Optimization of A Dynamic Program for Water Resources Utilization in the Mambal Irrigation Area

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ABSTRACT

The Irrigation Area (D. I.) Mambal, which passes through Badung Regency, Denpasar City, and Tabanan Regency, is the largest irrigation water supplied by the Ayung River, covering an area of 5.963 Ha. Despite the Ayung River's substantial water potential, the D. I. Mambal experiences water shortages during certain months. This research aims to improve the effectiveness and efficiency of irrigation water use based on the Global Planting Management Plan (RTTG) using simulation methods and dynamic program optimization. Simulations were carried out under low conditions, normal and sufficient dependable discharges, using both existing and alternative RTTG. The objective function of the dynamic optimization seeks to maximize revenue gain from the applied RTTG. The existing cropping pattern at the beginning of planting in October showed an average proportion of fulfillment of water irrigation needs at 85%. Under the Alternative I condition, with planting beginning in November, the average proportion of fulfillment of irrigation water needs was 89%. In Alternative II conditions, with planting beginning in December, the average proportion of fulfillment of irrigation water needs was 87%. By optimizing the water discharge using the dynamic program, the irrigation profit for the existing cropping pattern (October) amounted to IDR 491,816,154,938. The highest profit was obtained using the Alternative II cropping pattern (December), totaling IDR 606,675,369,830. Meanwhile, the lowest profit was obtained in the Alternative I cropping pattern (November), which was IDR 360,767,292,361. The analysis showed that the Alternative II cropping pattern, starting with the first rice planting period in December, yields the most optimal results. The analysis considers the optimized water allocation and irrigation benefits obtained from the third cropping pattern.

Keywords: Dynamic program; irrigation; maximum profit; optimization

INTRODUCTION

The Irrigation Area (D.I.) Mambal which passes through Badung Regency, Denpasar City, and Tabanan Regency, is the largest irrigation water supplied by the Ayung River Watershed (DAS), covering an area of 5,963 Ha (Figure 1). Despite the Ayung River's substantial water potential, D.I. Mambal still experiences water shortages during certain months. In Bali, the Subak irrigation system is the basis for irrigation water management, including in D.I. Mambal following the *Tri Hita Karana* principle, which is quantitative research from a combination of aspects of irrigation technology in Subak and its social and religious culture. This process of irrigation is carried out by simulating reliable discharge and optimizing agricultural yields in the Subak irrigation scheme based on the initial

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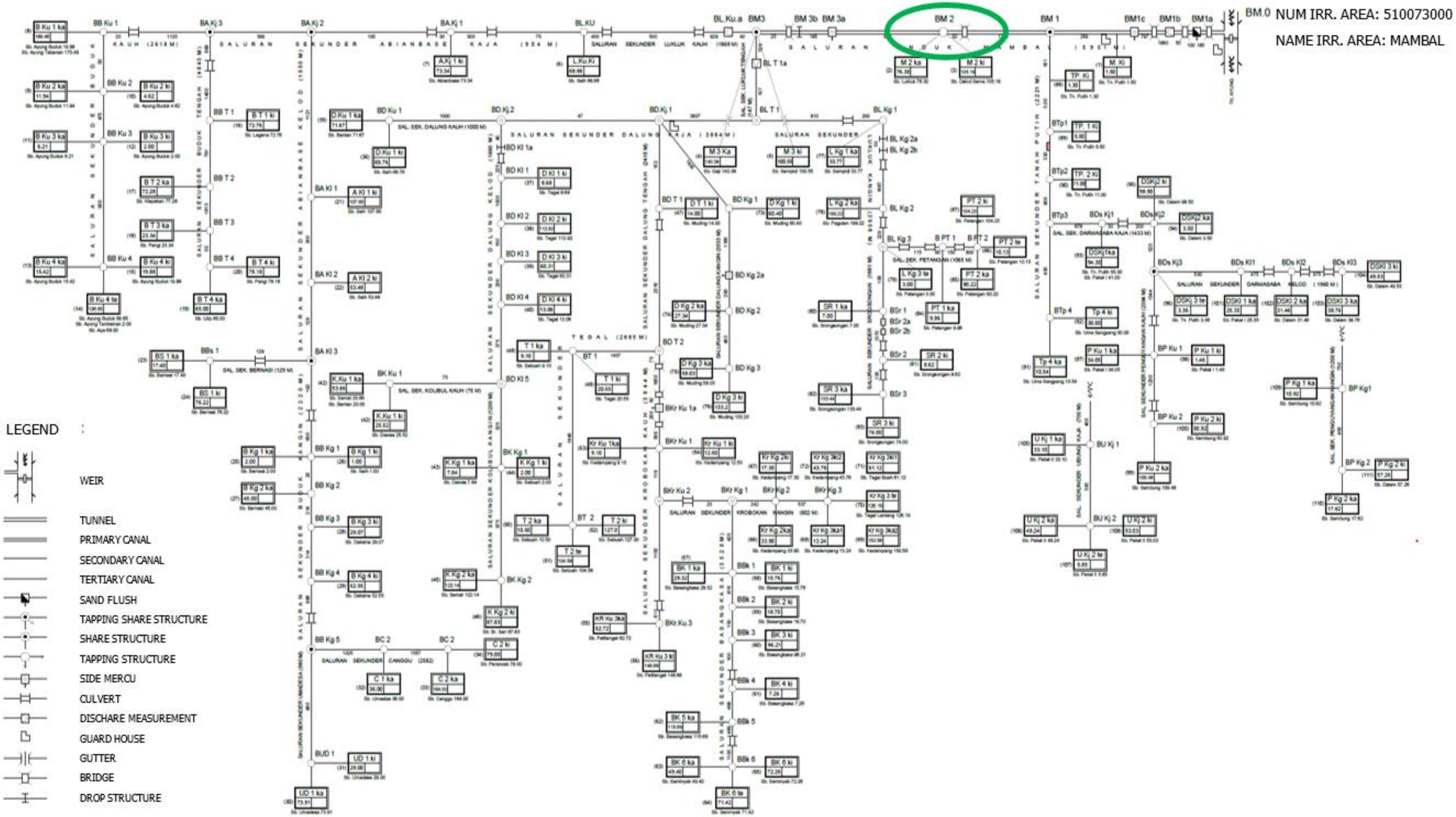

Figure 1. Scheme and water balance of the Mambal Irrigation Area (D.I. Mambal Discharge Registrar's Office, 2018)

shift in land preparation (*nyorog*). For effective operation and maintenance of the Subak irrigation network, farmers in the location practice one of three technical activities referred to as *Nyorog* (Yekti, 2017).

Fluctuations in water availability in D.I. Mambal influence the planned planting area in the Global Planting Management Plan (RTTG), which has been determined. In line with these findings, fears persist that the inability to meet water needs will lead to the non-realization of RTTG, thereby the outcome of D.I. Mambal did not go according to plan. Therefore, it is necessary to make plans and efforts to maintain planting productivity, namely by optimizing.

Optimization is a process of obtaining ideal results or achieving effective values (Septiadi & Nursan, 2021). Dynamic programming is an optimization method for allocating water distribution to several buildings in an irrigation network and is an approach program for optimizing a multi-stage decision process (Ritonga, 2016).

Hoesein et al. (2012) in Metro Hilir, carried out research on dynamic program optimization in the Metro Hilir Irrigation Area and obtained profits from the discharge flowed during the year amounting to IDR 7,689,357,989.67. In a normal year, IDR 7,846,078,284.11 was achieved, while IDR 8,430,727,741.74 was achieved in a low year and IDR 8,238,633,915.83 in a dry year. Out of these profits, there was an 11.86% increase in good years, 13.62% in normal years, 19.61% in low years, and 17.74% in dry years (Hoesein et al., 2012).

Ritonga (2016) carried out research on dynamic program optimization based on several analyses including rainfall, water needs, and planting time for food crops in the East Lombok Regency area, with projected results of 20.49% in increased production profits. Nalurita et al. (2017) in the Tengoro Irrigation Area, which is part of the Banyuwangi Regency area, carried out a dynamic program optimization on the distribution of irrigation water and the level of irrigation efficiency before the optimization efficiency was obtained at 86.52%. During the optimization of the stochastic dynamic program, an efficiency of 97.27% was obtained. Therefore, the maximum profit based on water availability in the rainy season (MH) amounted to Rp. 9,329,487,956.68 (an increase of 20.84% before optimization) and amounted to Rp. 8,143,711,211.34 in the dry season (MK) 1 (an increase of 0.85% before optimization)(Nalurita et al., 2017).

Another research on optimization using dynamic programs was carried out by Dyolaksti (2020) in the Candilimo Irrigation Area, Mojokerto Regency. The application of dynamic program optimization is carried out to irrigate a one-year planting period on the planting area in all scenarios, plus an average increase in planting area of 24.45 Ha. Although in some planting seasons, there is a decrease in area, by examining the one-year planting period, there is an increase in all planting areas as well as financial *benefits*. The results of the highest increase in financial *benefits* occur when the water discharge is minimum (Q 75.3%) in Scenario 1 (RTTG 2017) with optimization of the one-year planting period producing IDR 42,016,501,766 or increasing to IDR 1,754,149,248. In the case of normal water discharge (Q 50.7%), when the water discharge is sufficient (Q 26.0%), that is following the principle in Scenario 3 (no fallow in the planting pattern with a rice planting area at MT II of 400 Ha) the amount of profit per year in the layout pattern planting amounted to IDR 51,603,697,273 and IDR 67,333,133,339 respectively.

The conditions laid down for the use of irrigation water D.I. Mambal is limited and optimization methods have not been implemented. Therefore, it is necessary to optimize the use of irrigation water with a dynamic program in order to increase irrigation efficiency and effectiveness of water use by taking into account the benefits of production results. Therefore, the utilization of water resources in D.I. Mambal can be managed and used optimally and rice fields can be achieved with the best crop production benefits (Anton, 2014). This is followed by improvements in the distribution of irrigation water by optimizing water allocation, and the distribution of irrigation water to agricultural land, according to optimization results, hence the benefits of agricultural products can increase (Imron et al., 2022).

The optimization in this research aims to analyze irrigation water needs within the existing RTTG in D.I. Mambal. The next objective is to analyze the functional land area that can be used for agriculture in D.I. Mambal. Using a dynamic program, this investigation also carried out an analysis of the maximum profit for each debit allocated to the tapping structures (BB/*bangunan bagi*, BBS/*bangunan bagi sadap*, and BS/*bangunan sadap*) D.I. Mambal.

METHODS

Data

This research was began by preparing hydrological data, climate data, soil type, plant type, and existing cropping patterns. Furthermore, this data was processed together with data on the clean water needs of rice fields and the need for water intake to create a balance. Using a water balance analysis, the available water discharge was greater than the required water

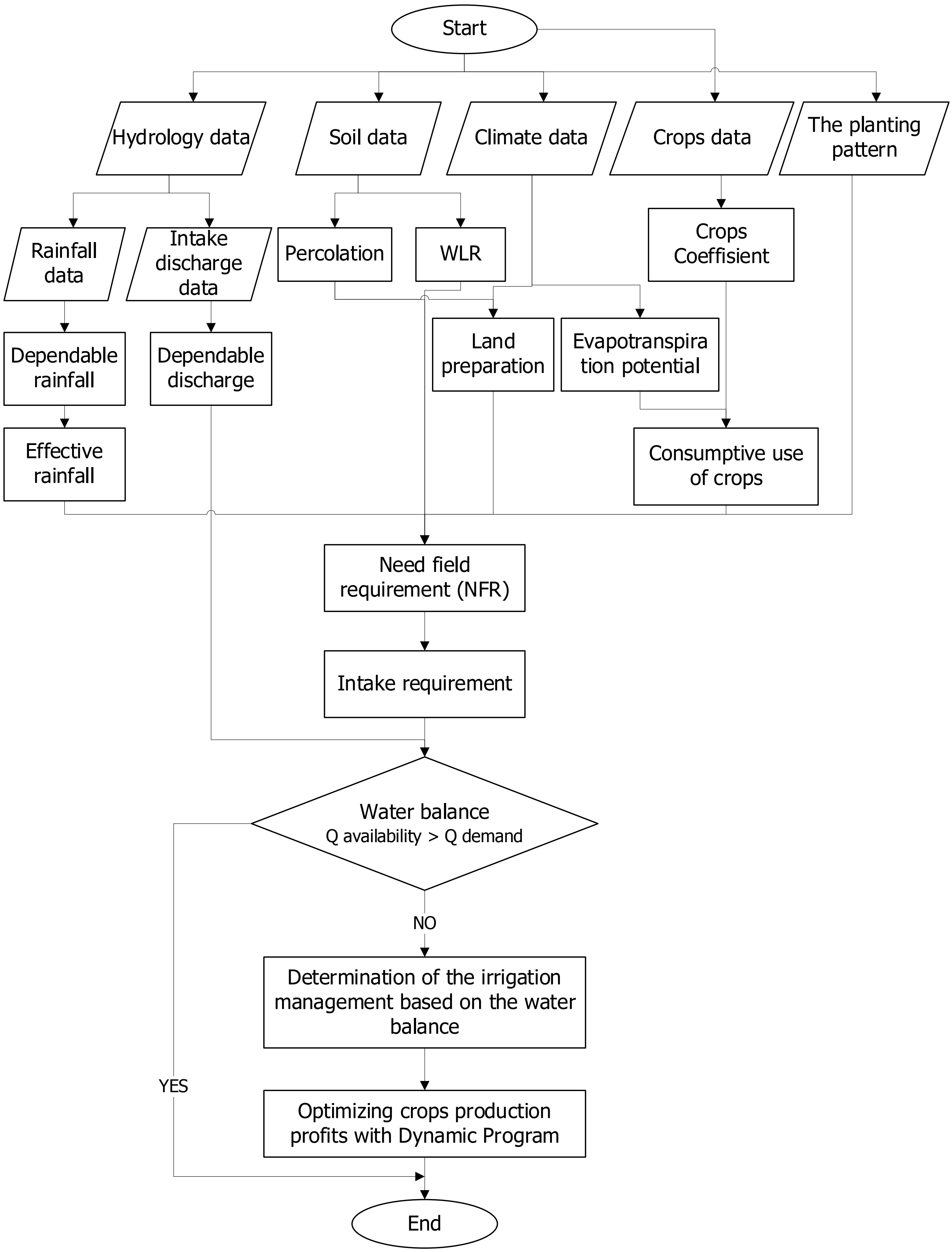

Figure 2. Research flow diagram

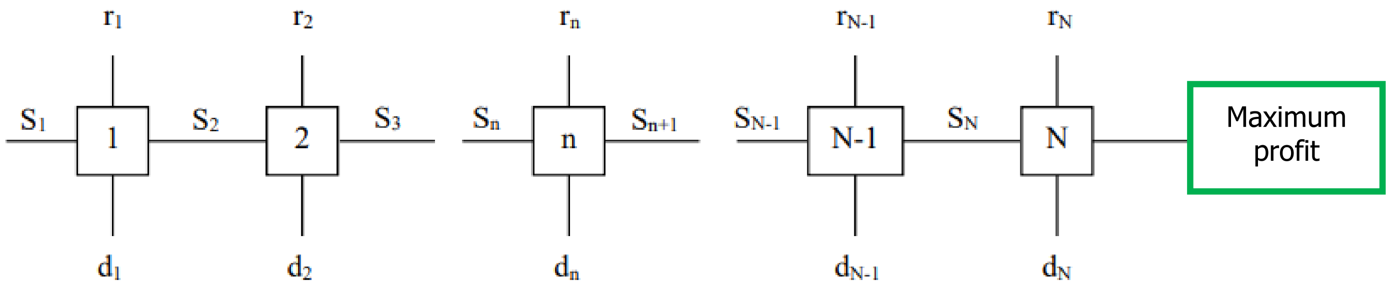

Figure 3. Serial dynamic problem sequence diagram

discharge. If the available water flow was not sufficient for the required water flow, then it is necessary to determine the water supply system. Consequently, this investigation is directed at optimizing water use with dynamic programs. The production costs were determined using an approach that has been carried out previously. Production and harvest costs for rice plants with production prices amounted to IDR 13,192,107 per Ha, while revenues amounted to IDR 32,743,011 per Ha, therefore profits amounted to IDR 19,550,904 per Ha (Dewi et al., 2017). Production and harvest costs for secondary crops with production prices amounted to IDR 1,693,355 per Ha, while revenues amounted to IDR 24,000,000 per Ha, therefore profits were worth IDR 22,306,645 per Ha (Namput et al., 2020).

Dynamic Program

The aim of using the principle to derive each mathematical algorithm from operations research is to achieve an optimum solution. In other words, the best solution is obtained using optimization techniques. Dynamic programming is one of the optimization techniques in the mathematical programming group (Anggraheni et al., 2018).

Dynamic programs use numerical methods for solving problems, and numerical methods involve the use of counting (arithmetic) operations such as addition, subtraction, multiplication, and division as a technique for solving problems. Using this method is optional because there are mathematical problems that cannot be solved analytically. Although some problems can be solved using analytical methods, the process is not efficient because it is often complicated and time-consuming. Numerical method solutions are in the form of numbers, while analytical method solutions are in the form of mathematical functions and are evaluated to obtain values in the form of numbers (Nalurita et al., 2017). Therefore, the use of analytical methods is suitable for limited and simple model problems, while the use of numerical methods is suitable for all types of problems (Rosidi, 2019).

Basic Concepts of Dynamic Programs in Irrigation Areas

One of the dynamic programs used is a deterministic program where the probability distribution is determined in sequential decision stages. The situation in some or all of the problem parameters is arranged in the form of random variables, solved by a deterministic dynamic program. This kind of situation is a reality everywhere, including in water systems (hydrosystems), therefore it is difficult to determine the exact value of the parameters (Linsley et al., 1996). The effect of changing *parameter* values for the optimal solution is examined using sensitivity analysis. This analysis uses a dynamic program to optimize the irrigation of each building, where the land irrigated by each building is planted with diverse plants, introducing variability (Dyolaksti, 2020).

The dynamic program begins by calculating economic data, followed by the profit function of the allocated discharge (D1) with the status variable (S1) which in this case is the discharge at the D. I. Mambal intake gate available continuously. With these variables, an alternative distribution of debits to S1 and D1 is obtained, after which the first maximum profit appears. Furthermore, these benefits function as a link between successive stages. If optimization at each stage is carried out separately, the decision result is called feasible for the entire problem, and the overall maximum profit value will be obtained (Figure 2).

Elements of Dynamic Program Models

Based on Figure 3, the dynamic program model part is described (Limantara & Soetopo, 2020).

Stage (n)

Stage (n) is decision-making as part of the problem. In dynamic programming formulation, there will be n stages when a problem is divided into n subproblems. Furthermore, the purpose of the stages in the multi-stage problem corresponds to different locations including the tapping structures (BB, BBS, BS) on the Main Mambal Channel.

Decision variable (d_n)

The Decision variable (d_n) is the size of the decision at each stage. The two decision variables are the amount of discharge allocated to each irrigation structure and the irrigation benefits obtained. Decision-making at each stage is then transferred to further decisions at the next stage, hence overall optimal results can be obtained.

State variable (S_n)

State variable (S_n) is a representation or explanation of the state in the form of a variable from the system connected to the nth stage. The status variable functions as a link between sequential stages, and if optimization at each stage is carried out separately, it produces feasible decisions on all problems. Furthermore, optimal decision-making in the remaining stages is carried out without having to check the effect of subsequent decisions on previous decisions. In the nth stage, the previous state variable (S_n) is the input state variable, then the previous state variable (S_{n+1}) is the output state variable. This status variable is the available discharge, which flows continuously by the implementation of the Mambal Dam intake gate operation and by the principle of channel water distribution in Subak irrigation.

Stage return (r_n)

Stage return (r_n) is a measure of the r scale of the decision results at each stage in equation 1. The result of this stage (stage return) is a function of the variables Sn (input status), Sn+1 (output status), and dn (decision), the process can be formulated in Equation 1 as follows.

$$r_n = r\,(S_n, S_n+1, d_n) \qquad (1)$$

Where r_n is a function of profit from debit in certain debit conditions from the *stage return*.

Stage transformation or state transition (tn)

Stage transformation or state transition (tn) is a relationship between the variable Sn (*input* status) which is expressed as a single value transformation,

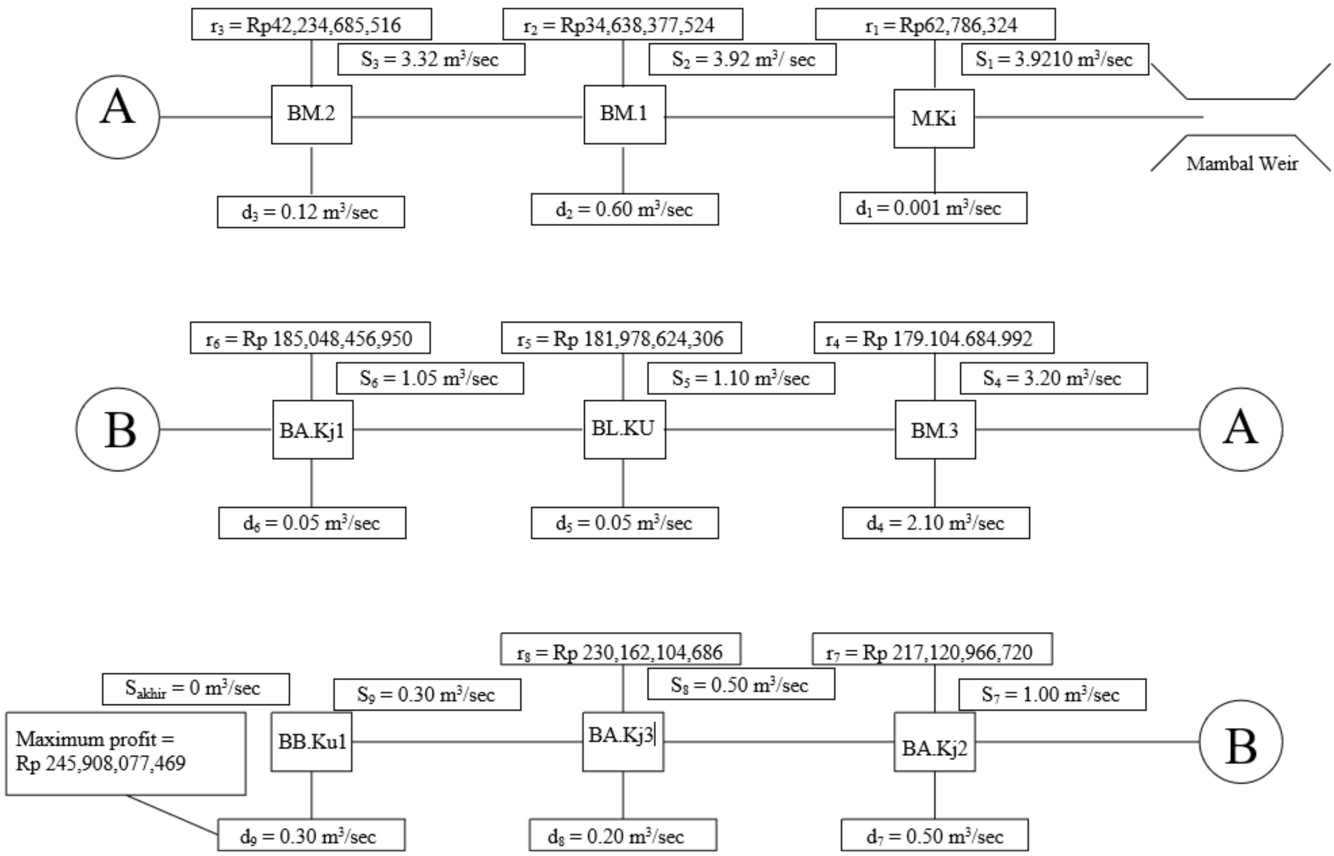

Figure 4. Example of optimizing water discharge allocation with a dynamic program at the primary Mambal Dam at the existing PTT in October at MK I

Table 1. Recapitulation of discharge and maximum profit from optimization of the existing dynamic program in the October Planting Pattern

No.	BB/BS/ BBS	MK I			MK II			MH		
		Max dependable discharge	Used discharge	Profit	Max dependable discharge	Used discharge	Profit	Max dependable discharge	Used discharge	Profit
		m^3/sec	m^3/sec	Rp	m^3/sec	m^3/sec	Rp	m^3/sec	m^3/sec	Rp
1	M.Ki	2.64	0.0006	62,786,324	1.78	0.0004	33,459,968	7.3	0.002	29,326,356
2	BM.1	2.64	0.4	34,638,377,524	1.78	0.3	18,459,417,937	7.3	1	16,178,959,587
3	BM.2	2.24	0.08	42,234,685,516	1.48	0.05	22,507,627,871	6.3	0.22	19,727,057,645
4	BM.3	2.16	1.3	179,104,684,992	1.43	0.9	95,448,126,357	6.08	4	83,656,558,635
5	BL.KU	0.86	0.03	181,978,624,306	0.53	0.02	96,979,700,603	2.08	0.09	84,998,923,703
6	BA.Kj 1	0.83	0.03	185,048,456,950	0.51	0.02	98,615,669,947	1.99	0.09	86,432,787,003
7	BA.Kj 2	0.8	0.4	217,120,966,720	0.49	0.3	115,707,690,545	1.9	1	101,413,276,175
8	BA.Kj 3	0.4	0.2	230,162,104,686	0.19	0.09	122,657,548,862	0.9	0.4	107,504,555,825
9	BB Ku 1	0.2	0.2	245,908,077,469	0.1	0.1	131,048,862,578	0.5	0.5	114,859,214,892
		Maximum profit		245,908,077,469	Maximum profit		131,048,862,578	Maximum profit		114,859,214,892

namely S_{n+1} (status *output*), and d_n (keputusan), the process is formulated in Equation 2 as follows.

$$S_{n+1} = t_n (S_n, d_n) \quad (2)$$

Where S_{n+1} is the state transition function of the decision variables S and d against time.

Stage transformation is a change in the availability of water discharge until it is distributed through each main irrigation building of the Mambal Canal. Analysis of dynamic *problem* sequence calculations based on elements one to six is carried out on a Microsoft Excel worksheet.

RESULTS AND DISCUSSION

In this research, the analysis carried out shows that in the existing PTT in the D. I. Mambal, namely Padi I - Padi II - Palawija, after calculating the need for water discharge in the rice fields, there is a shortage in several planting periods during dry and rainy season. Based on the debit deficiency data, discharge optimization is

Table 2. Recapitulation of discharge and maximum profit from dynamic program optimization Alternative 1 Planting Pattern November

No.	BB/BS/ BBS	MK I			MK II			MH		
		Max dependable discharge	Used discharge	Profit	Max dependable discharge	Used discharge	Profit	Max dependable discharge	Used discharge	Profit
		m^3/sec	m^3/sec	Rp	m^3/sec	m^3/sec	Rp	m^3/sec	m^3/sec	Rp
1	M.Ki	5.18	0.0013	29,326,356	2.68	0.0007	33,459,968	7.41	0.002	29,326,356
2	BM.1	5.18	0.70	16,178,959,587	2.68	0.40	18,459,417,937	7.41	1.10	16,178,959,587
3	BM.2	4.48	0.15	19,727,057,645	2.28	0.08	22,507,627,871	6.31	0.23	19,727,057,645
4	BM.3	4.33	2.80	83,656,558,635	2.2	1.40	95,448,126,357	6.08	4.00	83,656,558,635
5	BL.KU	1.53	0.06	84,998,923,703	0.8	0.03	96,979,700,603	2.08	0.09	84,998,923,703
6	BA.Kj 1	1.47	0.07	86,432,787,003	0.77	0.04	98,615,669,947	1.99	0.09	86,432,787,003
7	BA.Kj 2	1.40	0.70	101,413,276,175	0.73	0.40	115,707,690,545	1.90	1.00	101,413,276,175
8	BA.Kj 3	0.70	0.30	107,504,555,825	0.33	0.13	122,657,548,862	0.90	0.40	107,504,555,825
9	BB Ku 1	0.40	0.40	114,859,214,892	0.20	0.20	131,048,862,578	0.50	0.50	114,859,214,892
		Maximum profit		114,859,214,892	Maximum profit		131,048,862,578	Maximum profit		114,859,214,892

carried out using a dynamic program to determine optimal discharge, which can also produce maximum irrigation benefits.

The first rice planting period is 90 days starting in October, then the results of analysis and optimization of discharge using a dynamic program are then compared with the following month in the first rice planting period, namely in November as Alternative I and December as Alternative II. This process is carried out to examine which probability conditions are better than the existing PTT, providing alternative input for policies related to irrigation in the Mambal Irrigation Area.

The analysis comparing the existing PTT with two alternative PTTs showed that all three PTTs still faced water shortages insufficient to meet the needs of the rice fields. Therefore, water allocation optimization and irrigation benefits are calculated.

Based on two variables, namely the difference between the mainstay discharge and the demand discharge and irrigation profits, the optimization results showed that Alternative 2 PTT, starting planting in December, showed the best results. From backtracking based on the overall optimization results of applying the dynamic program in the Mambal Irrigation Area, an optimal discharge

Table 3. Recapitulation of discharge and maximum profit from alternative dynamic program optimization 2 December Planting Patterns

No.	BB/BS/ BBS	MK I			MK II			MH		
		Max dependable discharge	Used discharge	Profit	Max dependable discharge	Used discharge	Profit	Max dependable discharge	Used discharge	Profit
		m³/sec	m³/sec	Rp	m³/sec	m³/sec	Rp	m³/sec	m³/sec	Rp
1	M.Ki	5.41	0.0014	29,326,356	2.17	0.0006	62,786,324	3.92	0.001	62,786,324
2	BM.1	5.41	0.80	16,178,959,587	2.17	0.30	34,638,377,524	3.92	0.60	34,638,377,524
3	BM.2	4.61	0.17	19,727,057,645	1.87	0.07	42,234,685,516	3.32	0.12	42,234,685,516
4	BM.3	4.44	2.90	83,656,558,635	1.8	1.20	179,104,684,992	3.20	2.10	179,104,684,992
5	BL.KU	1.54	0.07	84,998,923,703	0.6	0.03	181,978,624,306	1.10	0.05	181,978,624,306
6	BA.Kj 1	1.47	0.07	86,432,787,003	0.57	0.03	185,048,456,950	1.05	0.05	185,048,456,950
7	BA.Kj 2	1.40	0.70	101,413,276,175	0.54	0.30	217,120,966,720	1.00	0.50	217,120,966,720
8	BA.Kj 3	0.70	0.30	107,504,555,825	0.24	0.11	230,162,104,686	0.50	0.20	230,162,104,686
9	BB Ku 1	0.40	0.40	114,859,214,892	0.13	0.13	245,908,077,469	0.30	0.30	245,908,077,469
		Maximum profit		114,859,214,892	Maximum profit		245,908,077,469	Maximum profit		245,908,077,469

allocation path was obtained which resulted in maximum crop production profits.

In the existing PTT (October) in Figure 4, the optimal discharge allocation path obtained in the tapping structures (BB, BBS, BS) M.Ki to BB. Ku 1 in the Mambal primary at MK I is 2.6406 m³/sec– 2.64 m³/sec– 2.24 m³/sec– 2.16 m³/sec– 0.86 m³/sec– 0.83 m³/sec– 0.80 m³/sec– 0.40 m³/sec– 0.20 m³/sec.

The optimal discharge allocation path obtained the tapping structures (BB, BBS, BS) M.Ki to BB. Ku 1 in primary Mambal on MK II is 1.7804 m³/sec– 1.78 m³/sec– 1.48 m³/sec– 1.43 m³/sec– 0.53 m³/sec– 0.51 m³/sec– 0.49 m³/sec– 0.19 m³/sec– 0.10 m³/sec.

The optimal discharge allocation path obtained in the tapping structures (BB, BBS, BS) M.Ki to BB. Ku 1 in primary Mambal on MH is 8.302 m³/sec– 8.30 m³/sec– 7.30 m³/sec– 7.08 m³/sec– 3.08 m³/sec– 2.99 m³/sec– 2.90 m³/sec– 0.90 m³/sec– 0.50 m³/sec.

Table 1 shows the results of the optimum benefits of water allocation from buildings for (BB, BS, and BBS) along a single line of the distribution system on the irrigation canal, reviewed according to Figure 1 (green circle). It provides the optimum yield benefits for each planting period in the dry season (MK) and rainy season (MH) under the existing PTT (start of planting in October). The

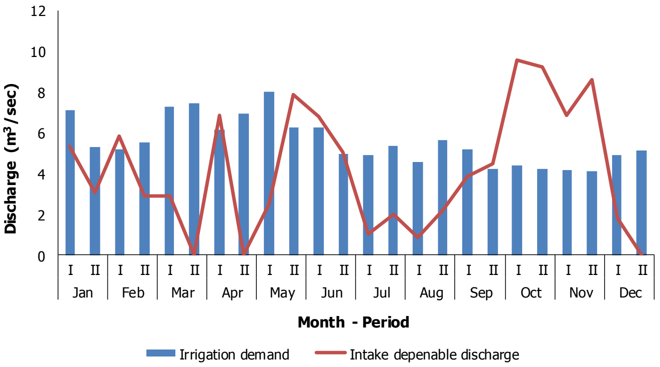

Figure 5. Water balance of Mambal Irrigation Area Alternative Planting Pattern 1

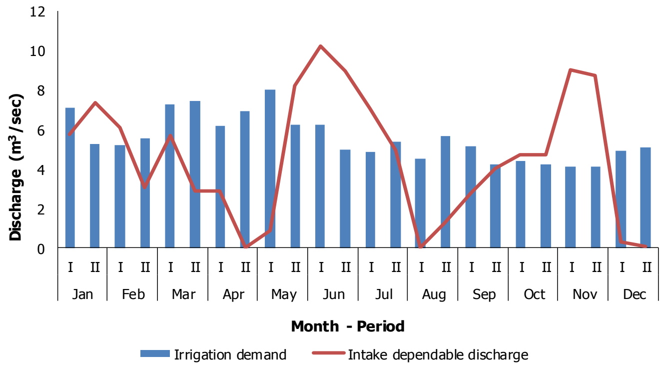

Figure 6. Water balance of Mambal Irrigation Area Alternative Planting Pattern 2

Table 4. Comparison of the results of the analysis of discharge needs and benefits of irrigation based on existing and alternative planting patterns in the Mambal Irrigation Area

The initial month of planting	Condition	Discharge shortage (m^3/sec)	Score	Advantages of irrigation (Rp)	Score	Average	Description
October	Existing	-33.957	1	491,816,154,938	2	1.5	-
November	Alternative 1	-21.276	3	360,767,292,361	1	2	-
December	Alternative 2	-25.369	2	606,675,369,830	3	2.5	Optimal

analysis shows that using existing PTT data in the form of Padi I – Padi II – Palawija starting from October in the Mambal Irrigation Area, a similar analysis will be carried out for November and December during the Rice I planting period in order to determine the differences in water discharge requirements in rice fields as well as assess irrigation profit.

The next analysis step was carried out on PTT with the start of planting Rice I in November as Alternative 1 and PTT with the start of planting Rice I in December as Alternative 2. The results obtained show a shortage of debit where the mainstay flow of Mambal Dam was not enough to meet the total debit needs in the rice fields. Therefore, the analysis progresses to the optimization stage using a dynamic program, where water allocation is optimized to ensure effective irrigation of rice fields through existing infrastructure such as dams and channels, the analysis calculates the maximum achievable profit. A recapitulation of the comparison of alternative PTT optimization results for alternative 1 (planting start in November) and alternative 2 (plant start in December) is presented in Tables 2 and 3 respectively.

The results of the analysis of Alternatives 1 and 2 (Figures 5 and 6) are recapitulated and compared to the existing PTT by examining the two variables. The first is the difference between demand discharge and mainstay discharge. whether there is a shortage or excess, and the second is the maximum profit obtained each planting season in the Mambal Irrigation Area. Out of the two variables obtained from each PTT, in this case, there are three PTTs. which are then assessed to see which one is optimal to be used as consideration for irrigation purposes in the Mambal Irrigation Area. both in terms of water discharge and irrigation benefits.

Based on the comparison of analysis results in Table 4. it shows that the existing PTT at the start of planting in October experienced a discharge shortage of -33.957 m^3/sec. The results of the previous analysis showed that the average percentage of fulfillment of irrigation water needs was 85% with the lowest percentage of fulfillment occurring in October Period II (MH), which was 36%.

In Alternative I conditions at the beginning of planting, in November there was a discharge shortage of -21.276 m^3/sec in available water compared to the required irrigation amount. The average percentage of fulfillment of irrigation water needs is 89% with the lowest percentage of fulfillment occurring in October Period I (MH) at 46%.

The ratio of available water to the water required for irrigation in Alternative II conditions at the start of planting in December experienced a discharge shortage of -25.369 m^3/sec. The average percentage of fulfillment of irrigation water needs is 87% with the lowest percentage of fulfillment occurring during November Period I (MH), namely 46%. Although the three PTTs experience a shortage of water discharge to fulfill irrigation requirements, the average percentage of discharge fulfillment for each PTT is still ≥ 85%. On the other hand. irrigation profits obtained from the existing PTT (October) amounted to IDR 491,816,154,938. The highest profit was obtained in PTT Alternative II (December) amounting to IDR 606,675,369,830. Meanwhile, the lowest profit was obtained in PTT Alternative I (November), IDR 360,767,292,361.

In general, it is known that PTT with the first rice planting period starting in December shows optimal results by taking into account the optimization of water allocation and the irrigation benefits obtained.

CONCLUSION

In conclusion, the average functional irrigation water discharge requirement in the existing PTT of the Mambal Irrigation Area was obtained as follows, 2.622 m^3/sec in the Dry Season I (MK I), 4.514 m^3/sec in the Dry Season II, and 4.957 m^3/sec during the Rainy Season (MH). These can be utilized on agricultural land in the Mambal Irrigation Area through dynamic program analysis based on an irrigation network scheme covering an area of 5,875 Ha. Furthermore, the percentage of the planting area used, namely Rice 1= 100%, Rice II= 100%, and Palawija= 50%, resulted in maximum profit per discharge allocated with this dynamic program to the tapping structures (BB, BBS, BS) the Mambal Irrigation Area for Existing PTT. The results were Rp. 245,908.,077,469 for Dry Season I (MK I). Rp. 131,048,862,578 for Dry Season II (MK II) and Rp. 114,859.,214,892 for Rainy Season (MH). Meanwhile, the maximum profit for PTT Alternative 1 in Dry Season I (MK I) amounted to IDR 114,859,214,892, IDR 131,048,862,578 for Dry Season II (MK II), and IDR 114,859,214,892 for the Rainy Season (MH). Moreover, the maximum profit for PTT Alternative 2 in Dry Season I (MK I) amounted to IDR 114,859,214,892. IDR 245,908,077,469 in Dry Season II (MK II) and IDR 245,908,077,469 in the Rainy Season (MH).

CONFLICT OF INTEREST

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