Plant Pattern Analysis To Increase Agricultural Harvest Production In Taebenu District, West Timor, Indonesia

Sutirto[1], Yunus Fallo[1], Arnoldus Nama[1]
{sutirtojatayu@gmail.com, yunus_fallo@yahoo.co.id, n.arnold.Id@gmail.com}

State Polytechnic of Kupang, Indonesia

Abstract. The Tulun Irrigation Network is an area of 200 hectares of irrigated agricultural area, the source of water in the Tulun irrigation network comes from the Fefanaek Dam. The Tulun irrigation channel consists of primary and secondary canals with a total length of 1430.47 m. In this study, an analysis of irrigation water needs was analyzed, analysis of irrigation water availability, analysis of water balance, and optimization of the Tulun Irrigation Area. The results of the water balance indicate that the availability of water is not sufficient to meet water needs based on existing cropping patterns. Results of analysis Establishment of cropping patterns according to water requirements to irrigate rice fields in order to increase agricultural output in the Tulun irrigation area of Taebenu District is rice - palawija (second crops in dry season) - palawija which started from the preparation of land in November 1 starting in January 2.

Keywords: planting pattern, production, harvest, agriculture, irrigation, optimization

1. Introduction

Increasing the water demand in the context of intensification and expansion of rice fields, as well as a limited water supply for irrigation and other needs, especially in the dry season, the distribution and use of irrigation must be carried out more efficiently and effectively [1].

The government's goal to achieve a just, prosperous and prosperous Indonesian society is the noble ideals of the Indonesian Nation as enshrined in the Preamble of the 1945 Constitution [2]. This needs to be supported by several factors, including natural resources and human resources. One of the current government targets is to make Indonesia a food self-sufficiency, country so that various government programs are launched to achieve this goal, even remote and disadvantaged areas are striving to develop such as the Province of East Nusa Tenggara (NTT).

President Joko Widodo said the problem of East Nusa Tenggara (NTT) was only water. According to the President, the development of NTT depends on the availability of water. If there is water, the community can use it to develop the agricultural potential such as corn. Communities in the East Nusa Tenggara (NTT) region have a variety of livelihoods, one of which is farming. Most farmers use irrigation water to meet water needs in rice fields, dry field farming, animal husbandry and fisheries. Generally, water is obtained from irrigation facilities and infrastructure built by the government or the farmers themselves. The NTT region is one area that is always experiencing drought and lack of water. To answer this, water management is very necessary in order to meet the needs of the community. The government

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is trying to develop irrigation areas of dryland or wetland that has the potential to be developed into agricultural land that can meet the needs of the community (Tempo, 2016)

One of the districts in NTT that often experiences drought problems is Kupang Regency. In supporting water needs in the agricultural sector with an irrigation system, there will indeed be several problems that arise. The availability of irrigation water in the dry season still lacks water and vice versa during the rainy season abundant water that is not used optimally.

In Taebenu Subdistrict, Kupang Regency, there are rice fields, the majority of the people are farmers, each year the agricultural output is decreasing every year because it always constrains water shortages. The area of agriculture is 200 Ha with a length of 1,430.7 m of primary and secondary channel infrastructure.

The existence of the above problems requires a study of cropping pattern analysis to improve agricultural output:

1. How is the application of plant pattern according to the water requirements to irrigate the rice fields to increase agricultural output in the Tulun irrigation area of Taebenu District.
2. What is the required debit in the intake channel according to the results of the analysis of the plant pattern schedule in order to meet the debit needed in the Tulun Irrigation Network to irrigate 200 hectares of rice fields.

2. Research Methods

2.1 Research Location

The research location was the Tulun irrigation network in Taebenu District, West Timor, Indonesia. Geographically, the location of the study is located at coordinates 10^{o}10'56.92" latitude and 123^{o}40'56.60" longitude. With territorial boundaries i.e. Northern with Central Kupang District, Eastern with East Baumata Village, Western with West Baumata Village, and Southern with Central Baumata Village.

The surface condition of the land in the village of North Baumata includes flat and low surface types. The climate in this region is a semi-arid climate with a dry season longer than the rainy season. The dry season is from April to October, while the rainy season is from November to March.

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Fig. 1. Research Location

2.2 Procedure of Research

The initial step in this research is collecting references used as a basis for research related to water resources, then hydrological analysis is carried out [3]. One of the important hydrological parameters in a work related to water resources is to calculate available water discharges, calculate the water requirements needed in a rice field by means of alternative cropping patterns, with the following steps:

1. 10-year Rainfall Data from (BMKG Lasiana Kupang Climatology Station) Station Climatology station adjacent to the Research Area;
2. Climatology Data of the last 10 years consisting of temperature, solar radiation, humidity, wind speed, area of irrigated rice fields, water availability analysis;
3. Calculate the average amount of ½ monthly rainfall;
4. Calculating potential evapotranspiration;
5. Calculate percolation and infiltration;
6. Analysis of the schedule calculation by means of shifting crops, according to the availability of the land and determining the types of plants to be planted;

7. Determine the flow of water at the intake (intake)
   according to the calculation results of shifting cropping patterns.

3. Results And Discussion

3.1 Irrigation Water Needs

Water Needs in Rice Fields

Calculation of Water Needs for Land Preparation (S). Calculation of water requirements for land preparation in November:
Evapotranspiration (ETo) = 4,104 mm / day
Percolation (P) = 2.00 mm / day
Number of Exponents (e) = 2.7182
Land Preparation Period (T) = 45 days
Water requirements for fulfillment (S) = 300 mm
Water requirements to replace water losses due to evaporation and percolation in rice fields:
M = 1.1 x ETo + P = 1.1 x 4.104 + 2.00
= 6,514 mm/day
k = M x = 6,514 x
= 0.977
ek = (2.7182) 0.977 = 2.657
LP = (M x ek)/(ek - 1) = (6,514 x 2,657)/(2,657 - 1)
= 10.446 mm/day.

3.2 Mainstay Rainfall (R80)

To calculate the water needs in a rice field, the daily rainfall data are calculated into semi-monthly data. Data was obtained from several rainfall stations around the Tulun Irrigation Area research site. The rainfall station is included in the Baumata Watershed (DAS) catchment area. The rainfall stations in the Baumata River Basin are Lasiana Climatology Station and Eltari Meteorological Station. Daily rainfall data have been calculated into semi-monthly rainfall data for the two rainfall stations above.

3.3 Calculation of Effective Rainfall (Re)

Effective rainfall for rice plants is calculated based on 70% of the mainstay rainfall value of 80% [4], while for effective rainfall for crops and sugarcane is calculated based on the value of the mainstay rainfall of 50%. This calculation was taken in November as an example calculation. The results of the calculation of Effective Rainfall (Re) are presented in Table 1.

Table 1. Calculation of Effective Rainfall (Re)

Bulan	R80	Re = 0.7*R80	Re Padi	Re = 0.5*R80	Re Palawija
		(mm)	(mm/hr)	(mm)	(mm/hr)
Jan	51.000	35.700	2.380	25.500	1.700
	178.940	125.258	8.351	89.470	5.965
Feb	54.220	37.954	2.530	27.110	1.807
	51.740	36.218	2.415	25.870	1.725
Mar	60.040	42.028	2.802	30.020	2.001
	47.240	33.068	2.205	23.620	1.575
Apr	0.720	0.504	0.034	0.360	0.024
	0.200	0.140	0.009	0.100	0.007
Mei	0.060	0.042	0.003	0.030	0.002
	0.000	0.000	0.000	0.000	0.000
Jun	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000
Ags	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000
Sep	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000
Okt	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000
Nov	1.200	0.840	0.056	0.600	0.040
	17.890	12.523	0.835	8.945	0.596
Des	51.920	36.344	2.423	25.960	1.731
	121.250	84.875	5.658	60.625	4.042

Source: Calculation Results of This Research

3.4 Irrigation Water Availability

Calculation of availability of irrigation water using the F. J. Mock method with the required data as follows:

1) Semi-monthly rainfall (mm)
2) Semi-monthly rainy days
3) Potential Evapotranspiration Value (ETo)
4) River Basin Area (DAS)

For example the calculation of Mainstay Debit by the F. J. Mock method for January 1 2009 is as follows:

Watershed Area = 7,414 km2

1. Rain Data
   - Semi-monthly rainfall
   - P = 78 mm / 15hr
   - Half-monthly rainy days h = 9 days
2. Limited Evapotranspiration (Et)
3. Semi-monthly potential evapotranspiration

   ETo = ETo x 15 days, = 3,076 x 15 days
   = 46,134 mm / 15 days

   Open land surface (m) = 40% (intended for cultivated agricultural land assuming m = 30% - 50%). (m / 20) x (18-h) = (40% / 20) x (18 - 9) = 0.180. E = (ETo) x (m / 20) x (18 - h) = 46,134 x 0,180 = 8,304 mm / 15hr

   Difference between Potential Evapotranspiration (ETo) and Limited Evapotranspiration (Et)
   Et = ETo - E = 46,134 - 8,304 = 37,830 mm / 15hr

3.5 Water Balance

1) Rainwater that reaches the ground surface
   Δs = P - Et

= 78 - 37,830
= 40,170 mm / 15hr.

2) Groundwater content (Is)

If the value of Δs> 0, the moisture content of water in the soil is 0. Conversely, if Δs <0, the amount of moisture content of water in the soil is the value of Δs itself. This means that if the price positifs is positive (P> Et) then water will enter the soil if the soil's moisture capacity has not been met, and vice versa will run out if the soil is saturated. If the price negatifs is negative (P <Et) then some ground water will come out and there will be a deficit. In January 1 2008, P> Et so Δs> 0. Therefore the amount of soil moisture content in January 1 2008 was 0 mm / 15hr.

3) Soil moisture capacity (SMC)

Determine soil moisture capacity (SMC) parameters [5]. The initial SMC value in January of the first period was estimated at 250 mm. For the next month / period depends on the value of the moisture content of the water in the soil. If the value is negative, the amount of SMC in the next month / period is the difference from the previous month / period SMC value and the value of padas in the following month. SMC values are usually taken from 50 to 250 mm.

4) Excess water (WS)

WS = Δs - Is = 40,170 - 0,000 = 40,170 mm / 15hr.

5) Groundwater Flow and Storage

The infiltration coefficient (i) is estimated based on soil porosity conditions and the slope of the drainage area [6]. Porous land such as fine sand has a higher infiltration than heavy clay soils. Steep land where water does not have time to infiltrate into the soil then the coefficient of infiltration will be small. The infiltration coefficient limit is 0 - 1.0. The infiltration coefficient (i) is taken = 0.8. Recession factor groundwater flow (k) = 0.9.

6). Infiltration (I)

I = WS x I = 40.170 x 0.8 = 32.136 mm / 15hr

0.5 x (1 + k) x I = 0.5 x (1 + 0.9) x 32,136 = 30,529

7) k x V (n - 1) = 0.9 x 415,686 = 374,117

7) Storage volume (Vn)

Vn = 0.5 (1 + k) I + k (V (n - 1))
= 30,529 + 374,117
= 404,647 mm / 15hr

8) Changes in water volume (ΔVn)

ΔVn = Vn - V (n - 1) = 404,647 - 415,686
= -11,039 mm / 15hr

9) Basic flow (BF)

BF = I - ΔVn = 32,136 - (-11,039) = 43,175 mm / 15hr

10) Direct flow (DR)

DR = WS - I = 40,170 - 32,136 = 8,034 mm / 15hr

11) Flow (R)

R = BF + DR = 43,175 + 8,034 = 51,209 mm / 15hr

12) River Flow Discharge

River flow discharge = (AxRx1000) / (86400 x Number of days) = (7,414 x 51,209 x 1000) / (86400 x 15) = 0.293 m3 / sec = 292,952 lt / sec

After knowing the amount of irrigation water needs that have been calculated based on 6 alternatives and the amount of water available that irrigates the Tulun Irrigation Area, it can be

seen how the potential of the water meets the irrigation water needs in the Tulun Irrigation Area by calculating planting intensity as follows:
Taken an example of calculation January 1 alternative 1
Where: NFR = 0.463 lt / sec / ha, Q Mainstay = 0.150 m3 / sec, Irrigation Area = 200 ha
Q Need = NFR x Irrigation Area
= 0.463 x 200 = 92,575 lt / sec
Q Mainstay = 0.150 x 1000 = 149,800 lt / sec
Irrigation Area = (Q Mainstay/ Q Need) x Irrigation Area
= (92,575/149,800) x 200 = 323,628 ha
The results of the calculation of cropping intensity can be seen in Tables 6 and 7 below. Furthermore, from the calculation of cropping intensity it can be seen the largest cropping intensity of the six alternatives available. The highest planting intensity is the optimal planting start time.

Table 2. Calculation of Monthly Mainstay Discharge from 2009 - 2018 using the F. J. Mock Method

Tahun	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Ags		Sep		Okt		Nov		Des		Total Tahunan
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk	m^3/dtk
2009	0.293	0.402	0.889	1.048	0.631	0.552	0.515	0.448	0.403	0.340	0.326	0.294	0.264	0.223	0.214	0.181	0.173	0.156	0.140	0.119	0.114	0.153	0.392	0.380	8.650
2010	0.617	0.481	0.722	0.658	0.464	0.409	0.372	0.335	0.302	0.254	0.244	0.220	0.198	0.167	0.160	0.135	0.130	0.117	0.105	0.089	0.085	0.202	0.328	0.510	7.305
2011	0.549	0.771	0.471	0.608	0.497	0.375	0.409	0.374	0.350	0.279	0.266	0.240	0.216	0.182	0.175	0.147	0.142	0.127	0.180	0.116	0.112	0.100	0.181	0.323	7.190
2012	0.461	0.509	0.416	0.607	0.565	0.498	0.419	0.557	0.416	0.335	0.322	0.290	0.261	0.220	0.211	0.178	0.171	0.154	0.138	0.117	0.112	0.101	0.220	0.228	7.506
2013	0.201	0.348	0.519	0.360	0.555	0.378	0.320	0.384	0.290	0.244	0.235	0.211	0.190	0.160	0.154	0.130	0.125	0.112	0.101	0.085	0.082	0.128	0.084	0.277	5.673
2014	0.746	0.473	0.362	0.900	0.851	0.525	0.481	0.433	0.390	0.329	0.316	0.284	0.256	0.216	0.207	0.175	0.168	0.151	0.136	0.115	0.110	0.177	0.206	0.247	8.255
2015	0.297	0.513	0.542	0.796	0.424	0.387	0.352	0.316	0.284	0.240	0.230	0.207	0.186	0.157	0.151	0.127	0.122	0.110	0.099	0.084	0.080	0.127	0.190	0.199	6.223
2016	0.569	0.512	0.383	0.403	0.605	0.397	0.345	0.335	0.287	0.242	0.233	0.209	0.188	0.159	0.153	0.129	0.124	0.111	0.100	0.084	0.081	0.073	0.079	0.200	6.000
2017	0.104	0.287	0.228	0.192	0.294	0.187	0.167	0.150	0.205	0.135	0.129	0.116	0.105	0.088	0.085	0.072	0.069	0.062	0.056	0.047	0.131	0.086	0.179	0.206	3.380
2018	0.137	0.625	0.638	0.470	0.413	0.327	0.343	0.285	0.257	0.217	0.208	0.187	0.168	0.142	0.136	0.115	0.111	0.099	0.090	0.132	0.092	0.175	0.153	0.202	5.722

Source: Calculation Results of This Research

Table 3. Resume of Water Needs with Alternative Planting Patterns Planting Pattern: Rice - Palawija - Palawija

Irrigation Area Area: 200

Alternatif		Jan		Feb		Mar		Apr		Mei		Jun		Jul		Ags		Sep		Okt		Nov		Des	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Nov I	1. NFR (lt/dtk/ha)	0.463	0.000	0.299	0.190	0.053	0.166	0.486	0.557	0.509	0.508	0.370	0.439	0.405	0.558	0.710	0.605	0.581	0.399	0.401	0.231	1.434	1.343	1.085	0.104
	2. Q Butuh (lt/dtk)	92.575	0.000	59.790	38.000	10.666	33.162	97.194	111.404	101.876	101.648	74.068	87.819	81.046	111.666	141.987	121.005	116.237	79.873	80.262	46.280	286.702	268.680	216.942	20.827
	3. Q Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
	4. Luas Terairi (ha)	323.628	200.000	1224.959	1940.020	7785.195	2030.021	667.940	522.780	515.136	436.014	573.525	434.985	423.462	259.703	195.793	194.042	194.774	253.401	228.752	363.008	56.644	66.101	90.162	1924.391
Nov II	1. NFR (lt/dtk/ha)	0.469	0.000	0.549	0.312	0.136	0.103	0.365	0.488	0.587	0.510	0.521	0.370	0.463	0.405	0.609	0.710	0.583	0.581	0.405	0.401	0.227	1.343	1.085	0.710
	2. Q Butuh (lt/dtk)	93.761	0.000	109.712	62.468	27.224	20.539	73.091	97.595	117.500	101.922	104.148	74.068	92.529	81.046	121.741	141.987	116.584	116.237	80.977	80.262	45.354	268.680	216.942	142.075
	3. Q Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
	4. Luas Terairi (ha)	319.534	200.000	667.566	1180.128	3050.296	3277.592	888.202	596.749	446.640	434.841	407.880	515.741	370.912	357.821	228.353	165.368	194.195	174.127	226.731	209.315	358.069	66.101	90.162	282.105
Des I	1. NFR (lt/dtk/ha)	1.080	0.000	0.439	0.562	0.248	0.205	0.291	0.367	0.512	0.588	0.522	0.521	0.386	0.463	0.432	0.609	0.682	0.583	0.593	0.405	0.377	0.162	1.085	0.710
	2. Q Butuh (lt/dtk)	216.054	0.000	87.753	112.390	49.688	41.046	58.278	73.493	102.424	117.546	104.435	104.148	77.219	92.529	86.403	121.741	136.324	116.584	118.536	80.977	75.424	32.481	216.942	142.075
	3. Q Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
	4. Luas Terairi (ha)	138.669	200.000	834.611	655.930	1671.235	1640.116	1113.967	792.461	512.379	377.044	406.761	366.785	444.452	313.417	321.747	192.868	166.075	173.609	154.890	207.466	215.317	546.784	90.162	282.105
Des II	1. NFR (lt/dtk/ha)	1.080	0.389	0.445	0.452	0.488	0.318	0.474	0.293	0.381	0.512	0.604	0.522	0.554	0.386	0.498	0.432	0.586	0.682	0.594	0.593	0.380	0.313	0.031	0.710
	2. Q Butuh (lt/dtk)	216.054	77.896	88.919	90.431	97.606	63.510	94.808	58.679	76.111	102.470	120.764	104.435	110.709	77.219	99.655	86.403	117.276	136.324	118.894	118.536	76.057	62.550	6.232	142.075
	3. Q Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
	4. Luas Terairi (ha)	138.669	921.234	823.675	815.203	850.767	1059.989	684.750	992.513	689.523	432.515	351.761	365.778	310.002	375.557	278.963	271.749	193.048	148.470	154.424	141.729	213.525	283.933	3138.451	282.105
Jan I	1. NFR (lt/dtk/ha)	1.080	0.389	1.059	0.458	0.377	0.557	0.606	0.477	0.300	0.381	0.525	0.604	0.555	0.554	0.410	0.498	0.420	0.586	0.696	0.594	0.546	0.316	0.148	0.000
	2. Q Butuh (lt/dtk)	216.054	77.896	211.701	91.597	75.361	111.428	121.171	95.370	59.939	76.157	105.008	120.764	111.028	110.709	81.986	99.655	84.029	117.276	139.283	118.894	109.291	63.183	29.625	0.000
	3. Q Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
	4. Luas Terairi (ha)	138.669	921.234	345.959	804.833	1101.893	604.155	535.772	610.675	875.561	581.957	404.542	316.319	309.111	261.948	339.082	235.613	269.430	172.584	131.818	141.303	148.594	281.088	660.255	200.000
Jan II	1. NFR (lt/dtk/ha)	0.231	0.389	1.059	1.072	0.382	0.446	0.865	0.609	0.489	0.300	0.388	0.525	0.646	0.555	0.603	0.410	0.482	0.420	0.598	0.696	0.548	0.482	0.151	0.000
	2. Q Butuh (lt/dtk)	46.280	77.896	211.701	214.380	76.431	89.184	172.987	121.732	97.709	59.985	77.506	105.008	129.208	111.028	120.637	81.986	96.497	84.029	119.609	139.283	109.607	96.417	30.117	0.000
	3. Q Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
	4. Luas Terairi (ha)	647.364	921.234	345.959	343.876	1086.471	754.848	375.288	478.427	537.107	738.852	548.087	363.783	265.617	261.195	230.444	286.390	234.619	240.869	153.500	120.618	148.165	184.199	649.458	200.000

Source: Calculation Results of This Research

Table 4. Water Needs and Maximum Area Acrossable for Alternatives Nov I - Jan 2 Planting Pattern: Rice - Palawija – Palawija Irrigation Area: 200 ha

Alt	Bulan	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Ags		Sep		Okt		Nov		Des	
	Periode	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	Debit Andalan (lt/dtk)	149.800	358.800	366.200	368.600	415.200	336.600	324.600	291.200	262.400	221.600	212.400	191.000	171.600	145.000	139.000	117.400	113.200	101.200	91.800	84.000	81.200	88.800	97.800	200.400
Nov I	Q Butuh (lt/dtk)	92.575	0.000	59.790	38.000	10.666	33.162	97.194	111.404	101.876	101.648	74.068	87.819	81.046	111.666	141.987	121.005	116.237	79.873	80.262	46.280	286.702	268.680	216.942	20.827
	Luas Terairi (ha)	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	195.793	194.042	194.774	200.000	200.000	200.000	56.644	66.101	90.162	200.000
Nov II	Q Butuh (lt/dtk)	93.761	0.000	109.712	62.468	27.224	20.539	73.091	97.595	117.500	101.922	104.148	74.068	92.529	81.046	121.741	141.987	116.584	116.237	80.977	80.262	45.354	268.680	216.942	142.075
	Luas Terairi (ha)	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	165.368	194.195	174.127	200.000	200.000	200.000	66.101	90.162	200.000
Des I	Q Butuh (lt/dtk)	216.054	0.000	87.753	112.390	49.688	41.046	58.278	73.493	102.424	117.546	104.435	104.148	77.219	92.529	86.403	121.741	136.324	116.584	118.536	80.977	75.424	32.481	216.942	142.075
	Luas Terairi (ha)	138.669	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	192.868	166.075	173.609	154.890	200.000	200.000	200.000	90.162	200.000
Des II	Q Butuh (lt/dtk)	216.054	77.896	88.919	90.431	97.606	63.510	94.808	58.679	76.111	102.470	120.764	104.435	110.709	77.219	99.655	86.403	117.276	136.324	118.894	118.536	76.057	62.550	6.232	142.075
	Luas Terairi (ha)	138.669	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	193.048	148.470	154.424	141.729	200.000	200.000	200.000	200.000
Jan I	Q Butuh (lt/dtk)	216.054	77.896	211.701	91.597	75.361	111.428	121.171	95.370	59.939	76.157	105.008	120.764	111.028	110.709	81.986	99.655	84.029	117.276	139.283	118.894	109.291	63.183	29.625	0.000
	Luas Terairi (ha)	138.669	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	172.584	131.818	141.303	148.594	200.000	200.000	200.000
Jan II	Q Butuh (lt/dtk)	46.280	77.896	211.701	214.380	76.431	89.184	172.987	121.732	97.709	59.985	77.506	105.008	129.208	111.028	120.637	81.986	96.497	84.029	119.609	139.283	109.607	96.417	30.117	0.000
	Luas Terairi (ha)	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	153.500	120.618	148.165	184.199	200.000	200.000

Source: Calculation Results of This

Table 5. Planting intensity in Tulun Irrigation Area

ALT	Bulan	Musim Tanam I		Musim Tanam II		Musim Tanam III		Total Luas (Ha)	Rencana	Prosentase (%)
		NFR Max	A (Ha)	NFR Max	A (Ha)	NFR Max	A (Ha)			
ALT 1	Nov I	1.434	56.644	0.557	200.000	0.710	194.042	450.686	200	225
ALT 2	Nov II	1.343	66.101	0.587	200.000	0.710	165.368	431.469	200	216
ALT 3	Des I	1.085	90.162	0.588	200.000	0.682	154.890	445.052	200	223
ALT 4	Des II	1.080	138.669	0.604	200.000	0.682	141.729	480.398	200	240
ALT 5	Jan I	1.080	138.669	0.604	200.000	0.696	131.818	470.488	200	235
ALT 6	Jan II	0.696	120.618	1.072	200.000	0.646	200.000	520.618	200	260

Mulai Tanam	Pola Tata Tanam	Tanam I		Tanam II		Tanam III		Total Luas	Areal Potensial	Intensitas Tanam
		NFR Max (lt/dt/ha)	Luas (Ha)	NFR Max (lt/dt/ha)	Luas (Ha)	NFR Max (lt/dt/ha)	Luas (Ha)	(Ha)	(Ha)	(%)
Jan II	Pd-Plw-Plw	0.696	120.618	1.072	200.000	0.646	200.000	520.618	200	260

Source: Calculation Results of This Research

Limited amount of water in the dry season can reduce water supply to rice fields [7]. To maximize farm production, it is necessary to increase land productivity and provide regular water supply according to needs and supplies. For this analysis a linear program Quantity Methods for Windows 3 is used with input water requirements for each type of plant and the mainstay volumes as constraints for the operation of the linear program [8]. The output of this program is the maximum area of rice fields for each type of crop, the growing season and the benefits of the farm [9]. From the several alternative plans, cropping patterns obtained that produce the greatest benefits are cropping patterns of sugarcane, rice-crops-sugarcane, sugar-crops at the beginning of November 1 with a profit of Rp 281,541,700,000.00 and cropping intensity 300 (Wahyudi, et al. 2014).

The condition of the water system in the study area is not completely good. The planting pattern in the study area is only once planting season in a year (rice) [10], while the planned planting pattern is three times planting season per year (rice-rice-palawija) and the maximum water demand occurs in October the second period of 261.35 mm/period or 17.42 mm/day. Secondary and tertiary sluice operation patterns of lowland rice plants during the rainy season focus on retention, controlled drainage to remove excessive rainwater or during fertilization, flushing and washing of toxic and acidic elements, and tidal irrigation [11]. Drainage is needed if the puddle becomes too deep or if the water quality deteriorates. For secondary crops planted in the dry season after harvesting the second rice crop is finished focusing on drainage. From the results of the analysis of the farming business, it is obtained that the prediction of profit for the current cropping pattern in the study area (Rice) is Rp 1,495,000 /ha/year and for the planned cropping pattern (Rice-Rice-Palawija) is Rp 7,730,750 /ha/year [12].

4. Conclusion

Based on the analysis results above, the following conclusions can be drawn:

1. The application of plant pattern according to water needs to irrigate rice fields to increase agricultural output in the Tulun irrigation area of Taebenu District is rice - Palawija - Palawija which starts from November 1 to January 2. In that month there was still a surplus, while in July to December the river water flow deficit.
2. Water intake at the largest intake is needed according to the results of the analysis of the plant pattern schedule to irrigate 200 hectares of rice fields in the Tulun Irrigation Network of 1,434 Lt/Sec/ha. The availability of incoming water discharge at Intake is in accordance with the analysis starting with the planting pattern from November to January, amounting to 2,205 Lt/Sec.

5. Recomendation

a) There are 4 parameters that can be changed to optimize the availability of water, namely planting season, class system, tertiary plot rotation coefficient, and planting start time. In this study, optimization is carried out by changing the start time of planting. So that in subsequent studies changes can be made to other parameters.
b) Communities must be more efficient in using and utilizing water.
c) Need for regular channel maintenance by P3A.
d) The community is more concerned with planting patterns that have been determined.
e) It is recommended that before conducting research it is better to prepare all the necessary data so that the preparation does not experience difficulties.

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