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Irrigation water economic valuation for irrigation water tariff basis

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Abstract. This research is intended to develop economic instruments to increase water use efficiency in the agricultural sector on the island of Lombok. In the short term, this study aims to analyze the availability and demand of season-based and commodity-based irrigation water, estimate the economic value of irrigation water resources both surface water irrigation and groundwater irrigation, determine the optimal amount of commodity-based irrigation water contributions, and analyze the factors expected to influence its implementation. Trend Analysis and Residual Imputation Approach (RIA) are used to analyze water demand and estimate the economic value of water. The results showed that the availability of water determines the cropping patterns applied in the study area. The upstream area has a pattern of planting rice for three growing seasons or paddy-paddy-palawija. Then in the middle area paddy-paddy-palawija or paddy-paddy- horticulture and Paddy-palawija for downstream areas. Food crops grown include corn, soybeans and peanuts. The contribution value of water in creating the production value of rice, corn, soybeans and peanuts amounted to Rp. 1581/m^3 (Rp. 14 720 691 /ha), Rp. 372 / m^3 (Rp. 2 611 812 / ha), Rp. 693/m^3 (Rp. 2 235 618/ha) and Rp. 1501/m^3 (Rp. 4 762 673 / ha).

1. Introduction

Irrigation water is a strategic agricultural resource. Different from fertilizers, seeds, and pesticides, which is limited in the production process. Water resources not only affect productivity but also affect the pattern of agricultural commodity exploitation. The demand for water resources for food production activities (especially rice) in the future will increase along with population growth and an increase in community income [1]. Increased production through extensification efforts is the focus solution for food demands when intensification efforts have stagnated. Land degradation caused by over-intensification syndrome as a result of the use of fertilizer doses that tend to exceed the needs [2]. Also decrease the quality of irrigation as a result of the degradation of irrigation network performance makes intensification efforts more difficult to do[3,4].

On the other hand, water demand for households, industry, tourism and environmental flows has also increased in line with population growth, increased economic activity and concern for ecological improvement. This causes increased competition for water use between sectors and regions and has an impact on the scarcity of water resources. This challenge began to receive serious attention in the last decade on the island of Lombok so that the efficient use of irrigation water is a strategic step to be taken.

Data from the Water Resources Information Center (2010) shows the availability of Lombok Island's water resources reaches 3941 million m3 per year, consisting of 2,912.0 million m3 of surface water and 1,029.0 million m3 of groundwater. While the need reaches 4164.03 million m3 per year, so the water balance has a deficit of 223.03 million m3 per year. Water consumption for irrigation purposes reaches 2318.87 million m3 per year or 55.69% of total water consumption. Technically, the allocation of irrigation water is carried out based on "standard" needs, which is 1.2 liters/ha/ sec or equivalent to 8,917 m3 per hectare per planting season [5]. The allocation is still higher than the optimal allocation of irrigation water [6].

The fact, the scarcity of water resources began to occur is shown by the deficit in the water balance and the high allocation standards applied by the *Office of the Kimpraswil* provide an opportunity to increase the efficiency of irrigation water use. From an economic view, the efficiency of using irrigation water is easier to increase if an appreciation of the economic value of irrigation water and becomes the basis for making decisions in the allocation of these resources. Then financial instruments can be applied to encourage the motivation of farmers to use irrigation water more efficiently. The economic instruments most discussed by experts are through market mechanisms. Incentives for efficiency are created through "user pays principle" or water pricing [7].

In general, this study aims to develop economic instruments for the efficient use of irrigation water at the farm level. Releasing the availability and need for season-based and commodity-based irrigation water. Analyzing the relationship between the availability of irrigation water and cropping patterns, cropping intensity and production levels in the upstream, middle and downstream areas of an irrigation network scheme, Estimating the economic value of irrigation water resources both surface water irrigation and groundwater irrigation, Determine the optimal amount of commodity-based irrigation water contributions and Analyzing the factors that are expected to influence its implementation.

2. Methods

2.1. Research methods and techniques

This research is a descriptive exploratory and comparative descriptive research-oriented to the development of economic instruments that can encourage increased efficiency in the use of water resources, and allocate water resources towards the use of more profitable commodities.

2.2. Determination of research locations and respondent farmers

The study uses descriptive exploratory methods. Data collection was done by survey techniques and measurements of water use discharge. Irrigation water valuation will be conducted on the use of irrigation water sourced from surface water. Consideration to facilitate the analysis of irrigation water flow selected paddy fields that received water flow from the Batujai Dam, Central Lombok Regency. The study area is grouped into three irrigation then chose Batujai Village, Darek Village and Desa Ranggagata as a research area. Upstream areas that receive relatively abundant flow, middle areas receive medium irrigation flow and downstream areas that receive relatively smaller irrigation water flow

Respondents selected by stratified random sampling by considering the elements of the distance of the land from the water source, the area of land ownership and the type of commodity being cultivated. The location is divided into Upper, Middle and Lower regions. The land ownership is categorized as wide land ownership (> 1 ha), medium land ownership (0.5 <L <1) and narrow land ownership (<0.5 ha). While the commodities of irrigation water users are rice, corn, soybeans and peanuts. Thus there are 32 categories (3 land distance categories x 3 ownership area categories x 4 commodity categories). The number of samples in each group was determined by three farmers so that in each research phase, there were 96 samples of farming units.

2.2.1. Stages of research and data analysis. Identification of physical performance of surface water irrigation farming includes aspects of cropping patterns, cropping intensity, and production based on location, and area of land ownership. The output of this stage is information on the performance of planting patterns and cropping intensity for one year.

2.2.2. Estimated economic value of irrigation water. Residual Imputation Approach (RIA - residual value calculation method) is used to estimate the economic value of irrigation water in a production process. The principle of RIA is to determine the shadow price of the use of inputs in a production process. The RIA method is approached using the principle of product exhaustion theorem, developed by Philip Wicksteed in the late 19th century (Young, 2005). The product exhaustion theorem shows that the total value of the product (TVP) can be divided entirely into the contribution of each input according to marginal productivity. The price of irrigation water can calculate from the production function that must be determined first. The production function describes the physical relationship between output and the inputs used in production. In this research, to produce the output of each commodity (Yi), Xi (land, seed, fertilizer, pesticide, and labor) production factors and irrigation water (Wi) are used, the production function can be

$$Y_i = f(X_i, W_i) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Assuming that the input market and output market are perfectly competitive markets, the price is assumed to be fixed (given, because farmers are price takers) then the total value of the product is:

$$TVP = \sum_{i=1}^{5}\left(VMP_{X_i}\ X\ Q_{X_i}\right) + \left(VMP_{W_i} x\ Q_{wi}\right) \ \ldots\ldots\ldots\ldots(2)$$

TVP is the total value of the product. VMPXi is the marginal product value from inputs i (land, seeds, fertilizer, pesticides, and labor). VMPWi is the marginal product value from the use of irrigation water, and Q is the quantity of each of these inputs. TVP is the value of production or total revenue if all the output is sold. The marginal product value of an input is the product of the output price (Py) and the marginal physical product (MPP) due to changes in the use of inputs. MPP is obtained from the first derivation of the partial production function for each input (∂Y/(∂X_i)).
Assuming the farmer tries to maximize revenue (R) by considering the budget constraints (C) he has (max R = Py. Y (Xi, Wi) subject to C = PXi. Xi + PWi. Wi). The first derivative condition requires that the input Xi and Wi must be the same as the marginal value of the product, PXi = VMPXi so that:

$$TVP_y - \sum_{i=1}^{5}(P_{Xi}\ X\ \ Q_{Xi}) = P_{Wi}\ X\ Q_{Wi} \ \ldots\ldots\ldots\ldots\ldots (3)$$

From equation (3) the price of water can be formulated as follows:

$$P_{Wi} = \frac{\{TVP_y - \sum_{i=1}^{5}(P_{Xi}\ X\ Q_{Xi}\ )\}}{Q_{wi}}$$

2.2.3. Formulation of commodity-based irrigation fees. Commodity-based irrigation fees are irrigation water levies (tariffs) where the main components are calculated based on the shadow price and the volume of irrigation water used in farming. As stated earlier, community-based irrigation contributions consist of two parts, the main component and supporting components. The formula is as follows:

$$PW_{ij} = \underbrace{\overline{CW}}_{\text{Supporting Components}} + \underbrace{\sum_{T=1}^{t}(W_T * A_{ijT}}_{\text{Main Components}}$$

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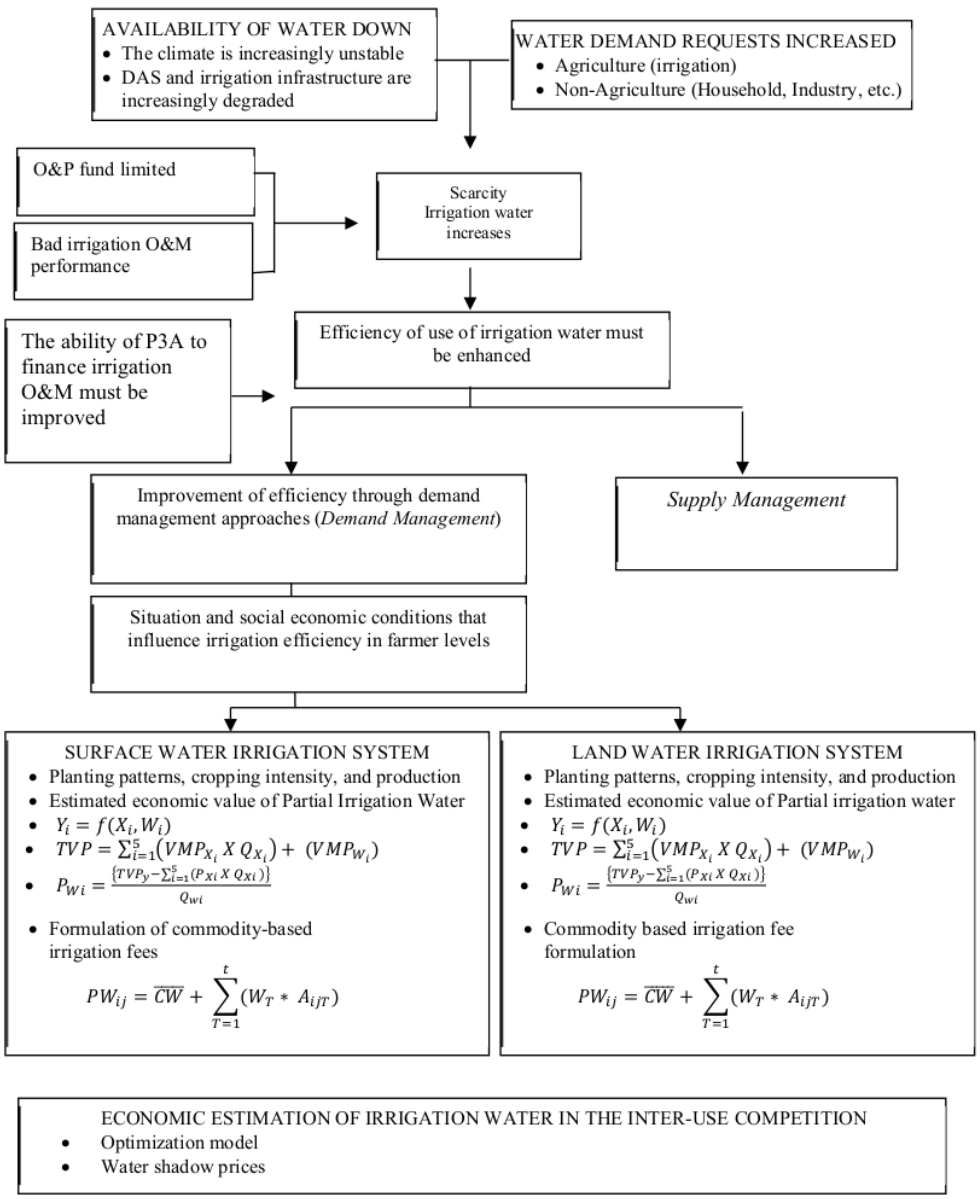
Which:

PW_{ij} = Value of commodity-based irrigation fees for commodity i group cultivated in period j
$\overline{CW}$ = Irrigation costs of supporting components whose value per hectare is fixed; determined based on the results of the group agreement (P3A)
W_T = Price of irrigation water shadow in T season
A_{ijT} = Irrigation water used during season T in commodity i farming which is cultivated in period j
T = Period of operation for one production cycle (unit of time is season)

2.3. *Reseearch framework*



3. Results and Discussion

3.1. Profile of water resources on the island of Lombok

The use of water on the island of Lombok is sourced from surface water and groundwater. Surface water is water that is above the surface of the earth that can come from rainwater runoff or streams that flow through rivers, canals, or accommodated in lakes and dams. Lombok Island Surface Water Management is grouped into 4 River Basin Sub-Units (SSWS), namely Dodokan, Jelateng, Menanga and Putih, which consist of a collection of Irrigation Areas (DAS) and dams.

In general, the northern part of Lombok Island is wetter than the southern part. This is because, in the Northern Region, there is Mount Rinjani with a relatively large forest area. Whereas the Southern Region is a lowland with the dominance of shrubs and forest vegetation with limited area. Springs, as one of the important sources for the availability of surface water, are spread in 3 SSWS except for SSWS Jelateng.

There are 95 springs on Lombok Island with a total discharge of 8 811 liters per second. Forty of them are in SSWS Dodokan with a total discharge of 4 951 liters per second, 53 are in SSWS Mananga with a total discharge of 3670 liters per second and 2 in SSWS White with a discharge of 190 liters per second. Surface water flows through the River Basin (DAS) or stored in a dam. The number of watersheds, dams, water potential and area of each SSWS are presented in Table 1 below:

Table 1. Profile of surface water sources in lombok island.

SSWS	Water Springs	Total DAS	DAM	Water potential (million m^3 / yr)	An area (km^2)
Dodokan	40	16	43	1,167	1,898.0
Menanga	53	22	26	532	817.9
Jelateng	-	14	10	198	608.3
Putih	2	62	2	1,015	1,228.5
Total	95	114	81	2,912	4,552.7

Sources: Bappeda, the Year 2010 and Balai Hydrology, 2014

There are 2 dams with large capacity, namely Batujai Dam with a catchment area of 169 km2 and water holding capacity of 25 million m3, capable of providing irrigation water for 3,250 ha of rice fields and Pengga Dam with a catchment area of 340 km2, water holding capacity of 27 million m3 with irrigation water services covering an area of 3,585 ha of rice fields. The two dams are located in Desa Batujai and Pelambik Kecamata Praya Barat, Central Lombok District. Besides, in dams, surface water is also traditionally accommodated by the community in small dams called embungs. The number of reservoirs, water capacity and area of irrigation services are presented in Table 2 below:

Table 2. Performance of government and community / village reservoirs on lombok island.

SSWS	Government DAM			Village DAM		
	Total	Capacity (M^3)	Irrigated area (Ha)	Total	Capacity (M^3)	Irrigated area (Ha)
Dodokan	13	54 559 495	9 729	30	2 760 558	6 795
Menanga	10	2 016 115	2 432	16	1 288 027	2 340
Jelateng	8	3 624 622	1 590	2	354 300	700
Putih	2	150 000	400	-	-	-
Total	33	60 350 232	14 131	48	4 402 885	9 835

Source: Bappeda, West Nusa Tenggara Province, 2014

Besides, there is also a lake, Lake Segara Anak, located on the summit of Mount Rinjani with a pool area of 10.06 km2, a depth of 200 m, and a water capacity of 1 375 million m3. Almost all rivers on the island of Lombok come down to Lake Segara Anak.

According to Law No. 7 of 2004, groundwater management is based on groundwater basins. There are 3 groundwater basins on the island of Lombok, namely Mataram-Selong whose territory covers Central Lombok with free water potential of 662 million m3 per year and depressed water of 8 million m3 / year and Tanjung-Sambelia Basin in the north with free water potential of 224 million m3 per year and depressed water of 22 million m3 / year while the southern part of Lombok (Sekotong-Awang) has not been designated as a groundwater basin.

The use of groundwater for irrigation is applied in dry areas where there is no technical or semi-technical irrigation network. Its territory includes the Eastern Islands of Lombok, North and South Lombok. The number of groundwater irrigation wells is presented in Table 3 below:

Table 3. Pump well (groundwater) irrigation data on lombok island.

SSWS	Total of wells	Wells conditions		Land area (Ha)
		Operation	Broken	
Dodokan	12	5	7	0.00
Jelateng	16	6	10	25.00
Putih	197	137	60	2,867.95
Mananga	102	78	24	1.427.02
Total	327	226	101	4,319.97

Source: NTB Kimpraswil official, 2015

The availability of water both surface water and groundwater is influenced by many factors, including rainfall, number of rainy days, air temperature, evaporation, soil type, area and type of vegetation, and other factors. From the data on the pattern of the number of rainy days and the amount of rainfall (Table 4), it can be concluded that the rainy season occurs in October-April and dry months in May-September.

Table 4. Average rainy days, rainfall, and air temperature on lombok island, 2014.

Month	Mataram			Lobar District			Loten District			Lotim District		
	HH	CH (mm)	SH (C°)	HH	CH (mm)	SH (C°)	HH	CH (mm)	SH (C°)	HH	CH (mm)	SH (C°)
1	21	201	27.35	21	201	28.00	10	165	NA	12	188	NA
2	18	258	27.80	17	258	27.80	16	174	NA	15	231	NA
3	23	70	27.35	23	70	27.35	21	199	NA	17	304	NA
4	19	54	27.50	19	64	27.50	14	187	NA	6	85	NA
5	9	142	27.00	10	142	27.00	2	144	NA	0	0	NA
6	10	64	26.30	10	64	26.30	2	163	NA	0	0	NA
7	1	0	25.75	1	0	25.75	1	11	NA	0	0	NA
8	5	37	26.35	5	37	26.35	2	64	NA	1	3	NA
9	4	47	27.55	5	47	27.55	6	28	NA	1	0.3	NA
10	17	89	28.45	17	89	28.45	12	133	NA	0	0	NA
11	25	368	27.90	25	368	27.90	22	234	NA	14	126	NA
12	21	100	28.10	21	100	28.10	13	149	NA	6	244	NA
Average	14.416	119.166	27.283	14.5	120	27.3375	10.08	137.58	NA	6	98.441	NA

Note: HH = Rainy Day CH = Rainfall SH = Air Temperature

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3.2. Estimation of water value in production of rice, corn, soybeans, and peanuts

The estimated economic value of irrigation water in a production process can be used Residual Imputation Approach (RIA - residual value calculation method). The principle of RIA is to estimate the shadow price (shadow price) from the use of inputs in a production process. The RIA method is approached using the principle of product exhaustion theorem, developed by Philip Wicksteed in the late 19th century. The product exhaustion theorem shows that the total value of the product (total value product - TVP) can be divided completely to the contribution of each input so that each input is "valued" according to marginal productivity. To calculate the marginal productivity value of irrigation water on each commodity can be done through the following stages:

3.2.1. Estimated production function. The production function describes the physical relationship between output and the inputs used in production. In this study, for example, to produce the production of each commodity (Yi) Xi factors of production (land, seeds, fertilizers, pesticides, and labor) and irrigation water are used. In this research, the production function is estimated in the Cob_Douglass function from with the following formula:

$$Y = \alpha X_i^{bi}$$

The form of Cobb-Douglass production function was chosen with the consideration that the form of the purpose is suitable to be applied in agriculture, the bi coefficient can show the elasticity of production which illustrates how changes in a product will occur with the addition of one percent of specific inputs, with other input conditions fixed. In addition, the Cob-Douglass function form can also be estimated with Ordinary Least Square (OLS) by transforming the Cob-Douglass function form into a linear function form in log/ln form, becoming:

$$Ln\, Y = Ln\, \alpha + b1\, Ln\, X1 + b2\, Ln\, X2 + \cdots + bi\, Ln\, Xi$$

Table 5. Regression coefficient estimates of rice, corn, soybean and peanut production functions.

Commodity	Variable	Coefficient	Standar error	Tstat	Pvalue
Paddy	EXP.INCPT	0.19065	0.726052	-2.282620	0.024756833
	Breeding	0.36103	0.057689	6.258225	1.149E-08
	Urea	0.13702	0.044575	3.073845	0.002781023
	TSP	-0.00686	0.088529	-0.077482	0.93840866
	Labor	0.12747	0.040831	3.121878	0.002387976
	Water	0.50511	0.060188	8.506570	2.73399E-13
	R^2	0.96051			
	Adjusted R	0.92257			
Corn	EXP.INTCPT	7.32790	1.254422	1.587732	0.115741086
	Breeding	0.91773	0.134116	6.842795	8.13507E-10
	Urea	0.35429	0.143347	2.471526	0.015273405
	Labor	-0.73978	0.096976	-7.628482	2.00895E-11
	Water	0.34497	0.091572	3.767199	0.000289383
	R^2	0.82846			
	Adjusted R	0.82108			
Soybean	EXP. INTCPT	3.74543	9.774492	0.135100	0.893659344
	Breeding	-0.18306	0.716052	-0.255651	0.800398353
	Urea	-0.06401	0.047021	-1.361348	0.186048974
	TSP	-0.04009	0.054548	-0.734883	0.469531294

	Labor	0.29525	0.270552	1.091296	0.285977653
	Water	0.34833	0.498589	0.698627	0.491500304
	R^2	0.51553			
	Adjusted R	0.41271			
Peanuts	EXP. INTCPT	2.23049	4.725255	0.169773	0.866611633
	Breeding	-0.70221	0.674915	-1.040442	0.308503143
	Urea	-0.05255	0.031398	-1.673714	0.107172403
	TSP	0.01391	0.033087	0.420545	0.677829463
	Labor	0.02721	0.126813	0.214579	0.831908015
	Water	0.56336	0.239652	2.350733	0.027288679
	R^2	0.50456			
	Adjusted R	0.46471			

The estimation results of the production function of rice, corn, soybean and peanuts are presented in Table 5. The level of rice and corn production is significantly affected by the level of use of seeds, urea fertilizer, TSP, total labor and water. While for soybean and peanut production, the relationship between all inputs and output is not significant. Likewise, from the value of R and Adjusted R, where the rice plants are consecutive values of 0.96051 and 0.92257. Corn plants respectively 0.82846 and 0.82108, which means that both the rice and corn production function models relatively good 96% and 82% are explained by independent variables (number of seedlings, level of use of urea fertilizer and TSP, amount of labor and water flowing to the land). Other factors explain only 4% and 18% of production levels.

In addition to having almost all variables not significantly affected (except water variables having a significant effect on peanut production), estimates of the function of soybean and peanut production also have relatively low R2 and Adjusted R values, which are only 0.51553 and respectively 0.41271 for soybeans and 0.50456 and 0.46471. The number of insignificant variables and the low R-value is thought to be caused by 1) the limited number of sample farmers who plant these commodities (only about 30% of sample farmers) so that the variation of data is relatively low; 2) Farming soybeans and peanuts according to farmers at risk of water fluctuations, if when planting soybeans and peanuts heavy rain and stagnant land, the plants will easily rot, therefore farmers tend to plant them in the 3rd planting season, and even then they consider only as a side effort, so that plant maintenance (including fertilization) is less intensive, so the production results are not as expected.

Production factors in rice plants have all positive signs, except for the use of TSP fertilizer, which has a negative sign, which means the addition of TSP fertilizer reduces production, but the effect is very small. The regression coefficient shows the magnitude of the production elasticity of each input used. Water usage, which has been considered a given factor, has the highest elasticity, which means the level of water use has the most significant influence on rice production, the production elasticity reaches 0.51, which means that if water use is increased by 1%, production will rise 0.51%.

Seedlings, fertilizer, labor and water use levels have a positive effect on corn production, as expected, except the amount of labor used has a negative impact, which is equal to - 0.74. The elasticity of water use production, even though the value is the smallest compared to the influence of other inputs, is positive with a value of 0.345, which means that if water use is increased by 1 percent, corn production will increase by 0.345 percent. For the production of peanuts and soybeans, although almost all inputs used have no significant effect, but especially water has a significant impact on peanuts and a positive impact on both. Amount of the production elasticity of water input each by 0.35 in soybeans and 0.56 in peanuts. This means that if water use is increased by 1%, soybean production rises by 0.35% and peanuts 0.56%.

3.3. Marginal products and marginal product value

Marginal product is a value that indicates how much production will increase if the input is added by one unit. The marginal product function is a partial derivative of the production function. Medium Marginal Product Value is obtained from marginal products multiplied by the selling price of the output. The equation of production function and the role of marginal products is presented in Table 6 below:

Table 6. Equation of production functions and marginal product functions of rice, corn, soybean and peanut commodities.

Information	Function
Paddy	
Production Function	$Y = 0.1907X_1^{0.361}X_2^{0.137}X_3^{-0.007}X_4^{0.127}X_5^{0.505}$
Marginal Product Function	$\frac{\partial y}{\partial X_5} = 0.0963X_1^{0.361}X_2^{0.137}X_3^{-0.007}X_4^{0.127}X_5^{-0.4949}$
Corn	
Production Function	$Y = 7.3279X_1^{0.9177}X_2^{0.3543}X_4^{-0.7398}X_5^{0.345}$
Marginal Product Function	$\frac{\partial y}{\partial X_5} = 2.5X_1^{0.9177}X_2^{0.3543}X_4^{-0.7398}X_5^{-0.655}$
Soybean	
Production Function	$Y = 3.7454X_1^{-0.1831}X_2^{-0.064}X_3^{-0.0401}X_4^{0.2953}X_5^{0.3483}$
Marginal Product Function	$\frac{\partial y}{\partial X_5} = 1.3046X_1^{0.361}X_2^{0.137}X_3^{-0.007}X_4^{0.127}X_5^{-0.6517}$
Peanuts	
Production Function	$Y = 2.2305X_1^{-0.7022}X_2^{-0.0526}X_3^{0.0139}X_4^{0.0272}X_5^{0.5634}$
Marginal Product Function	$\frac{\partial y}{\partial X_5} = 1.2566X_1^{0.361}X_2^{0.137}X_3^{-0.007}X_4^{0.127}X_5^{-0.4366}$

The average value of the use of each input, the value of marginal products for the use of irrigation water on each commodity can be calculated and shown in table 7. Information on the value of the MPP (Marginal Physical Product) water use gives an illustration of how much the production of each commodity will increase if Irrigation water is added by one unit (m3). Physically the increase in rice production due to the addition of 1 m3 of irrigation water is the highest compared to other commodities, which is 0.316 kg, with a value of Rp. 1581. The marginal product value, using the concept of residual value, illustrates the role of water in creating product value. By the principle of product exhaustion theorem, which was developed by Philip Wicksteed in the late 19th century [8], water should be valued according to its marginal product value. Therefore, each cubic meter of water used in rice farming is valued at Rp. 1581. Likewise, for its role in the agriculture of corn, soybeans, and peanuts, each use of 1 m3 of water in the farm must be valued at Rp. 372 for corn farming, Rp. 693 for soybean farming and Rp 1501 for peanut farming. From the marginal value of the four commodity products, the use of water in rice has the highest value, followed by peanuts, and the smallest is the use in corn farming. Although in terms of the addition of physical products due to the addition of 1 m3 of water to peanuts. The lowest production was added, only 0.107 kg / m3 of water, because the selling price of peanuts was relatively high (Rp. 14,000/kg), exploitation of peanuts gave quite a large value is almost equivalent to that produced by rice, which is Rp. 1501.

Table 7. Marginal products and marginal product values of rice, corn, soybean and peanuts commodities in the irrigation basin of batujai dam, 2015.

Information	Paddy	Corn	Soybeans	Peanuts
Land Average (ha)	0.54	0.3808	0,746667	0.6
Average Seedling (kg)	35.67	6,0204	71,60567	71.8
Average Urea (kg)	106.24	80,4082	47,33333	47.3
Average Fertilizer P (kg)	114.69	-	20,36667	20.3
Average Employment (HKO)	41.86	19,9694	111,9617	102.7
Air Average (m3)	5042.66	6082114.8	2408933	1989482.3
MPP	0.316	0.248	0.115	0.107
Output Price (Rp / kg)	5000	1500	6000	14000
VMP (Rp / m3)	1581	372	693	1501
TVMP (000Rp / Ha)	14 720	2 611	2 235	4 762

The contribution of water production factors creates a production of Rp. 14 720 000, - for rice plants, Rp. 2 611 000, - for corn plants, Rp. 2 235 000, - for soybean plants and Rp. 4762 000 for peanuts per planting. The upstream and middle regions with the Padi-Padi-Palawija cropping pattern contribute a production value of Rp 31 675 000 per year. Whereas the area that has a cropping pattern of Padi-Palawija-Bera (downstream areas) adding to the water production factor can reach Rp. 16, 955 000.-.

Water has high contributes to the value production of rice, corn, soybeans, and peanuts. On the other hand, the scarcity of water resources is beginning to be felt. The limited APBN for subsidies including irrigation and farmers only incur very minimal irrigation costs, which only provide rewards services (suwinih) to water guards (pekasih) of 40 kg of unhusked paddy harvested per hectare. Then in the future, farmers must be educated to pay irrigation fees. So that farmers do not feel burdened with these tariffs, the determination of irrigation water contribution rates can be done gradually.

The determination of irrigation water contributions can be done by way of comparison with the costs incurred by dry land farmers who obtain groundwater irrigation network services. Farmers receiving groundwater irrigation services must pay Rp 35,000 - 40,000 per hour. Irrigate an area of 1 ha, takes about 7-10 hours of irrigation, while for one growing season, rice, crops or horticultural crops require 6-7 times water. Therefore the farmer must pay around Rp. 1 470 000. By paying the irrigation water fee, the farmer still gets to, even if it is not as big as a paddy farmer. It is therefore natural that paddy farmers must pay irrigation water fees at least the same as those paid by farmers who use groundwater irrigation services.

The next problem is which institution will manage the irrigation contribution fund? Whether it is local government revenue or the acceptance of a Subak group (Water User Farmer Organization / P3A) and uses the funds to conserve water sources and repair and maintain irrigation networks. Farmers are only required to take care of the secondary network (in-take) only by way of cooperation. In the future, P3A can fund its repair and maintenance of secondary and even primary systems, so that dependence on government subsidies can gradually be reduced.

4. Conclusion

The research can be concluded as follows:

1. The water scarcity on Lombok Island has begun to be felt, where the Lombok Island Water Balance has experienced a deficit of 217.94 million m3 per year.
2. The use of irrigation water for rice plants is 1578.5 million m3 per year, with a total planting area of 177032 hectares and rice production of 896 674 tons per year. The use of water for corn plants reached 119.2 million m3, with a planting area of 29 370 ha and 92 763 tons of production. Meanwhile, the use of water for soybean plants was 131.55 million m3, with a planting area of 48 872 hectares and a production of 66 805 tons. As for the peanut crop, the

amount of water usage reached 29.01 million tons, with a planting area of 14 290 hectares and a production of 19 841 tons.

3. The availability of water affects the cropping patterns employed by farmers. In the Upper Area, the cropping pattern is Paddy-Paddy-Paddy or Paddy-Paddy-palawija. In the middle, the cropping pattern is Paddy-Paddy-Palawija or Paddy-Palawija-Horticulture (cantaloupe and watermelon). While in the downstream, the cropping pattern is Padi-Palawija-Bera.
4. The production function estimation gives the results that the seed production factor, Urea fertilizer, TSP fertilizer, the amount of labor and the amount of water supplied have a significant effect on rice and corn production. All of these factors have a positive sign except TSP fertilizer on rice and the amount of labor on corn production has a negative influence. The impact on soybean and peanut production is not significant unless the use of water in peanut production has a significant effect. The direction of influence is also positive except for seedlings, Urea and TSP fertilizer in soybean production and a negative relationship in the use of seeds and urea in peanut production.
5. Irrigation water resources contribute to rice farming by creating a value of product (value marginal product) of Rp. 14,720,000.- for rice plants, Rp. 2,611,000.- for corn, Rp. 2,235,000, - for soybean plants and Rp. 4,762,000.- for peanuts.

From some discussions conducted in this study, a temporary recommendation was formulated as follows:

1. It is expected that farmers using irrigation water to pay irrigation water contributions based on the value of the gift of water to the creation of product value. Because water has the highest amount compared to corn, soybeans and peanuts, farmers who work on rice must also pay higher. Next is farming peanuts, corn and soybeans.
2. Another alternative in determining the amount of irrigation water contributions is the opportunity costs. Farmers must incur that if the technical irrigation service is stopped. in the form of the amount that must be paid to get pump well irrigation services, where farmers must pay Rp 35,000- Rp 40,000 per hour or equivalent with IDR 1,470,000 per planting season

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