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Optimization of Planting Patterns to Increase Agricultural Productivity in Dalam Kom Irrigated Areas of East Kupang District, Kupang Regency

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Abstract— *This research was conducted with the aim of determining the Optimization of Planting Patterns to Increase Agricultural Productivity in Dalam Kom Irrigation Areas of East Kupang District, Kupang Regency. Dalam Kom irrigated has an area of 301.41 ha which is agricultural land in the Oesao area. The Weir of Dalam Kom 1 and 2 provides irrigation water to the irrigation areas in Dalam Kom. The geographical location of the study area is at 10°06'26.48"S and 123°48'37.63"E. This study investigates whether the existing water discharge can meet irrigation needs in Dalam Kom and whether there are other potential sources of irrigation water. In addition, this study also aims to plan alternative optimal planting patterns for Dalam Kom and to find out whether the results of optimizing planting patterns in Dalam Kom can increase agricultural productivity yields and find out how good institutional management to be able to improve efficiency in Dalam Kom. The Kupang Regency Government built the Dalam Kom 1 and Dalam Kom 2 weir to irrigate 301.41 ha of agricultural land in Dalam Kom irrigation area. Five alternative planting patterns are used to change planting patterns, namely alternative I with the rice-rice-crops (corn) planting pattern with the beginning of the February planting season period II, alternative II with the same planting pattern and the beginning of the growing season in January period I, and alternative III with the planting pattern rice–crops (corn) –crops (corn) with the beginning of the planting season in December period II and alternatives IV and V with the same planting pattern, namely rice-rice-crops (corn) with the beginning of the growing season in February period I and December period I. After optimization with alternative planting patterns III, an increase in rice production yields of 4 tons / ha / year and corn which was originally 3 tons / ha / year to 6 tons / ha / year, with an average selling price of Rp. 5,000 / kg for grain in Kupang Regency and Rp 4,000/kg for corn. According to this figure, the income of rice farmers is Rp. 11,353,500/ha/year and corn farmers from Rp. 4,736,000 to Rp. 9,472,000/ha/year. The questionnaire sent to 30 respondents showed that the management system of agricultural institute and farmer organizations has successfully managed agricultural land in the Irrigated area of Dalam Kom, from the development of farming enterprises to the improvement of facilities and the provision of agricultural facilities. The farmer group also has a good cooperation with the agricultural department. The business capital provided to farmers has not met the needs of respondents with large agricultural land. Agricultural institutions actively monitor agricultural activities once a month.*

Keywords— *Agricultural Productivity, Optimization of Planting Patterns.*

I. Introduction

A. Background

Water is needed for our lives such as for drinking water, agriculture, and hydroelectric dams. Rivers and groundwater must be managed according to our needs in order to improve the welfare of life.

In agriculture, of course, it also needs water. But with improper management, the existing water will not be enough to meet the needs. This problem can beminimized by adjusting the growing season and planting pattern based on hydrological analysis.

East Nusa Tenggara (NTT) has a dry tropical climate. NTT has an eight month dry season and a four month rainy season. The long dry season in NTT can reduce water discharge, making it difficult for agriculture and farm to obtain enough water.

Oesao village has a large area of farmland potential. Oesao farmland covers an area of 3,400 hectares (Irrigation work unit, 2017). The government built a dam to be able to meet Oesao irrigation. Oesao receives agricultural water from the government built Dalam Kom weir.

Dalam Kom irrigation area is located in Babau Village, East Kupang District, Kupang Regency. Dalam Kom irrigation area is located in the Manikin Watershed and the Oesao Sub-Watershed. Dalam Kom dam irrigates 301.41 hectares of agricultural land (Irrigation work unit, 2017). The water source comes from the Amabi river through the Dalam Kom weir.

Inadequate water availability in this region makes agricultural products such as rice and corn not optimal. Field surveys in the Dalam Kom irrigation area found that water is not used efficiently during the dry season so it is not enough to meet the needs of various planting activities. Water shortages cause hampering rice harvesting and planting activities. Poor water use in Dalam Kom irrigated areas ends up affecting annual production (P3A, 2019)

B. Formulation of the Problem

1. How is the availability of river discharge to meet irrigation needs in Dalam Kom irrigation area and is there any potential source of irrigation water?
2. How to plan the optimal planting pattern in Dalam Kom irrigation area?
3. How will the productivity of agricultural products increase in Dalam Kom irrigated area after it is optimized?
4. What is the proper institutional arrangement to organize and manage the irrigation areas of Dalam Kom so that their efficiency and maintenance can be maintained properly?

C. Research Objectives

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1. Knowing the availability of river discharge to meet irrigation needs in Dalam Kom irrigation area and whether there are other potential sources of irrigation water.
2. Knowing how to plan optimal planting patterns in the irrigation area in Dalam Kom.
3. Knowing the increase in the productivity of agricultural products in Dalam Kom irrigation area after being optimized
4. Knowing the proper institutional arrangements to regulate and manage the irrigation areas in Dalam Kom so that their efficiency and maintenance can be maintained properly.

II. Research Methods

A. *Similar Research*

1. Nuf'a, 2016. Optimization of Gondang Reservoir Water With Deterministic Dynamic Method.
2. Prasetijo, 2011. Study on Optimization of Planting Patterns to Maximize The Profit of Agricultural Production In The Left Prambatan Irrigation Network, Bumiaji District, Batu City.
3. Septyana, 2016. Planting Pattern Optimization Model to Increase Agricultural Product Profits with Linear Program (Case Study of Rambut Irrigation Area of Tegal Regency, Central Java Province).
4. Zahrati, 2018. Mathematical Modeling of Planting Patterns and Planting Schedules of Baro Irrigation Areas to Maximize Profits.

B. *Research Location*

1. Description of the Research Location

Dalam Kom irrigation area is an area that is used as a rice field area with an area of 301.41 ha. The water source for the Dalam Kom irrigation area comes from the Dalam Kom 1 weir and the Dalam Kom 2 weir. Geographically, the location of the study location is at coordinates 10°06'26.48"S and 123°48'37.63"E. Dalam Kom irrigated area is at an elevation of 29 m above sea level. The distance that can be reached from Kupang City to this area is approximately 28 km which can be penetrated by vehicle in approximately 40 minutes.

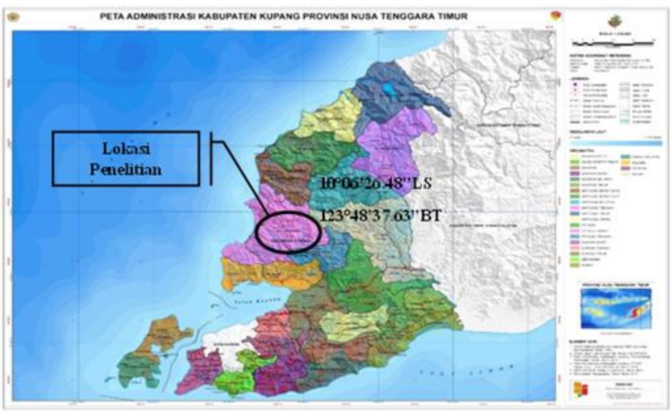

Fig. 1. Research Location

2. Boundaries of the Research Area

The boundary of the study area lies only in the coverage of the irrigation areas of Dalam Kom and Dalam Kom 1 and Dalam Kom 2 weir. Meanwhile, in other areas, data and samples or water treatment are not discussed.

3. Research Location Conditions

Based on geography, the study area has an unstable climate. Every year the wind blows very strongly and the east wind blows. Thus there is frequent wind erosion, the average speed reaches 13 to 18 km/h, sometimes the average wind speed reaches 36 - 44 km/h. These very strong winds occur 3 - 5 times a year caused by tropical cycles. This wind is the only one in Indonseia blowing from the northeast to the northwest along the north coast and south coast. Other climatic factors are humidity, humidity is generally high with striking variations, dry season low air humidity of about 40% - 50% is common. The average temperature in November to March ranges from 20.16ºC – 31ºC. Meanwhile, in the dry season around April to October it ranges from 29.1ºC – 33.4ºC.

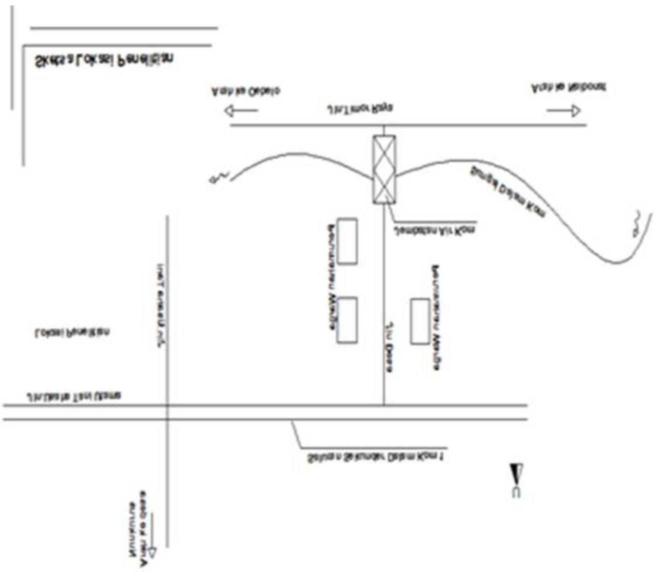

Fig. 2. Sketch of the Research Site

C. *Data Required:*

1. Data on rain stations and daily rainfall from 2011 to 2021 sourced from Naibonat Rain Post. This data is necessary to perform hydrological analysis.
2. Climatological data for the last 10 years used to calculate the magnitude of evapotranspiration that occurred in the study area. This data was obtained from Meteorology Climatology and Geophysics Council in Lasiana.
3. The irrigation network scheme is necessary to know the extent of the area to which the irrigation water supply is located and its area. This data was obtained from the Work Unit for Implementation of Water Utilization Network of Nusa Tenggara Water Resources II.
4. Discharge data obtained through direct data in the field by knowing the discharge data in the weir intakes.

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5. Data on the type of soil used to determine the percolation value in the study area.
6. Economic data in the form of data on agricultural production and incomes of farmers and other parties involved in managing Dalam Kom irrigation area.

D. Study Work Steps

1. Analyze rainfall data to determine effective rainfall and mainstay rainfall. The analysis used was R80 (mainstay rainfall) and Re (effective rainfall) for rice and corn.
2. Analyze climatological data to calculate the amount of evapotranspiration (ETo) in Dalam Kom irrigation area using the modified penman method. Evapotranspiration was analyzed based on climatological data including: Temperature (T), Relative Humidity (RH), Wind Speed (u) and Solar Irradiation (n)
3. Analyze the availability of water to find out how much water discharge is available from the water source by knowing how much discharge is in the weir intake.
4. Calculate the need for irrigation water needed to find out the amount of water needed by plants. The analysis used is NFR analysis (water requirements in rice fields mm/day).
5. Plan various alternative planting patterns based on the discharge of water availability in the weir so that the planting pattern can be optimal again.
6. Analyze the amount of agricultural production obtained based on the results of optimizing planting patterns.
7. Conduct surveys using questionnaires to farmers, doormen and other managing agencies on deficiencies and what is needed regarding the right institutional arrangements so that efficiency and management in Dalam Kom irrigation area can be properly organized.

E. Research Flowchart

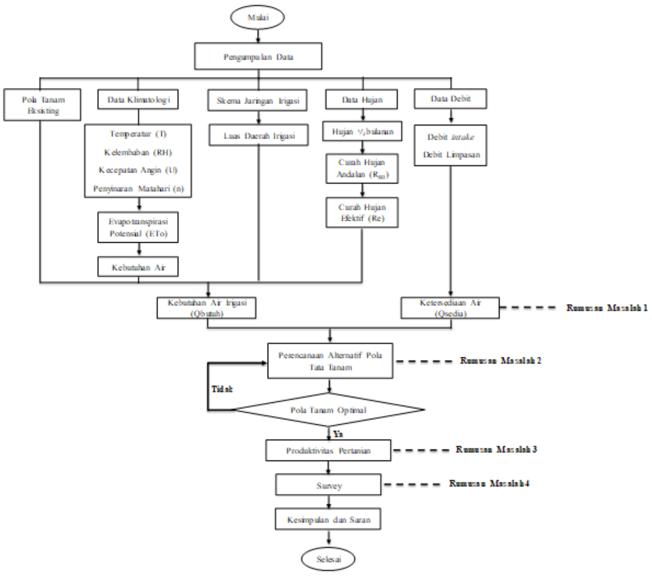

Fig. 3. Research Flowchart.

III. Result And Discussion

A. Rain Data Analysis

1. Rainfall Data

The data needed to calculate rainfall is daily rainfall data for the last 10 years which is then calculated into semi-monthly rain data.

TABLE 1. Naibonat Rainy Post Semi-Monthly Rainfall Data

Tahun	Januari		Februari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		November		Desember	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
2012	379.0	185.0	568.0	182.0	144.0	107.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	85.0	504.0	836.0	276.0
2013	327.5	121.0	478.5	148.0	210.5	46.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	196.5	184.5	326.5
2014	440.0	187.0	67.0	359.0	154.0	205.0	16.0	7.0	14.0	42.0	10.0	0.0	31.0	0.0	53.0	1.0	8.0	2.0	70.0	38.0	91.0	50.0	208.0	254.0
2015	315.0	466.0	0.0	0.0	0.0	0.0	67.7	48.8	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	59.9	0.5	128.1	96.6	12.4	33.2
2016	119.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	75.4	3.0	41.9	58.1	194.2	191.3
2017	652.6	459.3	141.4	442.8	365.1	39.5	0.0	0.0	0.0	119.8	28.0	70.7	0.0	0.0	0.0	0.0	0.0	0.0	70.4	1.0	85.9	113.4	73.8	586.6
2018	96.0	599.0	366.9	449.8	66.4	120.3	11.2	59.9	14.3	71.6	0.0	1.2	42.2	3.6	0.6	0.0	0.0	0.0	0.0	0.0	45.4	42.0	171.2	79.0
2019	395.2	252.9	155.4	148.9	130.7	29.0	0.5	26.0	0.0	18.8	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.1	34.2
2020	107.8	77.1	131.0	101.2	81.5	132.8	14.0	0.0	53.9	0.0	0.0	30.2	59.0	0.0	0.0	0.0	0.0	20.0	12.2	0.0	116.3	115.7	166.4	194.4
2021	51.4	292.1	194.9	53.8	71.9	65.2	33.0	6.1	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.8	52.4	56.2	159.5	150.9	156.5
Rata - rata	288.4	263.9	210.3	188.6	122.4	74.5	14.9	14.8	8.2	25.3	5.2	10.2	14.1	0.4	5.4	0.1	0.8	2.2	36.1	9.5	65.0	133.6	204.9	213.2
CH Max	652.6	599.0	568.0	449.8	365.1	205.0	67.7	59.9	53.9	119.8	28.0	70.7	59.0	3.6	53.0	1.0	8.0	20.0	75.4	52.4	128.1	504.0	836.0	586.6
CH Min	51.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.4	33.2

2. Mainstay Rainfall Calculation (R_{80})

The calculation of the mainstay precipitation (R_{80}) is sought using the weishbull method. This calculation of data is sorted from largest to smallest then determined the probability for each data. The probability is calculated using the formula:

$$P=m/(n+1) \times 100\ (\%).$$

3. Calculation of Plant Effective Precipitation (Re)

Effective rainfall is rain that is used to meet the needs of plants. The effective daily rain is 70% of the 80% probability for rice and 50% of 80% for crops.

TABLE 2. Mainstay Rainfall Calculation Result (R_{80}) and Plant Effective Rainfall (Re)

Mo	Probabilitas	Januari		Februari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		November		Desember	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	9.091	652.6	599.0	568.0	449.8	365.1	205.0	67.7	59.9	53.9	119.8	28.0	70.7	59.0	3.6	53.0	1.0	8.0	20.0	75.4	52.4	128.1	504.0	836.0	586.6
2	18.182	440.0	466.0	478.5	442.8	210.5	132.8	33.0	48.8	14.3	71.6	10.0	30.2	42.2	0.0	0.6	0.0	0.0	2.0	70.4	38.0	116.3	196.5	208.0	326.5
3	27.273	395.2	459.3	366.9	359.0	154.0	120.3	16.0	26.0	14.0	42.0	9.4	1.2	31.0	0.0	0.0	0.0	0.0	0.0	70.0	3.0	91.0	159.5	194.2	276.0
4	36.364	379.0	292.1	194.9	182.0	144.0	107.0	14.0	7.0	0.0	18.8	4.6	0.0	5.0	0.0	0.0	0.0	0.0	0.0	59.9	1.0	85.9	115.7	184.5	254.0
5	45.455	327.5	252.9	155.4	148.9	130.7	65.2	11.2	6.1	0.0	0.5	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	50.0	0.5	85.0	113.4	171.2	194.4
6	54.545	315.0	187.0	141.4	148.0	81.5	46.5	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.8	0.0	56.2	96.6	166.4	191.3
7	63.636	119.5	185.0	131.0	101.2	71.9	39.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	0.0	45.4	58.1	150.9	156.5
8	72.727	107.8	121.0	67.0	53.8	66.4	29.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.9	50.0	73.8	79.0
9	81.818	96.0	77.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.0	51.1	34.2
10	90.909	51.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.4	33.2
	Curah Hujan Andalan (R_{80})	98.4	85.9	13.4	10.8	13.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	43.6	55.6	43.2
Re Efektif	Padi	4.6	4.0	0.6	0.5	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.0	2.6	2.0
	Palawija	3.3	2.9	0.4	0.4	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.5	1.9	1.4

The largest rainfall occurred in December period I of 2012 with rainfall of 836.0 mm.

From this calculation, the largest value of R_{80} occurred in January period I, which was 98.4 mm.

B. Climatological Data Analysis

1. Climatology Data

Climatological data are needed to calculate the value of potential evapotranspiration. These data were obtained from the Lasiana Meteorological Station. The data used is climatological data for the last 10 years from 2011 – 2021.

2. Calculation of Potential Evapotranspiration

The potential evapotranspiration value is calculated using the method of penman modification. This is because the existing climatological data (temperature data, relative humidity, wind speed, and solar irradiation) are data that are suitable for use with the modification method.

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To find the magnitude of the potential evapotranspiration value (Eto) can be calculated using the equation :

$$Eto = c\ [W \times Rn + (1 - W) \times f(u) \times (ea - ed)]$$

TABLE 3. Result of Calculation of Potential Evapotranspiration With Modified Penman Method

No	Uraian	Keterangan	Satuan	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sep	Okt	Nov	Des
I	DATA														
1	Temperatur (T)	(Data)	°C	27.6	27.5	27.2	27.6	27.5	26.5	26.2	26.7	27.2	28.9	29.4	28.5
2	Kecepatan Angin (U)	(Data)	km/hari	306.69	213.35	186.68	226.68	311.14	364.47	417.81	395.59	364.47	311.14	262.24	177.79
3	Kelembaban Relatif (RH)	(Data)	%	87	85	86	82	75	72	70	66	68	68	73	83
4	Penyinaran Matahari (n)	(Data)	%	42	58	60	71	79	81	82	89	87	85	79	56
II	KOREKSI DATA														
5	T = (T - 0.006 ΔH)		°C	27.520	27.420	27.120	27.510	27.440	26.440	26.130	26.610	27.170	28.810	29.310	28.450
6	n = (n - 0.010 ΔH)		%	42.200	57.420	59.520	70.880	78.410	81.260	82.160	88.490	87.210	84.440	78.470	55.470
III	ANALISIS DATA														
7	ea	(tabel)	mbar	36.90	36.69	36.06	36.88	36.73	34.63	33.98	34.99	36.16	39.78	40.86	38.95
8	ed = ea x RH / 100	(7)*(3)/100	mbar	32.100	31.147	31.153	30.091	27.510	24.933	23.785	22.986	24.554	26.890	29.825	32.290
9	(ea - ed)	(7) - (8)	mbar	4.797	5.540	4.904	6.785	9.219	9.696	10.193	12.000	11.608	12.888	11.031	6.660
10	f(u) = 0.27(1 + U/100)	0.27 (1+(2)/100)	km/hari	1.098	0.846	0.774	0.882	1.110	1.254	1.398	1.338	1.254	1.110	0.978	0.750
11	(1 - W)	(tabel)		0.235	0.236	0.239	0.235	0.236	0.246	0.249	0.244	0.238	0.226	0.223	0.228
12	W	(tabel)		0.765	0.764	0.761	0.765	0.764	0.754	0.751	0.756	0.762	0.774	0.777	0.772
13	Ra	(tabel)	mm/hari	16.41	16.30	15.50	14.19	12.79	11.98	12.38	13.49	14.80	15.90	16.21	16.17
14	n	(6)/100/12.1		0.035	0.047	0.049	0.059	0.065	0.067	0.068	0.073	0.072	0.070	0.065	0.046
15	N	(tabel)		11.60	11.80	12.00	12.30	12.60	12.70	12.60	12.40	12.10	11.80	11.60	11.50
16	n / N	(14)/(15)		0.003	0.004	0.004	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.004
17	Rs = (a + b n/N) Ra		mm/hari	4.129	4.110	3.908	3.584	3.233	3.030	3.132	3.415	3.747	4.025	4.101	4.078
18	Rns = (1 - a) Rs		mm/hari	3.096	3.083	2.931	2.688	2.424	2.273	2.349	2.561	2.810	3.019	3.076	3.058
19	f(T)	(tabel)		16.21	16.19	16.13	16.21	16.20	16.00	15.94	16.03	16.14	16.47	16.57	16.40
20	f(ed)	(tabel)		0.089	0.094	0.094	0.100	0.120	0.120	0.121	0.125	0.120	0.120	0.102	0.089
21	f(n/N)	(tabel)		0.103	0.104	0.104	0.105	0.105	0.105	0.105	0.106	0.106	0.106	0.106	0.104
22	Rn1 = f(T) x f(ed) x f(n/N)	(19)*(20)*(21)	mm/hari	0.149	0.159	0.158	0.169	0.204	0.202	0.203	0.212	0.205	0.209	0.178	0.151
23	Rn = Rns - Rn1	(18)-(22)	mm/hari	2.947	2.924	2.773	2.519	2.220	2.071	2.146	2.349	2.605	2.809	2.898	2.907
24	Kecepatan angin rata-rata (Ud)		m/s	3.550	2.469	2.161	2.624	3.601	4.218	4.836	4.579	4.218	3.601	3.035	2.058
25	Faktor perkiraan kondisi musim (c)			0.908	1.055	1.064	1.043	0.878	0.850	0.834	0.853	0.876	0.903	0.922	1.070
IV	EVAPOTRANSPIRASI POTENSIAL														
26	Eto = c [W x Rn + (1 - W) x f(U) x (ea - ed)]	(25)[(12)(23)+(11)(10)(9)]	mm/hari	3.172	3.522	3.211	3.477	3.606	3.869	4.300	4.855	4.777	4.886	4.297	3.619

The largest potential evapotranspiration value occurred in October at 4,886 mm/day. Meanwhile, the smallest potential evapotranspiration occurred in January, which was 3,172 mm/day.

C. Water Availability Analysis

Because there are two weir used to irrigate the Dalam Kom irrigation area, it is necessary to analyze it by summing the intake discharge value on the two weir so that the available discharge results are obtained in Dalam Kom irrigation area.

TABLE 4. Recapitulation of Weir Water Availability Data of Dalam Kom 1 and Dalam Kom 2

Tahun	Ketersediaan Air (m^3/dtk)											
	Jan-01	Jan-02	Peb-1	Peb-2	Mar-01	Mar-02	Apr-01	Apr-02	Mei-01	Mei-02	Jun-01	Jun-02
2012	3.637	2.363	1.436	2.957	3.495	1.801	1.664	0.883	0.559	0.314	0.196	0.140
2013	6.264	5.310	7.860	9.793	5.964	4.010	3.115	1.692	1.015	0.570	0.365	0.225
2014	8.705	6.050	10.913	9.148	7.643	4.611	2.782	1.691	2.766	1.523	0.922	0.553
2015	5.795	12.268	8.521	7.781	5.723	3.964	2.711	2.421	1.673	1.117	0.648	0.525
2016	3.084	3.459	3.670	4.678	3.198	2.626	1.868	4.113	2.605	1.367	0.875	0.524
2017	3.015	3.420	3.268	2.740	3.255	2.961	1.676	1.914	1.152	0.585	0.374	0.225
2018	6.211	5.785	5.158	6.844	6.323	3.401	2.839	1.542	0.925	2.064	1.228	1.301
2019	2.118	6.240	6.188	7.869	4.431	3.208	2.795	2.044	1.119	0.957	0.516	0.313
2020	3.226	3.161	3.351	3.688	2.602	1.287	0.789	1.432	0.655	0.398	0.242	0.141
2021	2.369	1.419	2.065	2.449	1.753	1.579	0.813	0.500	0.691	0.291	0.188	0.145
Rata2	4.442	4.948	5.243	5.795	4.439	2.945	2.105	1.823	1.316	0.919	0.555	0.409
Maks	8.705	12.268	10.913	9.793	7.643	4.611	3.115	4.113	2.766	2.064	1.228	1.301
Min	2.118	1.419	1.436	2.449	1.753	1.287	0.789	0.500	0.559	0.291	0.188	0.140

Tahun	Ketersediaan Air (m^3/dtk)											
	Jul-01	Jul-02	Agt-1	Agt-2	Sep-01	Sep-02	Okt-01	Okt-02	Nop-1	Nop-2	Des-01	Des-02
2012	0.335	0.185	0.476	0.571	0.580	1.062	0.003	0.267	0.056	0.934	1.869	2.228
2013	0.460	0.475	0.687	0.587	0.241	0.011	0.127	0.004	0.508	3.696	8.024	5.743
2014	0.332	0.187	0.119	0.068	0.043	0.030	0.015	0.009	0.005	2.604	2.872	7.039
2015	0.314	0.147	0.371	0.131	0.137	0.053	1.515	0.590	1.026	0.640	1.070	1.683
2016	0.320	0.177	0.114	0.063	0.041	0.025	0.210	0.651	1.088	1.116	1.929	2.044
2017	0.134	0.367	0.467	0.027	0.794	0.693	0.006	0.095	0.002	1.640	2.419	2.860
2018	0.640	0.359	0.230	0.129	0.082	0.051	0.039	0.292	0.033	2.048	2.078	2.274
2019	0.336	0.145	0.586	0.049	0.763	0.018	0.011	0.486	0.159	0.150	1.758	2.674
2020	0.569	0.470	0.647	0.819	0.580	0.006	0.004	0.541	0.020	0.001	1.119	0.598
2021	0.678	0.665	0.421	0.920	0.597	1.007	0.409	0.213	1.252	1.427	1.685	2.527
Rata2	0.412	0.318	0.412	0.336	0.386	0.296	0.234	0.315	0.415	1.426	2.482	2.967
Maks	0.678	0.665	0.687	0.920	0.794	1.062	1.515	0.651	1.252	3.696	8.024	7.039
Min	0.134	0.145	0.114	0.027	0.041	0.006	0.003	0.004	0.002	0.001	1.070	0.598

The largest discharge value occurred in January period II of 2015 which was 12,268 m^3/sec, while the smallest discharge occurred in November Period II of 2020 of 0,001 m^3/sec. The average discharge generated from the two weir after analysis ranged from 1.872 m^3/sec

D. Irrigation Water Needs Analysis

The need for irrigation water is the amount of water volume required to meet the needs of evaporation, water loss, water needs for plants by paying attention to the amount of water present.

Water requirements are determined by land preparation (IR), consumptive use (ETc), percolation (P), water layer change (WLR), and planting patterns.

TABLE 5. Result of Calculation of Plant Water Needs and Existing Irrigation Water Needs

NO	KETERANGAN	SATUAN	DES 2	JAN 1	JAN 2	FEB 1	FEB 2	MAR 1	MAR 2	APR 1	APR 2	MEI 1	MEI 2	JUN 1	JUN 2	JUL 1	JUL 2	AGU 1	AGU 2	SEP 1	SEP 2	OKT 1	OKT 2	NOV 1	NOV 2	DES 1
1	Pola Tanam		LP			PADI						LP		PADI						PALAWIJA JAGUNG						
2	Koefisien Tanaman																									
	C1		LP	1.1	1.1	1.05	1.05	0.95	0	0	0	LP	1.1	1.1	1.05	1.05	0.95	0	0.5	0.59	0.96	1.05	0.02	0.95	0	0
	C2		LP	LP	1.1	1.1	1.05	1.05	0.95	0	0	LP	LP	1.1	1.1	1.05	1.05	0.95	0	0.5	0.59	0.96	1.05	0.02	0.95	0
	C3		LP	LP	LP	1.1	1.1	1.05	1.05	0.95	0	LP	LP	LP	1.1	1.1	1.05	1.05	0.95	0	0.5	0.59	0.96	1.05	0.02	0.95
	C (rata - rata)		LP	LP	LP	1.08	1.07	1.02	0.67	0.32	0	LP	LP	LP	1.08	1.07	1.02	0.67	0.48	0.36	0.68	0.87	0.68	0.67	0.32	0.32
3	Evapotranspirasi (Eto)	mm/hari	3.619	3.172	3.172	3.522	3.522	3.211	3.211	3.477	3.477	3.869	3.869	3.869	3.869	4.300	4.300	4.855	4.855	4.777	4.777	4.886	4.886	4.297	4.297	3.619
4	Perkolasi	mm/hari	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	Penggunaan Konsumtif (Etc) = kc x Eto	mm/hari	10.098	9.784	9.784	3.815	3.757	3.265	2.141	1.101	0.000	10.089	10.089	10.277	4.191	4.587	4.372	3.237	2.347	1.736	3.264	4.234	3.306	2.893	1.389	1.146
6	Pergantian Lapisan Air																									
	WLR1	mm/hari				3.3		3.3							3.3		3.3									
	WLR2						3.3		3.3							3.3		3.3								
	WLR3							3.3		3.3							3.3		3.3							
	WLR (rata - rata)					1.1	1.1	2.2	1.1	1.1					1.1	1.1	2.2	1.1	1.1							
7	Total kebutuhan air	mm/hr	12.10	11.78	11.78	6.92	6.86	7.46	5.24	4.20	2.00	12.09	12.09	12.28	7.29	7.69	8.57	6.34	5.45	3.74	5.26	6.23	5.31	4.89	3.39	3.15
8	Hujan Efektif	mm/hr	2.0	4.6	4.0	0.6	0.5	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.5	1.9
9	Kebutuhan air bersih di sawah	mm/hr	10.08	7.19	7.78	6.29	6.35	6.84	4.97	4.20	2.00	12.09	12.09	12.28	7.29	7.69	8.57	6.34	5.45	3.74	5.26	6.23	5.31	4.61	1.94	1.29
10	Kebutuhan air irigasi (NFR)	ltr/dt/hektar	1.17	0.83	0.90	0.73	0.74	0.79	0.58	0.49	0.23	1.40	1.40	1.42	0.84	0.89	0.99	0.73	0.63	0.43	0.61	0.72	0.61	0.53	0.22	0.15
11	Efisiensi irigasi (E)		0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
12	Kebutuhan air di intake	ltr/dt/hektar	1.795	1.280	1.384	1.120	1.131	1.218	0.885	0.748	0.356	2.152	2.152	2.185	1.298	1.368	1.526	1.128	0.969	0.665	0.937	1.110	0.944	0.821	0.345	0.230

The existing planting pattern is rice-rice-corn with the beginning of the growing season in December period II.

The largest need for irrigation water was found in June period I with a water requirement of 1,42 liters/sec/ha. Meanwhile, the smallest irrigation water needs were found in December period I, which was 0,15 liters/sec/ha.

E. Analysis of Water Needs and Availability with Existing Planting Patterns

To calculate how the existing water availability conditions are for the needs of irrigation areas (surplus / deficit) data on water availability and water needs in the area are needed.

If the calculation result is positive then the condition of the water is surplus (excess water). Meanwhile, if the calculation result is negative then the water condition is a deficit (lack of water).

TABLE 6. The Result of the calculation of the condition of the existing water on Dalam Kom Irrigation Area .

Bulan	Periode	Ketersediaan Air (m3/det)	Kebutuhan Air (ltr/det/Ha)	Luas D.I (Ha)	Kebutuhan Air (m3/det)	{1} - {4} (m3/det)	Keterangan
		{1}	{2}	{3}	{4}	{5}	
Jan	1	4.442	1.280	301.41	0.386	4.056	Surplus
	2	4.948	1.384		0.417	4.530	Surplus
Feb	1	5.243	1.120		0.337	4.906	Surplus
	2	5.795	1.131		0.341	5.454	Surplus
Mar	1	4.439	1.218		0.367	4.071	Surplus
	2	2.945	0.885		0.267	2.678	Surplus
Apr	1	2.105	0.748		0.225	1.880	Surplus
	2	1.823	0.356		0.107	1.716	Surplus
Mei	1	1.316	2.152		0.649	0.667	Surplus
	2	0.919	2.152		0.649	0.270	Surplus
Jun	1	0.555	2.185		0.659	-0.103	Defisit
	2	0.409	1.298		0.391	0.018	Surplus
Jul	1	0.412	1.368		0.412	-0.001	Defisit
	2	0.318	1.526		0.460	-0.142	Defisit
Agu	1	0.412	1.128		0.340	0.072	Surplus
	2	0.336	0.969		0.292	0.044	Surplus
Sep	1	0.386	0.665		0.200	0.185	Surplus
	2	0.296	0.937		0.282	0.013	Surplus
Okt	1	0.234	1.110		0.334	-0.101	Defisit
	2	0.315	0.944		0.285	0.030	Surplus
Nov	1	0.415	0.821		0.248	0.167	Surplus
	2	1.426	0.345		0.104	1.322	Surplus
Des	1	2.482	0.230		0.069	2.413	Surplus
	2	2.967	1.795		0.541	2.426	Surplus

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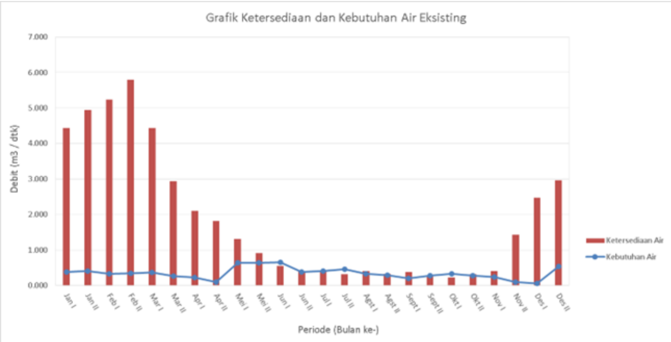

Fig. 4. Graph of Existing Water Availability and Needs Conditions in Dalam Kom Irrigation Area

There are several months that experience water shortages, namely from June period I, then July period I and period II and in October period I. The largest water shortage was found in July period II with the difference between availability and needs reaching -0.142 m3/sec. Meanwhile, the largest surplus condition occurred in February period II with the difference value reaching 5,454 m3/det.

Total surplus water conditions occur in 20 periods and deficits also occur in 4 periods.

F. Optimization of Planting Patterns

Optimization of planting patterns is carried out by changing the planting start time and changing the type of plants to be planted. There are 5 alternative planting patterns made, namely: :

- Alternative I.
  Planting pattern : Rice–rice–crops (corn)
  Start planting : February period II
- Alternative II.
  Planting pattern : Rice–rice–crops (corn)
  Start planting : January period I
- Alternative III.
  Planting pattern : Padi–crops (corn)–crops(corn)
  Start planting : December periode I
- Alternative IV.
  Planting pattern : Rice–rice–crops (corn)
  Start planting : February periode I
- Alternative V.
  Planting pattern : Rice–rice–crops (corn)
  Start planting : December periode I.

The results of this calculation are then used to calculate the water condition of each period for each alternative planting pattern.

The calculation uses the same method in the previous calculation, namely by calculating the difference between the water availability discharge and the water needs discharge for each alternative planting pattern.

For the planting pattern in alternative I deficit conditions rises to 7 periods and in alternative II also increased to 6 periods. For alternative III, there is no water deficit, but there is a change in planting pattern from rice - rice - crops (corn) to rice - crops (corn) - crops (corn). Then in alternative IV the deficit condition still rises to 8 periods. Furthermore, for alternative V, the condition of a fixed water deficit is to occur in 4 periods. Of these five alternatives, alternative planting pattern III is an alternative that has the least amount of water deficit compared to other alternatives because in this alternative there is no water deficit, meaning that harvesting activities in alternative III can be carried out optimally.

TABLE 7. Result of Calculating Water Needs for Various Alternative Planting Patterns

Bulan	Periode	Kebutuhan Air Bersih di Sawah					Kebutuhan Air Irigasi					Kebutuhan Air di *Intake*				
		mm/hari					Ltr/dtk/Hektar					Ltr/dtk/Hektar				
		Alt. I	Alt. II	Alt. III	Alt. IV	Alt. V	Alt. I	Alt. II	Alt. III	Alt. IV	Alt. V	Alt. I	Alt. II	Alt. III	Alt. IV	Alt. V
Jan	1	0.836	9.187	7.194	0.000	7.194	0.097	1.063	0.832	0.000	0.832	0.149	1.635	1.280	0.000	1.280
	2	0.126	9.770	2.528	0.142	2.528	0.015	1.130	0.293	0.016	0.293	0.022	1.739	0.450	0.025	0.450
Feb	1	2.715	7.440	6.231	11.404	6.231	0.314	0.861	0.721	1.319	0.721	0.483	1.324	1.109	2.030	1.109
	2	11.528	2.859	7.279	11.528	7.279	1.334	0.331	0.842	1.334	0.842	2.052	0.509	1.296	2.052	1.296
Mar	1	11.191	6.602	4.621	11.191	4.621	1.295	0.764	0.535	1.295	0.535	1.992	1.175	0.823	1.992	0.823
	2	11.541	7.631	4.381	6.308	3.846	1.335	0.883	0.507	0.730	0.445	2.054	1.358	0.780	1.123	0.685
Apr	1	6.866	5.060	3.263	6.808	2.000	0.794	0.585	0.378	0.788	0.231	1.222	0.901	0.581	1.212	0.356
	2	6.538	4.054	2.376	7.735	9.998	0.756	0.469	0.275	0.895	1.157	1.164	0.722	0.423	1.377	1.780
Mei	1	8.133	2.000	3.353	5.679	10.089	0.941	0.231	0.388	0.657	1.167	1.448	0.356	0.597	1.011	1.796
	2	5.679	10.089	2.618	4.325	10.089	0.657	1.167	0.303	0.500	1.167	1.011	1.796	0.466	0.770	1.796
Jun	1	4.325	10.277	5.705	2.000	7.291	0.500	1.189	0.660	0.231	0.844	0.770	1.829	1.016	0.356	1.298
	2	2.000	10.277	4.351	10.277	7.227	0.231	1.189	0.503	1.189	0.836	0.356	1.829	0.774	1.829	1.286
Jul	1	12.589	8.275	6.279	10.589	8.572	1.457	0.957	0.726	1.225	0.992	2.241	1.473	1.118	1.885	1.526
	2	12.589	8.195	4.662	10.589	5.967	1.457	0.948	0.539	1.225	0.690	2.241	1.459	0.830	1.885	1.062
Agu	1	12.997	9.167	6.418	8.360	5.447	1.504	1.061	0.743	0.967	0.630	2.314	1.632	1.142	1.488	0.969
	2	8.360	6.357	6.208	8.279	3.764	0.967	0.736	0.718	0.958	0.435	1.488	1.132	1.105	1.474	0.670
Sep	1	8.195	5.177	5.232	9.056	5.264	0.948	0.599	0.605	1.048	0.609	1.459	0.921	0.931	1.612	0.937
	2	9.056	3.561	5.216	6.284	6.140	1.048	0.412	0.604	0.727	0.710	1.612	0.634	0.929	1.119	1.093
Okt	1	6.357	4.473	3.580	5.461	5.306	0.736	0.517	0.414	0.632	0.614	1.132	0.796	0.637	0.972	0.944
	2	5.461	5.136	3.547	3.775	5.290	0.632	0.594	0.410	0.437	0.612	0.972	0.914	0.631	0.672	0.942
Nov	1	3.261	4.146	1.721	4.657	3.110	0.377	0.480	0.199	0.539	0.360	0.581	0.738	0.306	0.829	0.554
	2	3.436	4.136	0.547	4.271	1.907	0.398	0.478	0.063	0.494	0.221	0.612	0.736	0.097	0.760	0.340
Des	1	3.236	2.859	9.502	2.594	9.502	0.374	0.331	1.099	0.300	1.099	0.576	0.509	1.691	0.462	1.691
	2	3.049	1.662	10.084	2.998	10.084	0.353	0.192	1.167	0.347	1.167	0.543	0.296	1.795	0.534	1.795

TABLE 8. Result of Calculating Water Conditions in Each Alternative Planting Pattern

Bulan	Periode	Kebutuhan Air					Luas D.I	Kebutuhan Air					Ketersediaan Air	Qtersedia - Qbutuh				
		ltr/det/Ha						m3/det						m3/det				
		Alt. I	Alt. II	Alt. III	Alt. IV	Alt. V	Ha	Alt. I	Alt. II	Alt. III	Alt. IV	Alt. V	m3/det	Alt. I	Alt. II	Alt. III	Alt. IV	Alt. V
Jan	1	0.149	1.635	1.280	0.000	1.280		0.045	0.493	0.386	0.000	0.386	4.442	4.398	3.949	4.056	4.442	4.056
	2	0.022	1.739	0.450	0.025	0.450		0.007	0.524	0.136	0.008	0.136	4.948	4.941	4.423	4.812	4.940	4.812
Feb	1	0.483	1.324	1.109	2.030	1.109		0.146	0.399	0.334	0.612	0.334	5.243	5.097	4.844	4.909	4.631	4.909
	2	2.052	0.509	1.296	2.052	1.296		0.618	0.153	0.390	0.618	0.390	5.795	5.176	5.641	5.404	5.176	5.404
Mar	1	1.992	1.175	0.823	1.992	0.823		0.600	0.354	0.248	0.600	0.248	4.439	3.838	4.085	4.191	3.838	4.191
	2	2.054	1.358	0.780	1.123	0.685		0.619	0.409	0.235	0.338	0.206	2.945	2.326	2.535	2.710	2.606	2.738
Apr	1	1.222	0.901	0.581	1.212	0.356		0.368	0.271	0.175	0.365	0.107	2.105	1.737	1.834	1.930	1.740	1.998
	2	1.164	0.722	0.423	1.377	1.780		0.351	0.218	0.127	0.415	0.536	1.823	1.472	1.606	1.696	1.408	1.287
Mei	1	1.448	0.356	0.597	1.011	1.796		0.436	0.107	0.180	0.305	0.541	1.316	0.880	1.209	1.136	1.011	0.775
	2	1.011	1.796	0.466	0.770	1.796		0.305	0.541	0.140	0.232	0.541	0.919	0.614	0.377	0.778	0.687	0.377
Jun	1	0.770	1.829	1.016	0.356	1.298		0.232	0.551	0.306	0.107	0.391	0.555	0.323	0.004	0.249	0.448	0.164
	2	0.356	1.829	0.774	1.829	1.286		0.107	0.551	0.233	0.551	0.388	0.409	0.302	-0.142	0.176	-0.142	0.021
Jul	1	2.241	1.473	1.118	1.885	1.526	301.41	0.675	0.444	0.337	0.568	0.460	0.412	-0.264	-0.032	0.075	-0.156	-0.048
	2	2.241	1.459	0.830	1.885	1.062		0.675	0.440	0.250	0.568	0.320	0.318	-0.358	-0.122	0.068	-0.250	-0.002
Agu	1	2.314	1.632	1.142	1.488	0.969		0.697	0.492	0.344	0.449	0.292	0.412	-0.286	-0.080	0.067	-0.037	0.120
	2	1.488	1.132	1.105	1.474	0.670		0.449	0.341	0.333	0.444	0.202	0.336	-0.112	-0.005	0.003	-0.108	0.134
Sep	1	1.459	0.921	0.931	1.612	0.937		0.440	0.278	0.281	0.486	0.282	0.386	-0.054	0.108	0.105	-0.100	0.103
	2	1.612	0.634	0.929	1.119	1.093		0.486	0.191	0.280	0.337	0.329	0.296	-0.190	0.105	0.016	-0.042	-0.034
Okt	1	1.132	0.796	0.637	0.972	0.944		0.341	0.240	0.192	0.293	0.285	0.234	-0.107	-0.006	0.042	-0.059	-0.051
	2	0.972	0.914	0.631	0.672	0.942		0.293	0.276	0.190	0.203	0.284	0.315	0.022	0.039	0.124	0.112	0.031
Nov	1	0.581	0.738	0.306	0.829	0.554		0.175	0.222	0.092	0.250	0.167	0.415	0.240	0.192	0.323	0.165	0.248
	2	0.612	0.736	0.097	0.760	0.340		0.184	0.222	0.029	0.229	0.102	1.426	1.241	1.204	1.396	1.196	1.323
Des	1	0.576	0.509	1.691	0.462	1.691		0.174	0.153	0.510	0.139	0.510	2.482	2.309	2.329	1.973	2.343	1.973
	2	0.543	0.296	1.795	0.534	1.795		0.164	0.089	0.541	0.161	0.541	2.967	2.803	2.878	2.426	2.806	2.426

The greatest water shortage occurs in the July period II in alternative I is with a difference of -0,358 m^3/sec. Meanwhile, the largest surplus condition occurred in February period II in alternative II, which was 5,641 m^3/det.

G. Agricultural Production

According to the results of the interviews and from some additional secondary data in the Kupang Regency area, the average production yield for rice is ±4 tons/ha/growing season and crops (corn) is ±3 tons/ha/growing season. Meanwhile, the selling price for rice grain on average in Kupang Regency is Rp. 4.000/kg and for corn is Rp. 3.000/kg.

The average production cost of farming for rice crops in Dalam Kom irrigation area is Rp. 8.646.500,-/ha/growing season and for crops (maize) is Rp. 7.264.000,-/ha/growing season.

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TABLE 9. Details of Paddy Rice Commodity Farming Costs for 1Ha with a Period of One Planting Season in Dalam Kom Irrigation Area

NO		JENIS KEGIATAN	VOLUME		HARGA SATUAN (Rp)	JUMLAH (Rp)	KET
I		**BIAYA TETAP**					
	1	Tanah					
		Akumulasi Penyusutan 10 %	1	Ha	1,000,000	1,000,000	
	2	Bangunan/Gudang					
		Akumulasi Penyusutan 10 %	1	Unit	500,000	500,000	
	3	Sewa Traktor / Alat Mesin Pertanian	1	Unit	584,000	584,000	
		JUMLAH				**2,084,000**	
II		**BIAYA TIDAK TETAP**					
	1	Benih Padi	20	Kg	100,000	2,000,000	
	2	Biaya Pupuk SP-36	100	Kg	2,400	240,000	
	3	Biaya Pupuk Urea	250	Kg	2,250	562,500	
	4	Biaya Pupuk NPK	200	Kg	2,300	460,000	
	5	Pestisida, Insektisida, Fungisida	2	Ltr	100,000	200,000	
	6	POC & Hormonik	1	Ltr	100,000	100,000	
	7	Biaya Panen dan Pasca Panen	1	Pkt	2,000,000	2,000,000	10 OK
	8	Biaya Transportasi & Pemasaran	1	Pkt	500,000	500,000	
	9	BBM	50	Liter	10,000	500,000	
		JUMLAH				**6,562,500**	
	TOTAL I + II					**8,646,500**	

TABLE 10. Details of Corn Commodity Farming Costs for 1Ha with a Period of One Planting Season in Dalam Kom Irrigation Area

NO		JENIS KEGIATAN	VOLUME		HARGA SATUAN (Rp)	JUMLAH (Rp)	KET
I		**BIAYA TETAP**					
	1	Tanah					
		Akumulasi Penyusutan 10 %	1	Ha	1,000,000	1,000,000	
	2	Bangunan/Gudang					
		Akumulasi Penyusutan 10 %	1	Unit	500,000	500,000	
	3	Sewa Traktor / Alat Mesin Pertanian	1	Paket	584,000	584,000	
		JUMLAH				**2,084,000**	
II		**BIAYA TIDAK TETAP**					
	1	Bibit Jagung	15	Kg	80,000	1,200,000	Label Biru
	2	Biaya Pupuk Urea	200	Kg	2,250	450,000	
	3	Biaya Pupuk NPK	100	Kg	2,300	230,000	
	4	Pestisida, Insektisida, Fungisida	2	Ltr	100,000	200,000	
	5	POC & Hormonik	1	Ltr	100,000	100,000	
	6	Biaya Panen dan Pasca Panen	1	Pkt	2,000,000	2,000,000	10 OK
	7	Biaya Transportasi & Pemasaran	1	Pkt	500,000	500,000	
	8	BBM	50	Liter	10,000	500,000	
		JUMLAH				**5,180,000**	
	TOTAL I + II					**7,264,000**	

1. Analysis of Revenues and Income of Farmer in Dalam Kom Irrigation Area.

   The average production yield of rice farming in Dalam Kom irrigation area for one growing season is ±4 tons/ha/planting season and corn is ±3 tons/ha/planting season with the selling price for rice grain on average in Kupang Regency is Rp 5.000/kg and for Corn is Rp 4.000/kg. From this information, the average total revenue of farmers for rice farming is Rp. 20.000.000,-/ha/planting season while for corn farming is Rp. 12.000.000,-/ha/growing season. From the analysis of the calculation of revenues obtained by farmers, the remaining income or average income that can be obtained from rice farming is Rp. 11.353.500,-/ha/growing season and the average income for corn farming is Rp. 4.736.000,-/ha/growing season.

2. Income Analysis of Farmer in Dalam Kom Irrigation Area After Optimization

   After optimization with alternative planting pattern III, namely rice – crops (corn) – crops (corn) with the beginning of the growing season in December period I, the average production yield of rice becomes 4 tons/ha/year and corn is 6 tons/ha/year. So that the total income for the rice farming business is Rp. 11.353.500,-/ha/year and for the crops (corn) farming business becomes Rp. 9.472.000.-/ha/year.

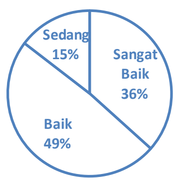
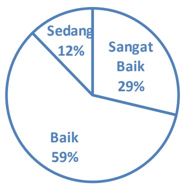
H. Survey On Dalam Kom Irrigation Area.

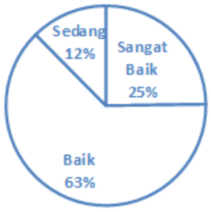
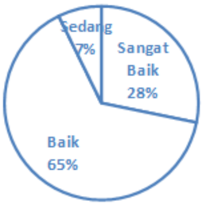
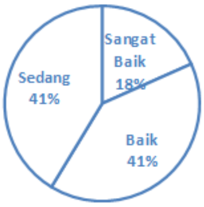
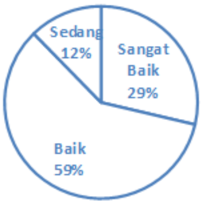
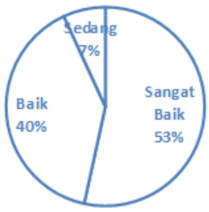
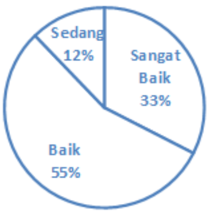
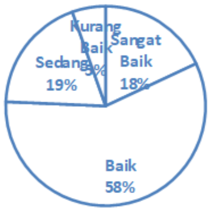
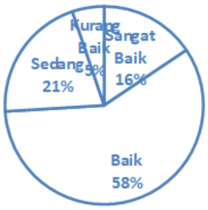
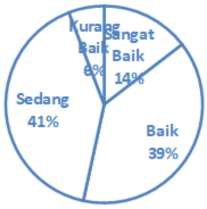
The purpose of this survey is to obtain further information and data on how to manage and maintain water resources in Dalam Kom and to find out how the role of relevant institutions in managing this irrigation area.

The survey was conducted by circulating several questionnaires containing several questions answered by respondents. The questionnaire that has been answered is then processed and analyzed to obtain information related to conditions in Dalam Kom irrigation area. The questionnaire is analyzed by giving weight to each question that has been answered by the respondent.

TABLE 11. Scoring from Respondent Statements in Dalam Kom Irrigation Area

Pernyataan	Skor nilai jawaban responden					Total
	Sangat Baik	Baik	Sedang	Kurang Baik	Buruk	
Skor	5	4	3	2	1	
Lembaga pertanian membantu petani untuk mendapatkan sarana produksi yang baik	45	60	18	0	0	123
Lembaga pertanian membantu dalam mendirikan dan mengembangkan kelompok tani	35	72	15	0	0	122
Lembaga pertanian membantu dalam meningkatkan fasilitas pertanian	30	76	15	0	0	121
Kerja sama antar anggota di dalam kelompok tani	35	80	9	0	0	124
Akses kelompok tani dengan Dinas Pertanian yang terkait	20	68	27	0	0	115
Kondisi infrastruktur pertanian (saluran irigasi, bendung, dll)	20	44	45	0	0	109
Pengelolaan infrastruktur untuk mendukung usaha tani	35	72	15	0	0	122
Ketersediaan sarana produksi (benih, pupuk, pestisida, dll)	70	52	9	0	0	131
Pemeliharaan terhadap sarana pertanian	40	68	15	0	0	123
Pengawasan terhadap kondisi ketersediaan air pada bendung yang menjadi sumber air untuk kegiatan bertani	20	64	21	6	0	111
Kondisi debit air saat musim kemarau	0	12	45	16	4	77
Rotasi pembagian air dilakukan secara baik dan tertata	15	40	42	6	0	103

Pernyataan	Persentase
Lembaga pertanian membantu petani untuk mendapatkan sarana produksi yang baik	
Lembaga pertanian membantu dalam mendirikan dan mengembangkan kelompok tani	

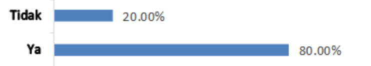
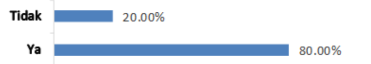
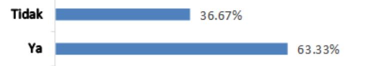
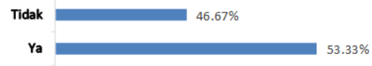
Lembaga pertanian membantu dalam meningkatkan fasilitas pertanian	
Kerja sama antar anggota di dalam kelompok tani	
Akses kelompok tani dengan Dinas Pertanian yang terkait	
Kondisi infrastruktur pertanian (saluran irigasi, bendung, dll)	
Pengelolaan infrastruktur untuk mendukung usaha tani	
Ketersediaan sarana produksi (benih, pupuk, pestisida, dll)	
Pemeliharaan terhadap sarana pertanian	
Pengawasan terhadap kondisi ketersediaan air pada bendung yang menjadi sumber air untuk kegiatan bertani	
Kondisi debit air saat musim kemarau	
Rotasi pembagian air dilakukan secara baik dan tertata	

From the recapture and weighting data that has been carried out, tabulation calculations are then carried out using a pie chart for each existing statement.

From the results of the questionnaire analysis, it can be seen that there is a good role of agricultural institutions in developing, assisting and improving the quality of agriculture through means of production, establishing farmer groups, and participating in improving various agricultural facilities.

Cooperation between group members in existing farmer groups is also well carried out which is shown by a percentage rate of 65%. The relationship between farmer groups and related agricultural agencies is also well done, shown by a percentage figure of 59%.

TABLE 12. Percentage of Answers to the Question on the Role of Farmer Groups and Agricultural Institutions

Jumlah Responden = 30 Orang	
Pernyataan	Persetase
Apakah sistem manajemen dalam kelompok tani ini telah berjalan dengan baik?	
Apakah air irigasi yang tersedia selalu cukup untuk memenuhi kebutuhan pertanian?	
Apakah kelompok tani membantu dalam memberikan modal usaha tani?	
Apakah kelompok tani ini mendapatkan subsidi dari pemerintah?	
Apakah modal usaha yang diberikan sudah cukup untuk memenuhi kebutuhan pertanian?	
Apakah lembaga pertanian atau pemerintah berperan aktif dalam mengawasi kegiatan pertanian?	

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The condition of agricultural infrastructure such as irrigation canals, weir, etc. and infrastructure management is also running well. For the availability of means of production such as fertilizers, plant seeds, pesticides, etc. are always available and fulfilled very well. Meanwhile, the maintenance of these production facilities is already good at a percentage of 55%. Supervision from related parties on the condition of water availability has also been good which is shown by a percentage figure of 58%. However, water conditions in the dry season are only in moderate conditions with a percentage of 58%, even very bad considering the reduced water discharge when entering the dry season. For the rotation of the water distribution is also quite good because of the supervision of agricultural institutions and from the farmer groups themselves

From the results of this questionnaire analysis, it can be seen that the management system of farmer groups in Dalam Kom has been running well. The condition of the available irrigation water has also not been able to meet the needs of farmers in Dalam Kom. Farmer groups have also played a role in helping farmers to obtain business capital that is partly subsidized by the government such as fertilizers. However, there are still some agricultural areas that have not received business capital assistance from farmer groups. There are respondents who already feel that they have enough business capital provided, but there are also respondents who feel that the capital provided is not enough to meet the needs. This is due to differences in the area of land that must be managed by respondents. In addition to providing business capital assistance, agricultural institutions also play a good role in supervising agricultural activities by monitoring agricultural activities on average once a month.

TABLE 13. Percentage of Answer to Land Treatment in Dalam Kom Irrigation Area

Pernyataan	Persentase
Berapa kali pembajakan dilakukan?	c 0%; b 40%; a 60%
Berapa kali penyiangan dilakukan?	c 17%; b 30%; a 53%
Berapa waktu yang ideal untuk melakukan pengolahan lahan?	c 13%; b 63%; a 23%
Kapan panen padi dilakukan?	c 0%; b 0%; a 100%
Berapa kali jumlah panen dalam setahun?	c 13%; b 30%; a 57%

After analyzing the respondents answers regarding land processing in Dalam Kom, it can be seen that farmers do plowing 2 times but for farmers whose agricultural areas lack water plowing is carried out only 1 time

For weeding the land, it can be done more than 3 times while for areas where there is less water, it is only done 2 times, and some even only do weeding 1 time.

For agricultural areas that have a large water discharge, land treatment can be carried out ideally which is 1-10 days. Meanwhile, for agricultural areas with small water conditions, land treatment is carried out for more than 20 days.

All respondents harvested when the rice was 2,5 to 3 months old. According to the type of rice grown.

The condition of the available water discharge also affects the amount of harvest in 1 year. Where agricultural areas with sufficient water conditions can harvest more than 2 times a year. Meanwhile, for agricultural areas with a small water discharge, they can only harvest 1 to 2 times a year.

IV. CLOSING

1. To be able to meet the needs of irrigation water in Dalam Kom, the Kupang Regency government built two weir, namely Dalam Kom 1 weir and the Dalam Kom 2 weir with the aim of irrigating an agricultural area with an area of 301,41 Ha. The discharge value used is the discharge data on the intakes of the two weirs where the condition of the water discharge in these two weirs after analysis has an average discharge of 1,872 m^3/sec. The largest discharge occurred in January period II in 2015 which was 12,268 m^3/sec, while the smallest discharge occurred in November period II in 2020 of 0.001 m^3/sec. From the results of surveys and studies, in this irrigation area, no other source of water has been found apart from the Dalam Kom 1 weir and the Dalam Kom 2 weir.
2. Changes in planting patterns are carried out using five alternative planting patterns, namely alternative I with the rice – rice – crops (corn) planting pattern and the beginning of the planting period in February period II, alternative II with the rice – rice – crops (corn) planting pattern and the beginning of the planting period in January period I, alternative III with the rice planting pattern rice – crops (corn) – crops (corn) and the beginning of the planting period in December period II, alternative IV with rice planting pattern rice – rice – crops (corn) and the beginning of the planting period in February period I, and alternative V with rice – rice – crops (corn) planting pattern and the beginning of the planting period in December period I. After changes were made to the beginning of the growing season and changes to the planting pattern in alternative III to rice – crops (corn) – crops (corn) with the beginning of the growing season in December period II, then there is a surplus in each growing season. This means that the available water discharge conditions are sufficient to meet the needs of irrigation water with planting patterns in alternative III so that farming activities can be carried out optimally by utilizing the available land area. The surplus discharge that occurs in alternative III ranges from 0,003 m^3/sec to 5,404 m^3/sec.
3. The total production after optimization with alternative planting pattern III is 4 tons/ha/ year for rice and for corn of 6 tons/ha/ year with the selling price for average rice

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grain in Kupang Regency is Rp 5.000/kg and for corn is Rp 4,000/kg. From this data, the average total revenue of farmers for rice farming is Rp. 20.000.000,-/ha/year while for corn farming is Rp. 24.000.000,-/ha/year. From the analysis of the calculation of revenues obtained by farmers, the income that can be obtained after optimization for rice farming is Rp. 11.353.500,-/ha/year and the income for corn farming is Rp. 9.472.000,-/ha/year.

4. From the results of the questionnaire analysis distributed to 30 respondents, it can be concluded that the role of institutions and farmer groups in managing agricultural areas in Dalam Kom irrigation area has been running well, starting from the development of farming businesses and improving facilities and providing agricultural facilities. The farmer group also has a good cooperative relationship with the relevant agricultural agencies. The management system in the farmer group has also been running well. Farmers are also given capital to support in managing farming businesses, although the business capital provided has not been fully able to meet the needs of respondents who manage large agricultural areas. Agricultural institutions are also quite active in supervising farm business activities by monitoring once a month.

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