INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2024, Vol. 5, No. 7, 2365 – 2375
http://dx.doi.org/10.11594/ijmaber.05.07.03

Research Article

Analysis of Land Water Balance in Various Rainfall Conditions and Its Utilization to Determine Planting Patterns of Food Crops in the Eastern Part of Seram District of Seram Island

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Article history:
Submission 19 February 2024
Revised 07 July 2024
Accepted 23 July 2024

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ABSTRACT

Soil water balance calculation is one of the methods used to estimate the dynamics of soil water content during plant growth. This study aims to describe rainfall conditions and analyze soil water balance as well as determine the growing season and composition of food crop combination patterns based on the available growing season in East Seram Island. This research uses rainfall data for 30 years of observation period 1992-2021 from Geser Meteorological Station (Data analysis with the following stages: (i) rainfall analysis (ii) calculation of average rainfall (iii) determination of rainfall with a 75% chance (iv) calculation of soil water balance using the Thornthwaite and Mather method (v) determination of the growing season and cropping pattern. The results showed that the average rainfall in East Seram was 2,194 mm/year with a water deficit (D) occurring in October and November, then the rainfall had a 75% chance of being exceeded at 1,439 mm/year with a water deficit of 228 mm/year which lasted for eight months, namely August - March. The growing season under normal rainfall conditions was available throughout the year, while under high rainfall conditions, a 75% chance of the growing season was available for five months, namely May and October. The cropping patterns and crop combinations used were monoculture, polyculture, and intercropping with combinations of cassava, maize, sweet potato, groundnut, mung bean, cassava-corn, cassava-peanuts/green beans, maize-peanuts, cassava-corn-peanuts/green beans, cassava-corn-horticultural crops.

Keywords: *Growing season, Land water balance, Rainfall*

Introduction

Indonesia is an agricultural country located right on the equator, and has a diverse climate. As a result, there are differences in geography and the interaction of various factors that affect the growth of climatic plants from one place to

How to cite:
Madubun, E. L., Ririhena, R. E., Laimeheriwa, S., & Simamora, R. (2024). Analysis of Land Water Balance in Various Rainfall Conditions and Its Utilization to Determine Planting Patterns of Food Crops in the Eastern Part of Seram District of Seram Island. *International Journal of Multidisciplinary: Applied Business and Education Research*. *5*(7), 2365 – 2375. doi: 10.11594/ijmaber.05.07.03

another. The diversity of existing climates also affects plant growth, one of the climatic factors is rainfall.

Rain is a form of returning water that has been evaporated into the atmosphere to the Earth's surface. This return of water occurs after water vapor has condensed, forming clouds containing water or ice grains. If the size of the ice grains is large enough so that the speed of the fall can resist the genre of air above it, then the water or ice grains will fall as rain (Rogers, 1983; Bruce and Clark, 1966).

The role of rainfall is very dominant in a farming system, but on the other hand, despite its high variability, it is often practical and sporadic. The situation can influence the availability of water inside the ground, deep connection. It is to estimate the availability of deep groundwater related to plant growth that deep groundwater content needs to be estimated. This estimation is done through water balance calculations.

One method that is often used to estimate the dynamics is to estimate the soil water content during plant growth, so as to calculate the amount of water needed by plants to produce, especially during the critical period when the soil water content is very low or under normal conditions.

One example of a water balance calculation method is based on the Thorntwite and Mather (1957) system book. This method has been applied in several previous studies, including the analysis of internal water balance to determine the potential planting season of food crops in Banten Province (Hidayat et al., 2005), for food crop development under different climatic conditions (Djufry, 2012), land water balance analysis for rice and maize crops in Bengkulu (Paski et al., 2017), a study to see the shift in the planting schedule in the Cimandiri irrigation area (Sofia et al., 2019), as well as the results of research in the Maluku region that uses consideration of the results of soil water balance calculations to determine the planting season including by (Nangimah et al., 2018) in the Waeapo area of Buru Island and Laimeheriwa et al.

Food crops generally consist of annual crops, which are more sensitive to environmental stress, especially drought, with more limited recovery power compared to annual crops. Low crop yields in certain parts of an agrosystem are those that are incompatible with plants, varieties, and farming packages with ecology (Baharsjah and Irsal, 1990). Therefore, the application of food crop farming system technology is based on an analysis and study of agroecology in certain agro-climatic conditions such as the determination and planning of planting periods and appropriate crop types in an area as a whole.

The Growing Period is based on the start of the rainy season for each location or region. First rains will fall on land with dry surface conditions or internal water deficit land profiles. When it comes to tillage, seeding and cultivation in the early rainy season, the amount and distribution of rainfall is very important based on land conditions (Pramudi and Santoso, 1992).

The available growing season or growing period is the period during which plants can potentially grow and develop based on local land conditions. Determining the growing period and growing season of a region is intended to choose the right planting time, at which time climate and land factors do not become a barrier.

Based on the background of the problem, Bula and Bula Barat sub-districts were chosen as research areas, considering that this area is one of the centers of food and secondary crop production with the potential for dry and rainfed land which is quite extensive in Maluku.

This research aims to: Analyze the land water balance in two rainfall conditions in East Seram Island, Determine the planting season in two rainfall conditions in East Seram Island, and determine the composition of food crop combination patterns in accordance with the available planting season in East Seram Island.

Methods

The materials used in this study were 30 years of rainfall data (period 1992 - 2011) recorded at the Gili Trawangan Island Meteorological and Geophysical Station, soil type data, agricultural condition data obtained from several previous studies, data on the types of agricultural commodities (especially food crops) cultivated by farmers, and other supporting data.

Unavailable data were generated through a statistical-mathematical approach based on physical indicators of the region. In this study, data analysis was conducted to (1) determine the average rainfall; (2) determine the rainfall that has a 75% chance of being exceeded; (3) calculate the land water balance; (4) determine the available growing season; (5) develop cropping patterns.

Calculation of monthly soil water balance used the bookkeeping system proposed by Thornthwaite and Mather (1957). Soil water balance calculations with this method used inputs of average rainfall and 75% chance exceedance rainfall data, as well as potential evapotranspiration data. The data was in the form of field capacity marks and permanent wilting points, latitude and longitude locations, and others.

The soil water balance analysis method involved the following steps:

a. Compiled table stuffing monthly water balance
b. Filled in column bulk rain, P (Pb or P_{75})
c. Filled in column evapotranspiration potential (Etp). Monthly ETp data in this area was not available, so it was necessary to estimate it using the Penman-Monteith method with the CROPWAT 8.0 program. The application program used the input data of: (i) location data: altitude, latitude, and longitude of the location; (ii) maximum and minimum air temperature (ºC); (iii) relative air humidity (%), sunshine duration (hours/day), and wind speed (km/day). The calculated ETp value was the daily value (mm/day). So to obtain the monthly ETp value, the daily ETp was multiplied by the number of days in each month.
d. Counted P value– ETp
e. Results negative on step (d) were accumulated month after month as APWL (accumulated water loss in a way potential) and filled on relevant column _

Determined mark field capacity (FC), period withered permanent (PWP) as well depth review 1 m, ie depth rooting maximum For plant age short or annuals. From the results researchers ever _ done obtained trait data on physique land; especially texture data land (Faculty of Team Agriculture 2018). Texture data from each soil type or order could then be connected to the conditions of field capacity, permanent wilting period, and water availability or WHC (water holding capacity).

Table 1. FC, PWP, and WHC Values in Various Soil Textures

No.	Soil Texture	mm of water per m of soil depth		
		Field Capacity, FC	Permanent Wilting Point, PWP	Water Holding Capacity, WHC
1.	Sand	150	70	80
2.	Sandy Loam	200	90	110
3.	Clay	310	140	170
4.	Clay Clay	360	170	190
5.	Dusty Clay	400	190	210
6.	Look	430	210	220

Source: 2018 Faculty of Agriculture Team

Based on the type of soil in the Eastern Seram Region, the dominant soil is food cropland with a slope of 8%, namely: (1.) Regosol soil with the texture of clayey loam and sandy loam, (2.) Alluvial with the texture of clayey loam and sandy loam, (3.) Gleisol with the texture of clayey loam to dusty loam. Then the soil KL value of 310 mm/m depth, soil PWP of 140 mm/m depth, and soil WHC of 170 mm/m depth were determined.

a. Filled in column soil water content (KAT), starting from the beginning occurrence of APWL until the last APWL. Continued KAT filling for months the next one has its P-ETp value positive, where maximum KAT value = FC value
b. To determine the KAT value (initial APWL and so on) was calculated with equality :

$$KSA = WHC \; x k^{|APWL|}$$

WHC = FC – PWP; WHC = AT; water is available
KAT = PWP + KSA
Where
KSA = groundwater availability actual, WHC = capacity store groundwater, and k = constant value _ calculated with the equation: k = po + pi or WHC;
Where po = 1.000412351 and p1 = -1.073807306. The k value obtained of 0.9941

c. The filled column changes soil water content (dKAT), where dKAT a moon is KAT month the said minus KAT month previous: dKATi = KATi – KATi-1
d. Filled in column evapotranspiration actual, ETa :
If P ≥ ETp --→ ETa = ETp
P < ETp --→ ETa = P + | dKAT |
If the results of the calculation ETa > ETp so used mark ETa = ETp (value ETa maximum = ETp; mark ETa No Can surpass mark ETp)
e. Filled in column deficit, D = ETp – Eta
f. Filled in surplus column, S = CH – ETp – dKAT

Result and Discussion

Astronomically, Bula District is located between 2° 58'-3° 32' South latitude 130° 6'-130° 52' East longitude. Meanwhile, geographically, it has the following boundaries:

The south is bordered by Werinama Subdistrict, The north is bordered by the Seram Sea, The east is bordered by Teluk Waru Subdistrict, and The west is bordered by West Bula Subdistrict, Astronomically, West Bula Subdistrict is located between 5° 33'-5° 53' South latitude 132° 32'-132° 47' East longitude. Geographically, it is bounded by: South bordering Werinama Sub-district, North bordering Seram Sea, East bordering Bula Sub-district, and West bordering Central Maluku Regency.

Based on regional regulations, Bula and West Bula Sub-districts are one of the sub-districts in Seram Island which is located in the eastern part of Seram Island. This region consists of 15 (fifteen) sub-districts, the 15 sub-districts are Gorom Island (91.303 Km 2), Kesui Watubela (37.58 Km 2), Teor (23.41 Km 2), Gorom Timur (29.29 Km 2), Pulau Panjang (20.53 Km 2), Seram Bagian Timur (73.35 Km 2), Seram Bagian Timur (73.35 Km 2). 35 Km 2), Tuktuk Tolu (330.09), Kilmury (837.62), Lian Vitu (172.37), Kian Darat (129.23), Weri Nama (993.84 Km 2), Siwalalat (847.19 Km 2), Bula (643.36 Km 2), West Bula (880.29 Km 2), Teluk Waru (669.67 Km 2) with an area of 5,779.123 Km 2. Source: BPS Kabupaten Seram Bagian Timur (2021).

Table 2. Monthly Climate Conditions at the Research Location

Monthly	Rainfall (mm)	Average air temperature (^{0}C)	Maximum air temperature (^{0}C)	Minimum air temperature (^{0}C)	Relative humidity (%)	Sunshine duration (%)	Average wind speed (knot)
January	176	28,2	32,0	25,1	82	63,9	5,5
February	156	28,2	32,1	25,1	82	67,0	5,8
March	185	28,0	32,0	25,1	83	66,7	5,7
April	262	27,2	31,5	25,2	85	62,6	5,1
May	301	27,5	31,3	25,0	87	60,6	5,3
June	233	26,9	30,5	24,7	86	53,1	6,9
July	193	26,2	29,8	24,2	84	50,6	7,8
August	123	26,1	29,5	24,0	84	57,5	7,4
September	124	26,5	30,0	24,4	84	60,9	6,6
October	132	27,5	31,3	24,7	83	72,7	5,4
November	117	28,3	32,1	25,0	82	71,1	5,0
December	192	28,4	32,4	25,2	82	65,2	6,0
Annually	2194	27,5	31,2	24,8	84	5,0	6,0

Thus, based on the Oldeman climate classification system (1975), the region is classified as an agro-climatic zone characterized by the number of wet months (rainfall > 200 mm) for 3 consecutive months, namely April to June and humid months, namely 9 months (July to March).

Table 3. Rainfall Values 75% chance (P_{75}) and Evapotranspiration Potential (Etp) at Location Study

Component	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	A year
P_{75}	119	114	125	126	159	88	64	32	32	40	36	55	1.142
ETp	176	137	148	129	121	111	119	127	130	148	144	148	1.638

The 75% chance rainfall at the study site was 1,142 mm/year with a range from a low of 32 mm per year in August and a very heavy rainfall of 159 mm/year in May.

The description of the shape of the region, topography, and geology in East Seram influenced the morphological characteristics of the soil formed in this region. Based on observations of morphological characteristics in the field and supported by data from chemical analysis, the dominant soils in Eastern Seram were in the order of Organosol, Regosol, Alluvial, Glisol, Cambisol, Rensina, Nitosol (Team Faperta Unpatti, 2015). However, the dominant land for food crops was with a slope of 8%:

1. Regosol Soil with Clay and Sandy Loam Texture
2. Alluvial with sandy clay and clay texture
3. Gleisol with a sandy to dusty clay texture

The textures of the three soil types ranged from sandy loam to loam, resulting in field capacity values of approximately 310 mm/meter into the soil, TLP of 140 mm/meter into the soil depth, and available water holding capacity (WHC) of 170 mm/meter into the textured soils ranging from sandy loam to loamy loam.

Agricultural commodities that were generally cultivated by farming communities or agricultural land users in Kecamatan Bula in 2021 consisted of (BPS, 2021):

1. Food Crops: Corn, Cassava, Sweet Potato, Peanuts, Green Beans: total harvest area: 250 ha.
2. Horticulture vegetables with a wide harvesting of 394 ha and horticulture fruit with a total production of 210 ha.
3. Plantation crops: _ coconut palm oil (24.00 tonnes/ha), coconut (1302.20 tonnes/ha), cloves (14.00 tonnes/ha), coffee (1.85 tonnes/ha), cocoa (31.00 tonnes/ha), and nutmeg (16.00 tons/ha).

Agricultural commodities generally cultivated by farming communities or agricultural land users in West Bula District in 2021 consisted of (BPS, 2021):

1. Food Crops: Corn, Cassava, Sweet Potato, Peanuts, Green Beans: total harvest area: 999 ha
2. Horticulture vegetables with a wide harvesting of 394 ha and horticulture fruit with a total production of 140 ha.

Plantation crops: oil palm (36,050 tons/ha), coconut (1,333 tons/ha), cloves (127 tons/ha), coffee (1,791 tons/ha), cocoa (61,236 tons/ha), and nutmeg (37,050 tons/ha).

Land Water Balance Calculation

Calculating soil water balance is an approach that connects rainfall, potential evapotranspiration, and fluctuations in soil water content through the calculation of soil water balance (climatological water balance). From the results of the water balance calculation, it can be seen when there is a deficit (lack) of water and when there is a surplus (excess) of water in the soil. In addition, the water balance also provides information on how the groundwater level fluctuates periodically, so that better crop management actions can be taken such as determining the right planting time and pattern, and when to apply water if there is a shortage, as well as other actions. Soil water balance also provides information on how groundwater levels fluctuate periodically, which can be used for better management measures for crops.

To describe the soil water balance at the study site, the bookkeeping system proposed by Thornthwaite and Mather (1957) was used. Land water balance calculations using this method generally used rainfall input data with potential evapotranspiration with the rainfall component as the only component of soil water input during the ongoing growth period.

Data on potential evapotranspiration (ETp) in an area was generally not available, so it was necessary to estimate it using empirical equations. One way that can be used to look at potential evapotranspiration is to use the method proposed by Thornthwaite and Mather (1957) to calculate this method using climatic elements, average air temperature, and the geographical location of a location such as latitude and longitude related to the day length component.

A 75 percent chance means that in 4 years there will be rain, during 3 years there will be rain of a certain value. If the average rainfall value is used, then the chance of occurrence is below 50 percent on average; meaning that the risk of no rain of a certain value will be greater. Thus, in the calculation of land water balance, rainfall values that have a 75 percent chance of being exceeded will be used, in addition to using average rainfall values as a comparison. The results of the land water balance calculation at the research site under the conditions of average rainfall and rainfall with a 75% chance are presented in Tables 4 and 5, respectively.

Table 4. Calculation of land water balance at the research location in average rainfall condition

Monthly	P	ETp	P-ETp	APWL	KAT	dKAT	ETa	D	S
January	176	146	30		310	2	146	0	28
February	156	137	19		310	0	137	0	19
March	185	148	37		310	0	148	0	37
April	262	129	133		310	0	129	0	133
May	301	121	180		310	0	121	0	180
June	233	111	122		310	0	111	0	122
July	193	119	74		306	0	119	0	74
August	123	127	-4	-4	300	-4	127	0	0
September	124	130	-6	-10	286	-6	130	0	0
October	132	148	-16	-26	264	-14	146	2	0
November	117	144	-27	-53	264	-22	139	5	0
December	192	148	44		308	44	148	0	0
Annually	2.194	1.608			3634,5	0	1.601	7	593

Description: P=rainfall (mm); ETp=potential evapotranspiration (mm); APWL=acumulation of potential lost water (mm); KAT=soil water content (mm); dKAT= change in soil water content (mm); ETa=actual evapotranspiration (mm); D=water deficit air (mm); S=water surplus (mm).

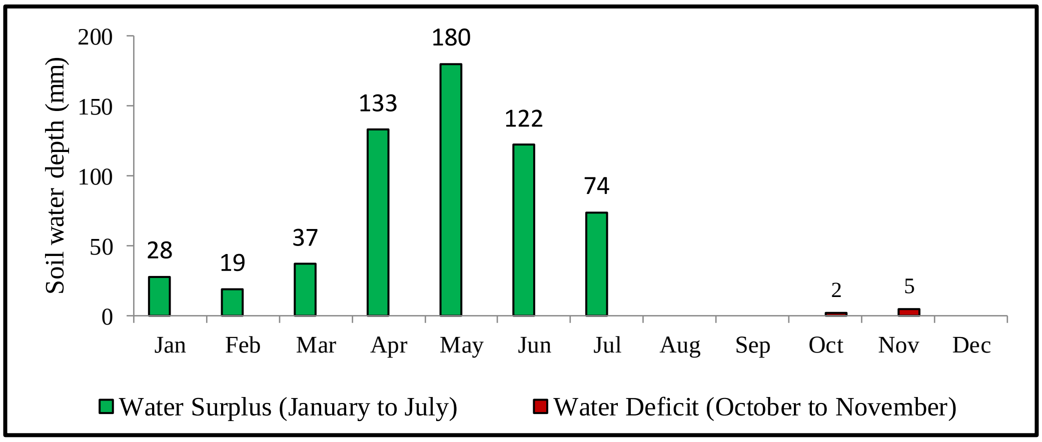

Figure 1. Periods of water deficit and surplus at the location study under average rainfall conditions

Water deficit occurs because the potential value of evapotranspiration (ETp) exceeds the actual value (ETa) due to low rainfall (P). Meanwhile, the water surplus period (S) lasts for 7 months, namely January to July with a range of 19 - 180 mm and a total surplus of 539 mm/year. The water surplus that occurs in the rainy season is highly dependent on the difference between rainfall and potential evapotranspiration and changes in soil water content each month.

Table 5. Calculation of land water balance at the research location in rainfall conditions 75% Chance

Monthly	P75	ETp	P75-ETp	APWL	KAT	dKAT	ETa	D	S
January	114	146	-32	-315	166	-6	120	26	0
February	98	137	-39	-354	161	-5	103	34	0
March	122	148	-26	-380	158	-3	125	23	0
April	185	129	56		214	56	129	0	0
May	217	121	96		310	96	121	0	0
June	161	111	50		310	0	111	0	50
July	128	119	9		310	0	119	0	9
August	71	127	-56	-56	262	-48	119	8	0
September	72	130	-58	-144	227	-35	107	23	0
October	78	148	-70	-184	197	-30	108	40	0
November	66	144	-78	-262	176	-21	87	57	0
December	127	148	-21	-283	172	-4	131	17	0
Annually	1.439	1.608					1.380	228	59

Description: P75=rainfall 75% chance (mm); ETp=potential evapotranspiration (mm); APWL=acumulation of potential lost water (mm); KAT=soil water content (mm); dKAT= change in soil water content (mm); ETa=actual evapotranspiration (mm); D=water deficit air (mm); S=water surplus (mm).

The results of the calculation of the land water balance under conditions of rainfall with a 75% chance of being exceeded (Table. 5) show that the water deficit lasts for 8 months, starting from the beginning of the first dry season (January-March) and for the second water deficit (August-December) with a deficit range between 8-57 mm/month with a total deficit of 228 mm/year. This condition tends to increase the water deficit value by 221 mm compared to normal (average) rainfall conditions. The water surplus period only lasted for 2 months, namely during the peak rainfall in June and July amounting to 59 mm. Graphically the period of groundwater deficit and surplus at the study site under rainfall conditions that have a 75% chance of being exceeded can be seen in Figure 2.

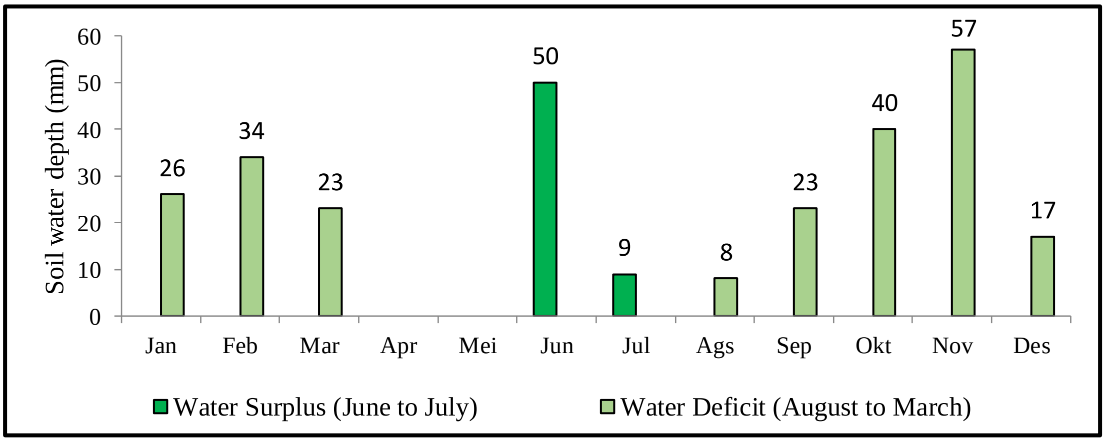

Figure 2. Periods of water deficit and surplus at the location study in rainfall conditions 75% chance

Growing Season

The growing season is the period during which crops can potentially grow and develop based on local land conditions. There are various methods to determine the growing season in an area/place. For the research location, the determination of the growing season uses the method proposed by FAO (1978). This method uses rainfall data that characterizes the potential availability of water for plants and potential evapotranspiration to see the need for water for plants.

Determination of the growing season in an area can use rainfall data under normal (average) conditions and rainfall conditions with a 75% chance as in Tables 4 and 5. Rainfall data is used to see the water deficit and water surplus in the soil for one year so that there is no drought or flooding during the growing season. One of the components considered in determining the growing season of an area is the value of soil moisture content at optimum conditions (KATopt), where the KATopt value is determined at 225 mm. Referring to the results of the water balance calculations in Tables 4 and 5, the soil moisture content (KAT) at the research site under two rainfall conditions as shown in (Figure 3) below:

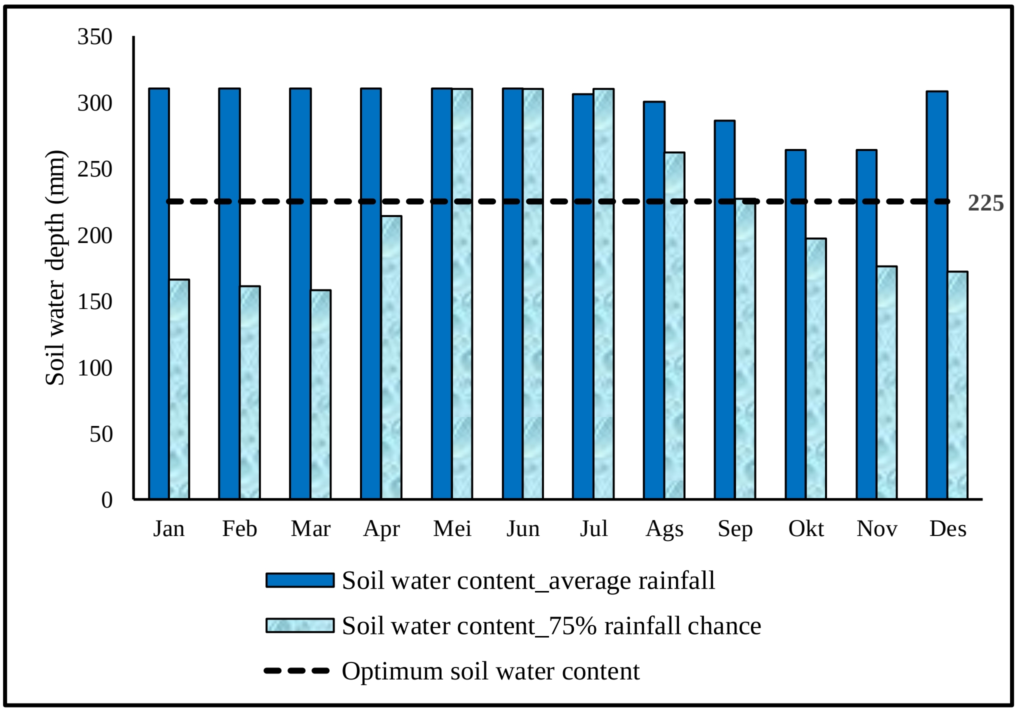

Figure 3. Soil water content under two rainfall conditions at the research location.

The timing of one month before and after the KATopt period is based on the consideration that in the early and late stages of crop development, water requirements are relatively smaller compared to other stages of crop development. Thus, the months that meet the criteria of P/ETp ≥ 0.75 are the beginning or end of the available growth period. The results of determining the crop season in the research location under two conditions of average rainfall and heavy rainfall with a 75% chance of exceedance can be seen in Table 6.

Table 6. Determination of the growing season at the research location under two rainfall conditions

Komponen	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average rainfall												
Period of optimum soil water content												
Ratio: P/ETp	1.21	1.14	1.25	2.03	2.49	2.10	1.62	0.97	0.95	0.89	0.81	1.30
Growing Season												
75% Rainfall chance												
Period of optimum soil water content												
Ratio: P_{75}/ETp	0.78	0.72	0.82	1.43	1.79	1.45	1.08	0.56	0.55	0.53	0.46	0.86
Growing Season												

ETp : Potential Evapotranspiration
P : Average Rainfall
P75 : 75% Rainfall Chance

Based on the results of determining the growing season under both rainfall conditions, Table 6 below presents the possible cropping intensity for several major vegetable and food crops in the study area. Planting intensity depends not only on the length of the growing season but also on the harvesting age of each crop. The types of vegetable commodities and food crops referred to are those commonly cultivated by farmers whose water needs depend solely on rainfall, including food crops: corn, cassava, sweet potato, peanuts, and green beans and vegetable crops: chili peppers, tomatoes, cabbage, eggplant, long beans, and chickpeas.

Table 7. Planting intensity of vegetable and food crops at the research location under two rainfall conditions

Harvest Age (month)	Commodity	Planting Intensity (times)
Average Rainfall Condition: Growing Season 12 months		
2	long beans, beans	3 – 4
3	peanuts, mung beans, soybeans, eggplant, chili	3 – 4
4	cassava, sweet potato	2
8	Cassava	1
75% Rainfall Chance: Growing Season 7 months		
2	long beans, beans	3
3	peanuts, mung beans, soybeans, eggplant, chili	1 - 2
4	cassava, sweet potato	1
8	Cassava	1

Table 7 above shows that the growing season in the study locations under average (normal) rainfall conditions occurs for 1 year (January to December), while the growing season under 75% rainfall conditions lasts for 7 months (April to October).

A further impact of the shorter growing season due to El Nino and La Nina is a reduction in crop intensity (especially 3-month-old annual crops), which in turn has an impact on the reduction of the harvested area and ultimately leads to a reduction in crop production per year.

Several studies have suggested that without adaptation to climate change, including major El Nino and La Nina rains, food production and yields by 2050 are expected to decline significantly.

Setting Planting Patterns as a Step to Anticipate Climate Change

The cropping pattern in a field is determined by the rainfall in the area. The reality in the field shows that farmers determine planting schedules and patterns based on habits that have been passed down from generation to generation, including based on the month of rainfall. Climate change has a major effect on cropping patterns, planting areas, and crop production. Due to climate change, almost every year farmers are faced with seasonal shifts related to changes in rainfall patterns. In addition, climate change is also causing extreme dry conditions due to El Nino and extreme wet conditions due to La Nina.

These conditions trigger the threat of floods, droughts, and attacks by plant pest organisms that result in decreased crop production and even crop failure. The magnitude of climate change impacts on agriculture is highly dependent on the level and rate of climate change on the one hand and the nature and flexibility of agricultural resources and production systems on the other. For this reason, various research and studies are needed on climate change and its impact on the agricultural sector, resources, infrastructure, agricultural/agribusiness systems, and national food security. In the seasonal calendar, it can be seen the natural conditions (season) and the sustainability of the agricultural sector in each commodity. In the seasonal calendar, it is known that the rainy season occurs in the middle of April to September, while the dry season occurs in the middle of November to March. Three methods of cropping patterns are applied, namely intercropping patterns, concurrent cropping patterns, monoculture cropping patterns, and rotating cropping patterns.

Conclusion

1. The average rainfall in East Seram is 2,194 mm/year, and the rainfall has a 75% chance of being exceeded at 1,439 mm/year.
2. Under high rainfall conditions, the average water deficit lasted for 2 months (October and November) amounting to 7 mm/year. Under conditions of 75% chance of rainfall, groundwater deficit occurs for 8 months (August-March) with a total deficit of 228 mm/year.
3. 3 The growing season in East Seram under normal rainfall conditions lasts throughout the year (12 months), while the growing season under 75% rainfall conditions is only 7 months, from May to October.
4. The cropping pattern applied in East Seram Regency is monoculture, polyculture, and intercropping with a combination of food crops, namely: corn with cassava, cassava with peanuts, sweet potato with green beans, peanuts with horticultural crops, and green beans.

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