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Study of Optimization Planting Patterns of Irrigation Areas Ciujung Ciruas District Using a Linear Program

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Abstract

Ciujung Irrigation Area (DI) has an area of 21,350 ha. The Ciujung Irrigation Area Irrigation Network is still found to be quite high sedimentation, so that the distribution of water for agricultural needs and other community needs has not been able to be carried out optimally. The purpose of optimizing the planting pattern is to determine the maximum price of the crop that a field with different types of crops can produce. Optimization in this study used a linear program using the POM QM application. In this optimization study, 4 alternatives were planned with 2 different crops, namely corn and peanuts. In the planting pattern, alternative 1 starts planting in December I, alternative 2 starts planting in December II, alternative 3 starts planting in January I, alternative 4 starts planting in January II. The alternative planting pattern chosen is alternative 2 by producing an area of MT I Rice covering an area of 21,350 ha, MT II Rice covering an area of 3671.62 ha, Palawija covering an area of 84.98 ha and the maximum profit obtained in a year is IDR 595,113,300,000

Keywords: *Optimization, Planting pattern, POM-QM, Profit*

1. Introduction

Ciujung Irrigation Area (DI) has an area of 21,350 Ha. The Ciujung Irrigation Area Irrigation Network is still found to have a fairly high sedimentation, so that the distribution of water for agricultural needs and other community needs cannot be carried out optimally [1]. It is necessary to conduct research and planning analysis. Optimization of irrigation water use is expected to meet the water needs of plants. In addition, it regulates a more optimal planting pattern based on the type of plant, land area and water availability [2] [3]. The objectives obtained from writing this final project are:

A. To find out the irrigation water needs of the Ciujung Irrigation Area (DI).
B. To find out the maximum profit from the production yield based on the planting pattern [4].

2. Literature Study

2.1 Planting Pattern

Planting pattern is an effort to plant on a piece of land by arranging the arrangement and order of plants in a certain period of time, both planting and non-planting periods. The

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selection of planting varieties is important because it must be adapted to the conditions of water availability or precipitation. The purpose of applying the planting pattern is as follows:
1. Increased food production.
2. Establish a planting schedule to facilitate irrigation water management.
3. Avoiding non-uniformity of tanaman.
4. Knowing the water needs of plants [5].

2.2 Irrigation Water Requirements

Irrigation water needs are defined as the amount of water provided by nature through rainwater for the purpose of optimal growth of plant needs, and the contribution of groundwater to irrigated land, taking into account evaporation, water loss, and plant water needs. The amount of water needed to meet water needs calculate the irrigation water needs needed to be the basis for planning irrigation networks (channels and buildings) [6]. Irrigation water requirements are calculated based on the planned planting pattern and the following parameters:
1. The need for water for soil preparation.
2. Plant water needs.
3. Water needs due to water loss and water distribution plants (infiltration).
4. The need for water for flood replacement.
5. Effective rainfall.
6. Irrigated land area.

2.3 Optimization with Linear Programs

Linear programming is used in formulating mathematical models of optimization, including determining decision variables, goal functions, and constraint functions [7] [8]. The decision variable used is the land area for each alternative planting pattern that has been planned using a solver in the POM-QM application to benefit from the function of goals and constraints [9] [10].

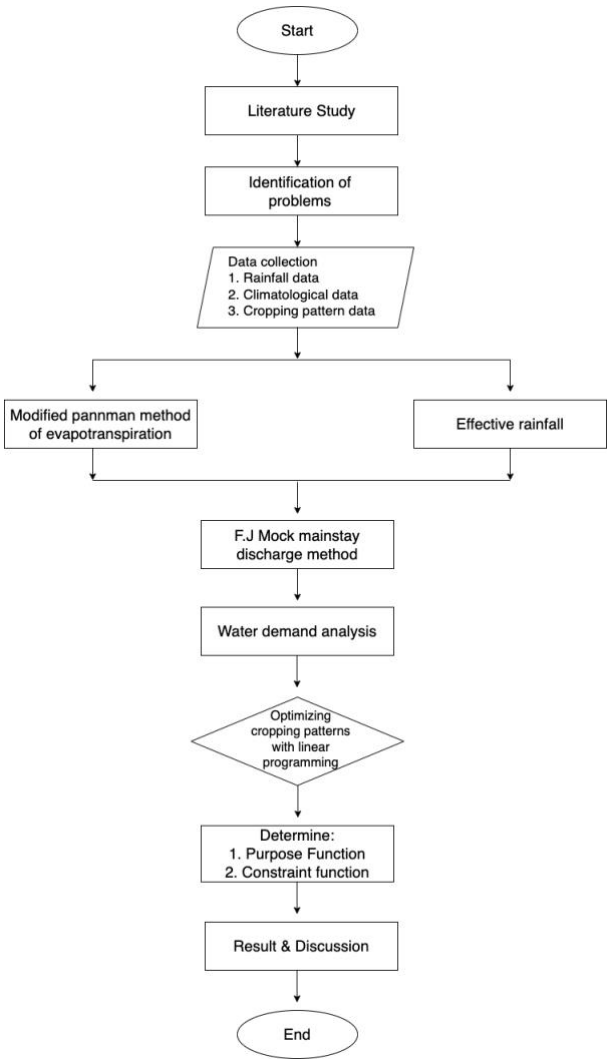


Figure 1. Research Flow Chart

3. Research Methods

3.1 Hydrological Data

Hydrological data is needed to calculate irrigation water needs and mainstay discharge [11]. Hydrological data in the form of daily rainfall obtained from the Cidanau-Ciujung-Cidurian River Basin BBWS (Balai Besar Wilayah Sungai) [12].

3.2 Climatology Data

Climatology data can be used to calculate water requirements and irrigation water discharge including air temperature data, humidity data, duration of exposure to sunlight and wind speed. These data can be used to calculate evaporation and evaporation in plants.

4. Data Analysis and Discussion

4.1 Effective Rainfall Analysis (Re)

Hydrological data were obtained from the Cidanau-Ciujung-Cidurian BBWS (River Basin Center) in the form of monthly rainfall [13].

TAHUN	BULAN											
	JAN	FEB	MAR	APR	MEI	JUN	JUL	AGS	SEPT	OKT	NOV	DES
2013	577	160	266	175	265	35	238	67	114	130	275	284
2014	467	330	128	120	434	117	150	114	25	59	285	0
2015	379	308	202	168	60	74	9	10	1	23	175	259
2016	202	307	163	229	96	109	218	55,7	187,4	159,7	195,7	302,9
2017	195,5	382	189	153	171,5	287	51,5	1	96,5	146	134	136,5
2018	235	165	122,5	103	312	145	26	4	49	61	305	232
2019	337,5	79	141	252,5	177	33	20,5	63	0	36,5	132	251,5
2020	485	284	237	269	410	210	48,5	73,5	125	156,5	199,5	0
2021	268,1	384	154,5	146	116,5	283,5	48,5	101,5	240,5	302	211,5	379
Rata-Rata (mm)	348,90	268,78	172,44	188,39	230,22	143,72	90,00	54,41	240,50	119,30	212,52	203,66

Figure 2. Monthly Average Rainfall Data (mm)
Source : Pamarayan Rainfall Station

TAHUN	BULAN											
	JAN		FEB		MAR		APR		MEI		JUN	
	I	II	I	II	I	II	I	II	I	II	I	II
2013	328	249	101	59	171	35	141	34	187	108	24	11
2014	204	263	193	137	37	91	62	58	106	328	95	22
2015	205	168	248	60	84	118	67	101	41	19	74	0
2016	59	143	170	137	90	73	59	170	45	51	64	45
2017	147	48,5	188,5	193,5	102	87	21,5	131,5	158,5	13	208	79
2018	49	186	100	85	85,5	37	86	97	59	253	16	129
2019	197,5	180	36	43	56	85	79,5	173	161,5	15,5	19,5	13,5
2020	252	206	121	163	149,5	87,5	92	177	189	221	84	126
2021	37,5	230,6	257	127	60,5	94	104	42	51,5	65	118	165,5
MAX	328	263	257	193,5	171	118	141	177	189	328	208	165,5
RERATA	164,33	186,01	157,17	111,61	92,83	78,61	79,11	109,28	110,94	119,28	78,06	65,67
MIN	37,5	48,5	36	43	37	35	21,5	34	41	13	16	0

TAHUN	BULAN											
	JUL		AGS		SEPT		OKT		NOV		DES	
	I	II	I	II	I	II	I	II	I	II	I	II
2013	94	144	64	3	55	59	17	113	235	40	114	170
2014	114	36	79	35	0	25	20	39	145	140	0	0
2015	9	0	4	6	0	1	23	0	76	99	120	133
2016	99	119	40,1	15,6	81,9	105,5	94,4	65,3	28,5	167,2	207,9	95
2017	5	46,5	0	1	0	96,5	64	82	58	76	78	58,5
2018	26	0	0	4	8	41	9	52	190	115	167	65
2019	20,5	0	0	63	0	0	23,5	13	59,5	72,5	91	160,5
2020	35,3	13	72,5	1	42,5	82,5	32	124,5	109,5	90	0	0
2021	35,5	13	69	32,5	164,5	76	72	230	123	88,5	140	233
MAX	114	144	79	63	164,5	105,5	94,4	230	235	167,2	207,9	233
RERATA	48,70	41,28	36,51	17,90	39,10	54,06	39,43	79,87	113,83	98,69	101,99	101,67
MIN	5	0	0	1	0	0	9	0	28,5	88,5	0	0

Figure 3. Semi-Monthly Rainfall Data of Pamarayan Rainfall Station
Source : Pamarayan Rainfall Station

The annually aggregated monthly rainfall data is sorted from largest to smallest, then look for probabilities using the weibull formula [14].

NO	P (%)	TAHUN	CURAH HUJAN (mm/jam)
1	10	2021	2629,6
2	20	2013	2556
3	30	2020	2498
4	40	2014	2229
5	50	2016	2225,4
6	60	2017	1943,5
7	70	2018	1859,5
8	80	2015	1656
9	90	2019	1523,5

Figure 4. Semi-Monthly Rainfall Probabilitras 50% and 80%
Source : Calculation 2022

Rainfall with a probability value of 80% is used to calculate effective rainfall in rice and rainfall with a probability value of 50% for palawija [15].

NO	P(%)	BULAN											
		JAN		FEB		MAR		APR		MEI		JUN	
		I	II	I	II	I	II	I	II	I	II	I	II
1	50	59	143	170	137	90	73	59	170	45	51	64	45
2	80	205	168	248	60	84	118	67	101	41	19	74	0
Re	Padi	9,57	7,84	11,57	2,80	3,92	5,51	3,13	4,71	1,91	0,89	3,45	0,00
Re	Palawija	2,75	6,67	7,93	6,39	4,20	3,41	2,75	7,93	2,10	2,38	2,99	2,10

NO	P(%)	BULAN											
		JUL		AGS		SEPT		OKT		NOV		DES	
		I	II	I	II	I	II	I	II	I	II	I	II
1	50	99	119	40,1	15,6	81,9	105,5	94,4	65,3	28,5	167,2	207,9	95
2	80	9	0	4	6	0	1	23	0	76	99	120	133
Re	Padi	0,42	0,00	0,19	0,28	0,00	0,05	1,07	0,00	3,55	4,62	5,60	6,21
Re	Palawija	4,62	5,55	1,87	0,73	3,82	4,92	4,41	3,05	1,33	7,80	9,70	4,43

Figure 5. Effective Rainfall of Rice and Palawija
Source : Calculation 2022

4.2 Analysis of Evapotranspiration Calculations (Eto)

Evaporation and transpiration events are simultaneously called evapotranspiration. The potential for evaporation is also commonly referred to as plant consumption needs, which is the amount of water needed to evaporate from the surface of the plant area. Climate plays an important role in determining these characteristics. Meteorological data include: temperature, humidity, wind speed and length of solar irradiation [16] The evaporation potential can be calculated using the Penman method Here is the calculation for Evapotranspiration

No	Parameter	Satuan	Bulan											
			Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ags	Sept	Okt	Nov	Des
I	DATA													
1	Suhu, T	(°C)	27,3	27,3	27,3	27,6	28,1	27,3	27,2	27,3	27,5	28,2	27,7	27,5
2	Lama Penyinaran, n/N	(%)	41	48	55	68	66	61	73	72	73	65	51	41
3	Kelembapan Udara, RH	(%)	83	84	84	83	81	81	79	78	76	77	79	82
4	Kecepatan Angin, u	m/dt	2,4	2,1	1,9	1,7	1,6	1,4	1,5	1,8	1,9	1,8	1,9	2,4
		km/hari	207,36	181,44	164,16	146,88	138,24	120,96	129,6	155,52	164,16	155,52	164,16	207,36
II	PERHITUNGAN													
1	Tekanan Uap Jenuh, ea	(mbar)	34,305	34,305	34,305	34,935	35,809	34,305	34,095	34,305	34,725	36,039	35,145	34,725
2	Tekanan Uap Nyata, ed	(mbar)	28,473	28,816	28,816	28,996	29,006	27,787	26,935	26,758	26,391	27,750	27,765	28,475
3	Perbedaan Tekanan Uap, ea-ed	(mbar)	5,832	5,489	5,489	5,939	6,804	6,518	7,160	7,547	8,334	8,289	7,380	6,251
4	Fungsi Angin, f(u)	(km/hari)	0,830	0,760	0,713	0,667	0,643	0,597	0,620	0,690	0,713	0,690	0,713	0,830
5	Temperatur dengan faktor perimbang, W		0,757	0,757	0,757	0,763	0,762	0,757	0,755	0,757	0,761	0,763	0,765	0,761
6	Faktor Pembobot (1-W)		0,243	0,243	0,243	0,237	0,238	0,243	0,245	0,243	0,239	0,237	0,235	0,239
7	Radiasi Ekstra Terrestial, Ra	(mm/hari)	15,800	16,000	15,600	14,700	13,400	12,800	13,100	14,000	15,000	15,700	15,800	15,700
8	Radiasi Gel. Pendek, Rs	(mm/hari)	7,189	7,840	8,190	8,673	7,772	7,104	8,057	8,540	9,225	9,028	9,085	7,144
9	Radiasi Netto Gel. Pendek, Rns	(mm/hari)	5,392	5,880	6,143	6,505	5,829	5,328	6,042	6,405	6,919	6,771	6,814	5,358
10	Fungsi Tek. Uap Nyata, f(ed)		0,105	0,104	0,104	0,103	0,103	0,108	0,112	0,112	0,114	0,108	0,108	0,105
11	Fungsi Penyinaran, f(n/N)		0,469	0,532	0,595	0,712	0,694	0,649	0,757	0,748	0,757	0,685	0,559	0,469
12	Fungsi Suhu, f(T)		16,049	16,049	16,049	16,169	15,967	16,049	16,009	16,049	16,129	16,007	16,209	16,129
13	Radiasi Netto Gel. Panjang, Rnl	(mm/hari)	0,792	0,886	0,991	1,187	1,142	1,126	1,353	1,349	1,391	1,187	0,980	0,796
14	Radiasi Netto, Rn	(mm/hari)	4,600	4,994	5,151	5,318	4,687	4,202	4,689	5,056	5,527	5,584	5,834	4,562
15	Faktor Koreksi, c		1,100	1,100	1,000	0,900	0,900	0,900	0,900	1,000	1,100	1,100	1,100	1,100
16	Evapotranspirasi Potensial, Eto	(mm/hari)	5,124	5,274	4,851	4,497	4,152	3,714	4,165	5,092	6,189	6,178	6,270	6,270

Figure 6. Potential Evapotranspiration
Source : Calculation 2022

4.3 Analysis of River Discharge Calculation by FJ Method. Mock

Calculation of The Mainstay Discharge using the FJ method. Mock simulates river flow calculations using effective rainfall data, potential evapotranspiration and hydrological characteristics of watersheds [17].

No		Satuan	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	Mei I	Mei II	Jun I	Jun II
	Jumlah Hari		15	14	15	13	15	16	15	15	15	16	15	15
	Presipitasi													
1	R (Curah Hujan Efektif)	mm/15hr	205	168	248	60	84	118	67	101	41	19	74	0
2	n (Jumlah Hari Hujan)	Hari	11	9	9	4	9	5	3	7	6	2	7	0
	Evapotranspirasi													
3	Evapotranspirasi Potensial	mm/hari	5,12	5,12	5,27	5,27	4,85	4,85	4,50	4,50	4,15	4,15	3,71	3,71
		mm/15hr	76,86	71,73	79,10	68,56	72,77	77,62	67,45	67,45	62,28	66,43	55,71	55,71
4	Presentasi Permukaan Terbuka (M)	%	30	30	30	30	30	30	35	35	50	40	45	45
5	Nilai Perbandingan (%) De/dEp = (M/20)(18-N)	%	10,5	13,5	13,5	21	13,5	19,5	26,25	19,25	30	32	24,75	40,5
6	Perubahan Evapotranspirasi (dE)	mm/15hr	8,07	9,68	10,68	14,40	9,82	15,14	17,71	12,98	18,68	21,26	13,79	22,56
7	Evapotranspirasi Aktual (Ea)	mm/15hr	68,79	62,05	68,42	54,16	62,95	62,49	48,75	54,47	43,60	45,17	41,92	33,14
	Water Balance													
8	Excess Rainfall (ER)	mm/15hr	136,21	105,95	179,58	5,84	21,05	55,51	17,25	46,53	-2,60	-26,17	32,08	-33,14
9	Soil Moisture (SM)	mm/15hr	236,21	205,95	279,58	105,84	121,05	155,51	117,25	146,53	97,40	73,83	132,08	66,86
10	Soil Moisture Capacity (SMC)	mm/15hr	100	100	100	100	100	100	100	100	100	100	100	100
11	Initial Soil Moisture Storage (ISMS)	mm/15hr	100	100	100	100	100	100	100	100	100	100	100	100
12	Soil Storage (SS)	mm/15hr	0	0	0	0	0	0	0	0	0	0	0	0
13	Water Surplus (WS)	mm/15hr	136,21	105,95	179,58	0,00	21,05	0,00	17,25	46,53	0,00	0,00	32,08	0,00
	Runoff dan air tanah													
	Water Storage													
14	**Infiltrasi (I)**	mm/15hr	68,11	52,98	89,79	0,00	10,53	0,00	8,63	23,27	0,00	0,00	16,04	0,00
15	Sebagian Infiltrasi Pengisian air tanah Tambahan Vol = 0,5 (1+k) I	mm/15hr	51,08	38,73	67,34	0,00	7,90	0,00	6,47	17,45	0,00	0,00	12,03	0,00
16	Pengisian air tanah sebelumnya Vol. sebelumnya = k (Vn-1)	mm/15hr	5,14	28,11	33,92	50,63	25,32	16,61	8,30	7,39	12,42	6,21	3,10	7,57
	Total Storage Volume													
17	Vn = 0,5 (1+k) I+k (VN-1)	mm/15hr	56,21	67,84	101,26	50,63	33,21	16,61	14,77	24,84	12,42	6,21	15,13	7,57
18	Perubahan Simpanan Dvn = - Vn-1 + Vn	mm/15hr	45,94	11,62	33,42	-50,63	-17,42	-16,61	-1,83	10,06	-12,42	-6,21	8,93	-7,57
19	Base Flow Bn = I - dVn	mm/15hr	22,16	41,35	56,37	50,63	27,95	16,61	10,46	13,20	12,42	6,21	7,11	7,57
	Aliran Permukaan													
20	Direct runoff (Dro) = ER-I	mm/15hr	68,11	52,98	89,79	5,8	10,53	55,51	8,63	23,27	0,00	0,00	16,04	0,00
21	Runoff = Bn + Dro	mm/15hr	90,27	94,33	146,15	56,47	38,47	72,12	19,08	36,47	12,42	6,21	23,16	7,57
22	Debit	m3/dt	138,40	154,95	224,08	99,90	58,99	103,66	29,26	55,91	19,04	8,92	35,50	11,60

No		Satuan	Jul I	Jul II	Ags I	Ags II	Sept I	Sept II	Okt I	Okt II	Nov I	Nov II	Des I	Des II
	Jumlah Hari		15	16	15	16	15	15	15	16	15	15	15	16
	Presipitasi													
1	R (Curah Hujan Efektif)	mm/15hr	9	0	4	6	0	1	23	0	76	99	120	133
2	n (Jumlah Hari Hujan)	Hari	2	0	2	0	0	1	1	0	5	5	9	6
	Evapotranspirasi													
3	Evapotranspirasi Potensial	mm/hari	4,17	4,17	5,09	5,09	6,19	6,19	6,18	6,18	6,27	6,27	6,27	6,27
		mm/15hr	62,48	66,64	76,39	81,48	92,84	92,84	92,66	98,84	94,05	94,05	94,05	100,32
4	Presentasi Permukaan Terbuka (M)	%	50	50	45	45	45	45	40	40	35	35	35	35
5	Nilai Perbandingan (%) De/dEp = (M/20)(18-N)	%	40	45	36	40,5	40,5	38,25	34	36	22,75	22,75	15,75	21
6	Perubahan Evapotranspirasi (dE)	mm/15hr	24,99	29,99	27,50	33,00	37,60	35,51	31,51	35,58	21,40	21,40	14,81	21,07
7	Evapotranspirasi Aktual (Ea)	mm/15hr	37,49	36,65	48,89	48,48	55,24	57,33	61,16	63,26	72,66	72,66	79,24	79,25
	Water Balance													
8	Excess Rainfall (ER)	mm/15hr	-28,49	-36,65	-44,89	-42,48	-55,24	-56,33	-38,16	-63,26	3,34	26,34	40,76	53,75
9	Soil Moisture (SM)	mm/15hr	71,51	63,35	55,11	57,52	44,76	43,67	61,84	36,74	103,34	126,34	140,76	153,75
10	Soil Moisture Capacity (SMC)	mm/15hr	100	100	100	100	100	100	100	100	100	100	100	100
11	Initial Soil Moisture Storage (ISMS)	mm/15hr	100	100	100	100	100	100	100	100	100	100	100	100
12	Soil Storage (SS)	mm/15hr	0	0	0	0	0	0	0	0	0	0	0	0
13	Water Surplus (WS)	mm/15hr	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,34	26,34	40,76	53,75
	Runoff dan air tanah													
	Water Storage													
14	**Infiltrasi (I)**	mm/15hr	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,67	13,17	20,38	26,87
15	Sebagian Infiltrasi Pengisian air tanah Tambahan Vol = 0,5 (1+k) I	mm/15hr	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,25	9,88	15,29	0,00
16	Pengisian air tanah sebelumnya Vol. sebelumnya = k (Vn-1)	mm/15hr	3,78	1,89	0,95	0,47	0,24	0,12	0,06	0,03	0,01	0,63	5,26	10,27
	Total Storage Volume													
17	Vn = 0,5 (1+k) I+k (VN-1)	mm/15hr	3,78	1,89	0,95	0,47	0,24	0,12	0,06	0,03	1,27	10,51	20,54	10,27
18	Perubahan Simpanan Dvn = - Vn-1 + Vn	mm/15hr	-3,78	-1,89	-0,95	-0,47	-0,24	-0,12	-0,06	-0,03	1,24	9,24	10,03	-10,27
19	Base Flow Bn = I - dVn	mm/15hr	3,78	1,89	0,95	0,47	0,24	0,12	0,06	0,03	0,43	3,93	10,35	37,14
	Aliran Permukaan													
20	Direct runoff (Dro) = ER-I	mm/15hr	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,67	13,17	20,38	26,87
21	Runoff = Bn + Dro	mm/15hr	3,78	1,89	0,95	0,47	0,24	0,12	0,06	0,03	2,11	17,10	30,73	64,02
22	Debit	m3/dt	5,80	2,72	1,45	0,68	0,36	0,18	0,09	0,04	3,23	26,22	47,12	92,01

Figure 7. FJ Mainstay Discharge Calculation. Mock
Source: Calculation 2022

4.4 Calculation of Irrigation Water Needs

Alternative planting patterns in this optimization study are as follows:

1. Alternative 1: Start planting in December I
2. Alternative 2: Start planting in December II
3. Alternative 3: Start planting in January I
4. Alternative 4: Start planting in January II

In this optimization study, the author conducted 2 experiments in each alternative. By replacing the crops used, namely Corn and Peanuts.

1. Calculation of Water Needs in Rice Plants

There are 2 stages that are used when calculating the water needs of rice plants, namely soil preparation and growth.

The calculation of water requirements at the tillage stage uses the following formula:

PL = $\frac{M - e^k}{e^k - 1}$

$$K = \frac{M\ x\ T}{s}$$

$$M = 1{,}1\ x\ Eto + P$$

NFR = PL – Re

Information:

PL = Need for irrigation water in rice fields (mm / day)
M = Water requirement to replace water loss due to evaporation and percolation in saturated rice fields
T = Land preparation period (days)
S = Need for saturated water coupled with a 50 mm layer of water
P = Percolation (mm/day)
Re = Effective Rainfall (mm.day)
NFR = Water requirements in rice fields 1 mm / day
(0.116 liters/second/ha)

During the growth period of rice or palawija using the water balance equation to calculate the water needs needed in the rice field at the growth stage:

NFR (Padi) = ETc + P + WLR – Re
NFR (Palawija) = dll – re
Information:
Etc= Consumptive use (mm/day)
P= Percolation (mm/day)
Re= Effective Rainfall (mm/day)
WLR= Replacement of water layer (mm/day)

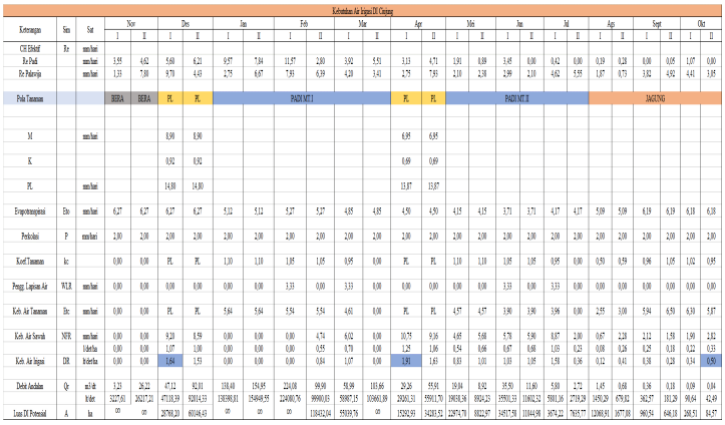


Figure 8. Irrigation Water Needs of Alternative Rice and Corn Crops 1
Source : Calculation 2022

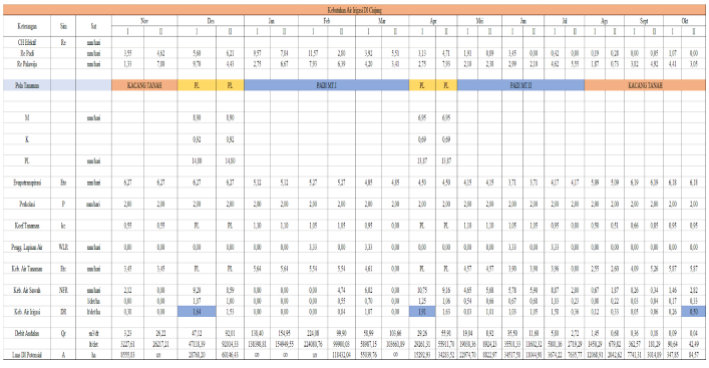


Figure 9. Irrigation Water Needs of Rice and Peanut Crops Alternatives 1
Source : Calculation 2022

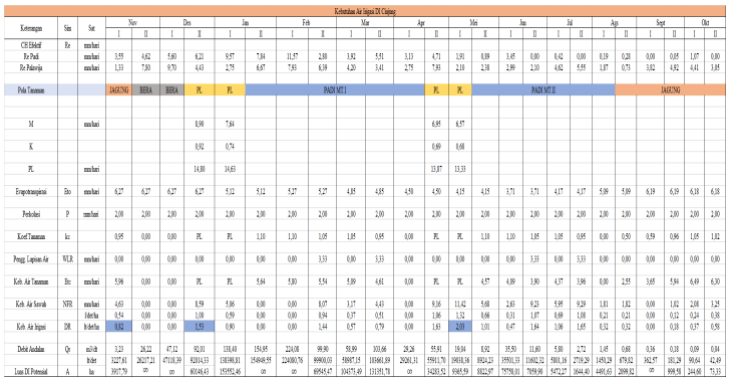


Figure 10. Irrigation Water Needs of Alternative Rice and Corn Crops 2
Source : Calculation 2022

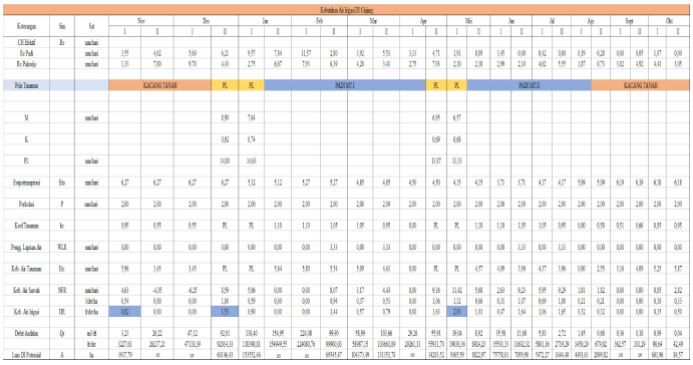


Figure 11. Irrigation Water Needs of Alternative Rice and Peanut Crops 2
Source : Calculation 2022

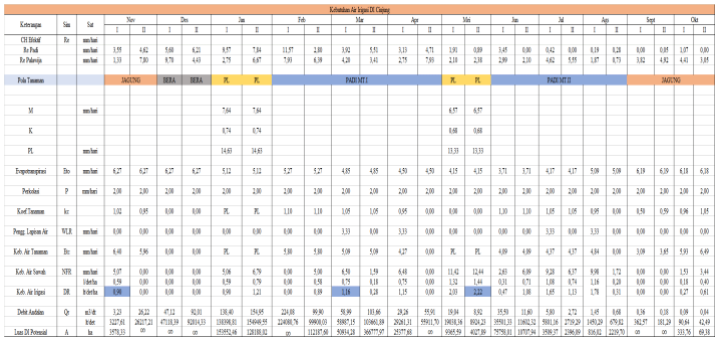


Figure 12. Irrigation Water Needs of Alternative Rice and Corn Crops 3
Source : Calculation 2022

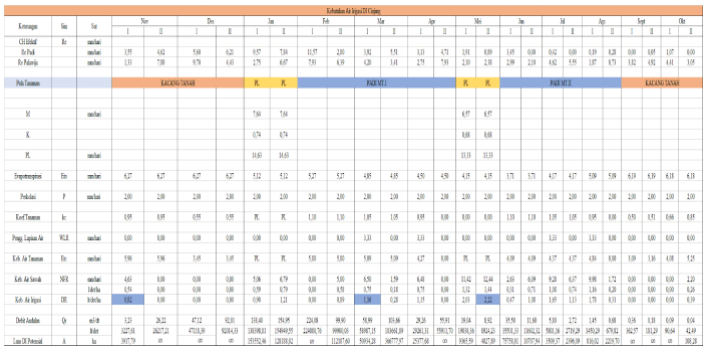


Figure 13. Irrigation Water Needs of Rice and Peanut Crops Alternative 3
Source : Calculation 2022

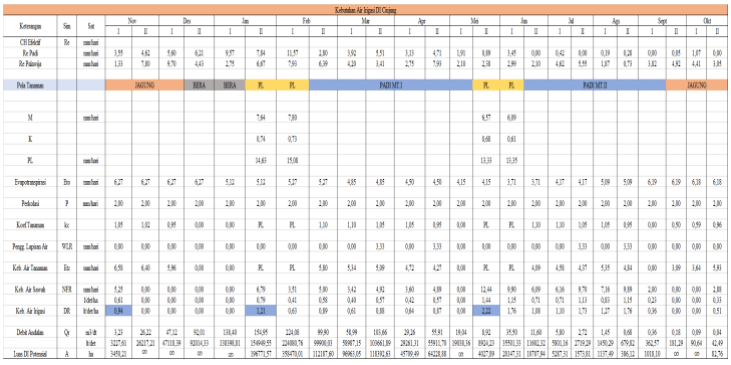


Figure 14. Irrigation Water Needs of Alternative Rice and Corn Crops 4
Source : Calculation 2022

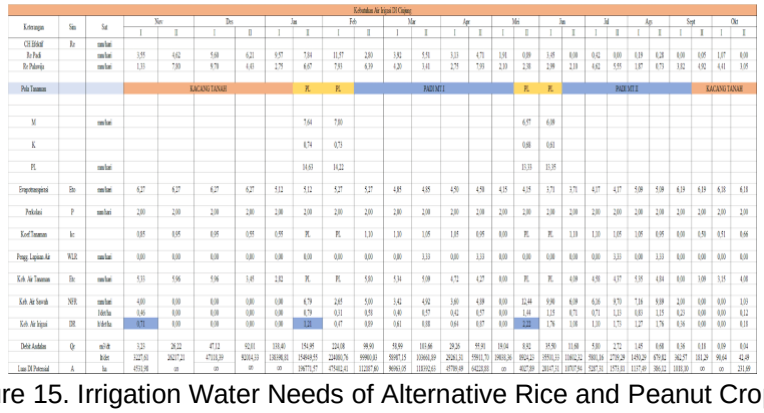


Figure 15. Irrigation Water Needs of Alternative Rice and Peanut Crops 4
Source : Calculation 2022

4.5 Analysis of Farm Business Results

The results of the Farming Business are the result of a farmer's net profit from the harvesting process. Revenue is production minus production costs, which brings you a net profit [18]. The performance of agricultural production in each rice field is multiplied by the price of its products. The following is an analysis of the results of farming:

Table 1. Production Yield and Production Cost per Hectare

	RICE	CORN	PEANUT
Yield Production (Rp/Ha)	IDR 36,000,000	IDR 18,000,000	IDR 11,400,000
Cost Production (Rp/Ha)	IDR 12,250,000	IDR 8,000,000	IDR 6,750,000
Profitability (Rp/Ha)	IDR 23,750,000	IDR 10,000,000	IDR 4,650,000

4.6 Planting Pattern Optimization

- Mathematical Model Optimization

  Based on the results of the analysis of water needs for each alternative and the mainstay denit so that it becomes an input for linear programs to obtain optimal planting pattern results.

➢ Purpose Function

Maximize

By Land Area

Zmaks = (XA1. YA1) + (XB1. YB1) + (XC1. YC1) + (XD1. YD1)

➢ Constraint Function

a) Mainstay Debit

DR ≤ Q

b) Maximum Area

YA1 ≤ A

YB1 ≤ A

YC1 + YD1 ≤ A

Where, Total = 21,350 Ha

➢ Non Negativitas

YA1,YB1,YC1,YD1 ≥ 0

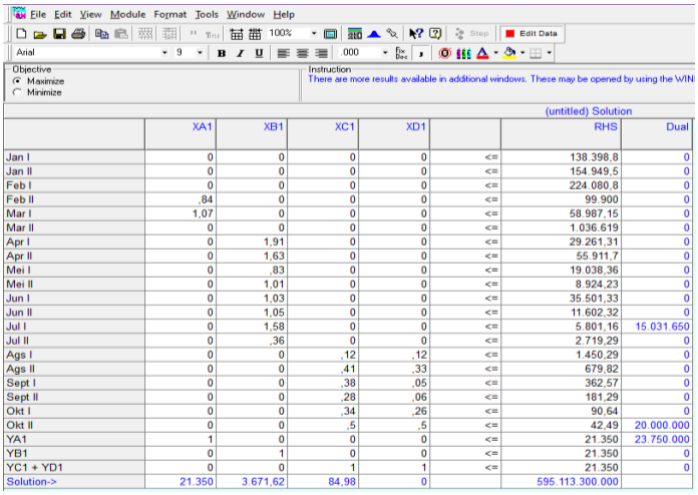
Information:

Zmaks = Maximum profit (Rp)
XA1 = Mt I rice profit (Rp/ha)
XB1 = Mt II rice profit (Rp/ha)
XC1 = Corn Profit (Rp/ha)
XD1 = Peanut Profit (Rp/ha)
YA1 = Rice Land Area MT. I (ha)
YB1 = Rice Land Area MT.II (ha)

YC1 = Corn Land Area (ha)
YD1 = Peanut Land Area (ha)
DR = Irrigation Water Needs Discharge (m3/sec/ha)
Q = Mainstay Discharge (m3/sec)

- Analysis of Optimization Results

  Optimization analysis is based on 2 objectives, namely maximum broad purpose and maximum profit using the AUXILIARY POM-QM for Windows 3 program.


File Edit View Module Format Tools Window Help

Objective: Maximize / Minimize

Instruction: There are more results available in additional windows. These may be opened by using the WIN

(untitled) Solution

	XA1	XB1	XC1	XD1		RHS	Dual
Jan I	0	0	0	0	<=	138.398,8	0
Jan II	0	0	0	0	<=	154.949,5	0
Feb I	0	0	0	0	<=	224.080,8	0
Feb II	,84	0	0	0	<=	99.900	0
Mar I	1,07	0	0	0	<=	58.987,15	0
Mar II	0	0	0	0	<=	1.036.619	0
Apr I	0	1,91	0	0	<=	29.261,31	0
Apr II	0	1,63	0	0	<=	55.911,7	0
Mei I	0	,83	0	0	<=	19.038,36	0
Mei II	0	1,01	0	0	<=	8.924,23	0
Jun I	0	1,03	0	0	<=	35.501,33	0
Jun II	0	1,05	0	0	<=	11.602,32	0
Jul I	0	1,58	0	0	<=	5.801,16	15.031.650
Jul II	0	,36	0	0	<=	2.719,29	0
Ags I	0	0	,12	,12	<=	1.450,29	0
Ags II	0	0	,41	,33	<=	679,82	0
Sept I	0	0	,38	,05	<=	362,57	0
Sept II	0	0	,28	,06	<=	181,29	0
Okt I	0	0	,34	,26	<=	90,64	0
Okt II	0	0	,5	,5	<=	42,49	20.000.000
YA1	1	0	0	0	<=	21.350	23.750.000
YB1	0	1	0	0	<=	21.350	0
YC1 + YD1	0	0	1	1	<=	21.350	0
Solution->	21.350	3.671,62	84,98	0		595.113.300.000	

Figure 16. Land Area Results and Alternative Profit Analysis 1 using POM-QM Application for Windows 3

Optimum land area results using the POM-QM for Windows 3 program generate data on the optimum surface area for each plant type for each alternative planting pattern and generate maximum profits based on agricultural analysis. The profit value is generated from the total area of each type of plant.

Table 2. Comparison of Irrigation Water Needs and Advantages of Planting Patterns for Each Alternative

Optimization Results	**Advantage**	**Irrigation Water Needs**
Alternative	**Rp**	**en/dt/ha**
1	IDR 595,113,300,000	1,91
2	IDR 556,274,900,000	2,03
3	IDR 527,109,800,000	2,22
4	IDR 517,333,900,000	2,22

In the table above, it can be seen that alternative 1 which has a maximum profit of Rp. 595,113,300,000 compared to other alternatives and the maximum irrigation water needs are 1.91 lt / dt / ha.

5. Conclusions

The conclusions that can be drawn from the results of the calculation and analysis of the study are as follows:

1. The amount of irrigation water needs for each alternative planting pattern is as follows:
   - Alternative 1: 1,91 lt/det/ha
   - Alternative 2: 2,03 lt/det/ha
   - Alternative 3: 2,22 lt/det/ha
   - Alternative 4: 2,22 lt/det/ha
2. In the planting pattern with alternative 1 starting planting December I, alternative 2 starting planting December II, alternative 3 starting planting January I, alternative 4 starting planting January II. The alternative planting pattern chosen is alternative 1 by producing a land area of MT I Rice covering an area of 21,350 ha, MT II Rice covering an area of 3671.62 ha, Palawija covering an area of 84.98 ha and a maximum profit obtained in a year of Rp. 595,113,300,000.

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