

Annotation : AN = above normal, N = Normal, BN = below normal

The combined DPM 4 and 6 would represent a pattern that is considered to represent the Indramayu regency. From the analysis of variability of rainfall between stations on the DPM, the result that there is no longer a sufficient diversity of high rainfall between stations on a single DPM, especially on the DPM 4. There is still strikingly visible variation is caused by local factors that had an impact on the regional diversity of rainfall, although basically Indramayu region is relatively flat. These factors include the water vapor content of the atmosphere, topography, surface properties, the temperature of the sea surface sea-land breeze circulation and convection intersection beaches.
Table II. Distribution of rainfall nature results BMKG of 1987-2001 years, Indramayu regency.

| Year | May | June | July | Aug | Sept | Oct | Nov | Dec |
|------|-----|------|------|-----|------|-----|-----|-----|
| 1995 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1996 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1997 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1998 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1999 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 2000 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 2001 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |

In contrast to the evaluation of the nature of the rain, the evaluation is done at the beginning of the season showed higher accuracy. Based on Table II, a comparison between forecasts with initial evaluations dry and rainy seasons in DPM 4 shows the accuracy of 57.1%. While the DPM 6, accuracy ranged from 50 to 85.7%. From these results indicate that the skill of BMKG forecast to predict early in the season, especially early dry season is quite good, see Table III, but it still needs to be improved by the method of atmospheric dynamics.

Table III. Forecast and evaluation of the early season

| Year | April | May | June | July | Aug | Sept | Oct | Nov | Des | Nov | Nov |
|------|------|-----|------|------|-----|------|-----|-----|-----|-----|-----|
| 1995 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1996 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1997 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1998 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 1999 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 2000 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
| 2001 | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III | I-III |
4.4. Forecast maps crop calendar for the Indramayu regency 2015 year

Based on the forecasts using the method of the **sum of sin** for 2014 and 2015, the beginning of the wet season and its connection with the crop calendar has been started in the third deciles in August 2014 in Indramayu northwest it looks apparent motion of the sun approached the equator and west monsoon season occurs, then continues throughout the Indramayu region see figure 6 in the first deciles of Sept to the first deciles in May 2015, which this month has begun to look into the area of the dry season. Forecast beginning of the dry season begins in the second deciles in May 2015 which has covered all parts of the north, northeast and parts of southeast Indramayu it is local factors influence sea surface temperature has begun to play a role in addition to the apparent movement of the sun in the north to the south of the equator and future the transition to easterlies monsoon season. In the Nov-III until Dec-III occurred about 40 days lag time to dry (dry spell).

![Figure 6. The map of the early wet (upper) and dry season (bottom)](image)

5. Conclusion

From the discussion carried out mainly developing analytical methods and the interpretation of the model, it can be taken a few tentative conclusions are the model predictions of the number of sinus can be used as an alternative to estimate the amount of rainfall deciles and monthly for a one year ahead to achieve the 0.979 correlation with the observed data, data residue prediction model is anomalous rainfall that is oscillating in regional and global events such as the ENSO which can lead to advance or retreat of the growing season Climatic factors have a very important role in the planning and agricultural production systems because all the elements of the climate effect on various physiological processes, growth and productivity of plants. Basically by using curve fitting Sum of Sine results was associated with the monsoon and climatic classification. While the residue obtained by frequency of 12.59, 28.89, 61.79 and 80.9 months. The frequency associated with
ENSO events and based on the data of rainfall and wind data, Java predominantly controlled by the ITCZ, monsoon, sea breeze and land breeze so that it can be concluded Indramayu regions dominated by wet dry tropical climate.

Appendix-1: Forecasting use the sum of sin method

Appendix-2: The forecast of precipitation residue to each DPM

Appendix-3: The determination of early season in the Indramayu regency along 1998-2014 years
Appendix-4: The flow chart of analysis of precipitation anomalies in the Indramayu regency
Appendix-5: The forecast maps crop calendar for 2015 year ahead
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