WATER SUPPLY AND CROPPING INTENSITY SIMULATION BASED ON SYSTEM OF RICE INTENSIFICATION (SRI) IN IRRIGATION AREA

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ABSTRACT

Water supply from the dam through the irrigation area often decreases. This is because of dam capacity reduced by sedimentation, hydrologic conditions, expansion of irrigation area, usage development of drinking water (household needs) and the channel efficiency decreases due to channel damage. Therefore, it is important to research the methods to conserve water usage. One croppingmethod is the System of Rice Intensification (SRI) that is developed in several areas. The case study is taken at Batujai dam in Lombok, West Nusa Tenggara, Indonesia. The research objective is to obtain a pattern of water supply, croppingintensity and the allocation of water reservoir using the SRI method compared with conventional method. Stages of research include data collecting of dam water capacity, hydrology, agriculture and inflow outflow of dam reservoir. Based on plant pattern and the availability of dam water, the data is analyzed and simulated to obtain water demand, the cropping intensity and water deposit for each year. According to analysis result obtained the croppingintensity average in the conventional method is equal 235%. Whereas SRI method can obtain the croppingintensity is equal 266%. The other result is in conventional method give deposit of dam water 1 MCM in average, while SRI method can achieve 10.8 MCM in average per year. Based on the croppingintensity and deposit of dam water, SRI method is more profitable and recommended.

Key words: ***Water supply, CroppingIntensity, Irrigation, SRI***

INTRODUCTION

There are an effective reduction in storage for about 6 MCM (million cubic meter) of Batujai Dam (from 18 MCM to 12 MCM), which give to impact a reduction of

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planting area in the dry season (Karya, UJ, 2005). However, this case demands to new operation innovation of water-efficient but still remain high production. In order to overcome the above problems, the steps necessary to save water, one of which is the application of patterns SRI (System of Rice Intensification).

Paddy cultivation SRI pattern is an innovation in the field of agricultural irrigation for saving water with high production. This technology is expected to anticipate the limited water resources and food shortages in the future (Nugroho, B.W., 2009).

The purpose of this study is to analyze the demands of irrigation water for rice cultivation with SRI pattern, determine the cropping intensity and get the balance of water reservoirs. The observation was done in Batujai Irrigation Area in Central Lombok regency is ± 20 km to the south east of Mataram, NTB (Kenzo, 2007).

LITERATURE REVIEW

SRI (System of Rice Intensification) is a technique of rice cultivation which can increase productivity by changing management of crop, soil, water and nutrients, and proved to have been able to increase rice productivity by 50% even in some places reached more than 100%.

Cultivation technique was first discovered in Madagascar between the years 1983-1984 by a French monk called FR. Henri de Laulani, S.J. He called “le System de Riziculture Intensive” abbreviated SRI and in the English language is popularly known as the System of Rice Intensification (SRI). SRI became world famous through the efforts of Norman Uphoff (Director of the Cornell International Institute for Food, Agriculture and Development). In 1997, Uphoff held a presentation in Indonesia which is the first opportunity SRI conducted outside Madagascar. The first SRI pattern trials in Indonesia have been conducted by the Institute of Agricultural Research and Development in Sukamandi, West Java. During the summer 1999, It can produce about 6.2 tons / ha and 8.2 tons / ha during rainy season 1999/2000. (DISIMP , 2006).

Conventional intermittent supply is done on an irrigation area due to the limited availability of water from an irrigation system (Basset, D.L., 1980). Whereas, the supply of water for SRI pattern is interrupted (intermittent), namely, water flowed to the paddy field until a certain height (standard). Then the supply stopped until the specified time limit from 5 to 10 daily. In the period, paddy fields ground will be cracked (Yamaji, 2007). The main concept of SRI is water supply intermittent in accordance with the amount and time needed by plants, so It can be water efficient.

Five technical prerequisites for SRI Intermittent supply can really well and not cause problems at the irrigation system as well as farmers, are as follows (BPTP-NTB, 2004). First, there is sufficient water in irrigation system which ensure the implementation of intermittent supply. Secondly, the conditions of irrigation water can ensure this comes to the paddy field with right quantity and time. Thirdly, the topography allows water from field can be drainage quickly and timely. Fourth, farmers have sufficient understanding of this technology. Fifth, operational and maintenance irrigation personnel should have the ability and seriousness of carrying out the task well and understand the differences SRI intermittent supply on conventional intermittent.

METHODOLOGI

In general, the research phase is divided into stages of data collection and analysis. At this stage of data collection include the gathering of secondary data, field reviews, field surveys, agricultural surveys, hydrological surveys, questionnaires and interviews. Agricultural surveys conducted through direct interviews and questionnaires by the farmer or the charging of farmers and village communities. Researchers also involved staff of Irrigation observer. Hydrological survey carried out by observing directly the condition of the catchment area, hydro-climatology station conditions and cross check with the dam functional staff and area residents. Activity analysis is based on field data or facts obtained in the data gathering phase. Works analysis consisted of Agricultural data Analysis of and Hydrological Data Analysis.

RESULTS AND DISCUSSION

Irrigation Water Demands

Irrigation water requirements include evapotranspiration, land preparation, percolation and infiltration, replacement of soil, water-level requirement, effective rainfall and irrigation efficiency.

Evapotranspiration is the total amount of water returned to the atmosphere from the surface of the soil, water bodies and vegetation, combined processes of evaporation, interception and transpiration (FAO, 1998). On average evapotranspiration that occurs every phase of the plant as shown in table 1.

Table 1 Mean Values of Evapotranspiration per Phase Growth

Phase of Growth	Mean of Evapotranspiration (mm/hour)	
	SRI	**Conventional**
Land conduct + Seed-bed	0.145	0.152
Growth	0.148	0.157
Growth of Generative-Reproductive	0.162	0.161
Growth of Reproductive - Perfection	0.166	0.175

Land preparation require water to saturate the soil so that it helps facilitate the processing of soil and maintaining soil moisture levels in accordance with the demands at the time of planting (FAO, 1996). Paddy needs to be saturated during the 30 days period of land preparation of about 300 mm or 10.0 mm/day. Whereas, the other crops (*palawija*) do not require land preparation. In very dry areas, to be not solid during, the land preparation and provide fit soil moisture, irrigation water added only about 50 mm.

Infiltration is the process of entry of water from the soil surface into the soil (unsaturated region). Percolation of irrigation water is lost in the reduction of agricultural land and irrigation efficiency.

Based on the testing / measuring the rate of percolation is performed on each 5 cm depth soil layer, showed the following table 2.

Table 2 Rate of Percolation in each soils

Depth of Land layer (cm)	Percolation Rate (mm/day)				
	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
5	0.292	0.254	0.269	0.263	0.268
10	0.0502	0.0437	0.0463	0.0453	0.0461
15	0.0233	0.0203	0.0216	0.0211	0.0215
20	0.0117	0.0102	0.0108	0.0105	0.0107
25	0.0093	0.0081	0.0086	0.0084	0.0086
30	0.0009	0.0008	0.00086	0.00084	0.00086
35	0.0005	0.00041	0.00043	0.00042	0.00043
Total	1.552	1.352	1.433	1.400	1.427

Source: Results of soil analysis in the laboratory of Soil Science, UNRAM, 2008

In general, it can be concluded for Vertisol soil type / grumosol on Batujai Irrigation area, the percolation rate is high enough in the layer 0-5 cm, which is characterized by relatively high percentage of sand in the soil layers more. Percolation rate is a significant influence in the calculation of irrigation water requirement appears only to a depth of 25 cm, on a deeper layer of soil percolation rate is very small and relatively no effect in the calculation of irrigation water requirements.

The result of the calculation the average percolation rate is 1.430 mm/day. To be reliability in service, the needs of irrigation water percolation rate used amounted to 1.50 mm/day in the Batujai Irrigation area.

Replacement of the water layer is needed in paddy cultivation to replace the layer of water needed during planting seeds and fertilizing (Larry, G.J., 1980). The quantity of replacement water used was 3.33 mm/day. Whereas, the cultivation of other crops do not require replacement of the water layer.

In the analysis of croppingwater demands for irrigation pattern of intermittent inundation SRI requires a unique condition. The demands not be included replacement of the water layer itself but coupled with high demand and demands water volume to fill the soil cracks.

Needs of water-inundation is a demand for replacement of water and patterns of SRI paddy fields resulting from percolation and the consumptive use as well as filling cracks of drying soil (Saka Buana Y.S., 2007).

The concept of water inundation patterns for paddy cultivation with SRI is to provide to the demands of plants and replace water lost due to percolation of water depending on the age of the cropping(planting coefficient, Kc) and soil type. High water-inundation is based on water demand of plant and percolation, also needs a dry land conditioning.

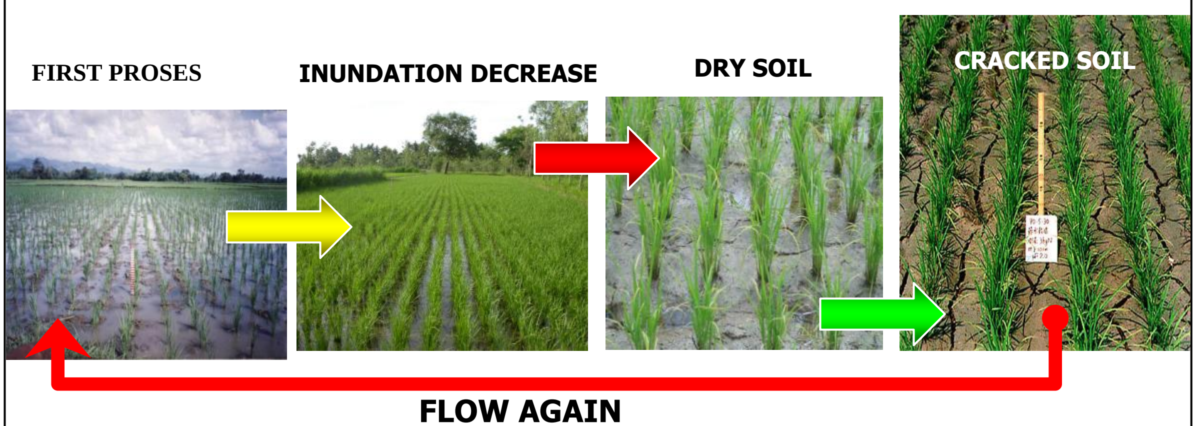

Figure 1 Cycle of water level for SRI pattern

Under conditions of water cycle system mentioned above need to be fit soil moisture conditions. In periods of water-inundation must consider factors of water losses in field (evapotranspiration and percolation), in order to reach the optimal soil moisture conditions for plant growth (IRRI, 1999).

Soil moisture of 15.72% is the wilting point conditions of paddy plants which in practice taken by the amount of 16% as security. The average condition of the soil moisture at the end of the period the water breaks at MT-1 and MT-2 is 20% - 25% with the condition of the soil crack width of cracks 3 cm and 8 cm depth, where to facilitate in field applications has been done measuring the volume of water demanded for logging and filling cracks in the ground which then converted in units of centimeters. For water inundation of 2 cm height required = 3.1 cm, 3 cm height required = 3.9 cm, 5 cm height is needed = 7.0 cm.

Effective rainfall (reff) was calculated according to KP standards-Irrigation, for paddy Reff = 0.70 x R80, for "palawija" crops Reff = 0.70 x R50. Where R80 is a debit or debit mainstay of dry years and the R50 is the discharge normal year (Soemarto, 1985 and Sosrodarsono et al., 1988).

Irrigation efficiency values taken in this study amounted to 61%, with details: efficiency at 90% level of primary channel, secondary channels and in 90% to 75% of tertiary canals. This condition can be achieved with the assumption that the main and secondary channels rehabilitated (Dirjen Pengairan, 1986 and Howel, T.A. et al., 1980).

Determination of irrigation water demanded by SRI pattern

Standard of inundation water height of SRI pattern planned base on planting age or DAT (days after planting). Based on the research results obtained as follows in table 3.

Table 3 Application Standard of Inundation Height of SRI Paddy Cultivation in NTB

No	Description	Unit	Days After Planting (DAP)									
			5	10	15	25	35	45	55	65	75	85
1.	Water level of MT-1	cm	2	2	5	5	3	3	3	3	3	3
2.	Water level of MT-II	cm	2	2	5	5	5	5	5	5	5	5

Results obtained by calculating the irrigation water requirement of optimum (early season of planting / land preparation in December-2) are as follows:

Table 4 Water Demands of Every Season Cropping Pattern Conventional and SRI

Planting Period	Conventional Pattern **(m3/ha)**	**SRI** Pattern **(m3/ha)**
MT-1	6.369 m3/ha	3.156 m3/ha
MT-2	11.734 m3/ha	6.100 m3/ha

Sources: Results of calculation

Analysis Results of Cropping Intensity and Water Balance Dam

After assessment of irrigation water demands and potential inflow of water resources, then the following will be presented a summary of the analysis of water balance in the DI. Batujai with a total area of 2816 ha of services:

In dry years or mainstay debit (Q80), cropping pattern and intensity that can be applied are: Paddy (100%) - Paddy (60%) & *Palawija* (40%) - *Palawija* (71%). Cropping intensity can be achieved is 243%, with the remaining water in the reservoir deposit end of the MT-3 is 10.80 MCM (effective storage). Secondary plant Crops in MT-2 is soybean and MT-3 is soybean.

In a normal year or 50% probability of discharge (Q50), cropping pattern and intensity that can be applied are: Paddy (100%) - Paddy (100%) – *Palawija* Crops (71%). Cropping intensity is 271%, with *palawija* crops are corn, MT-2 and MT-3 are a corn / soybean / peanut. The water deposit is 18.20 MCM in dam recervoir.

In wet year or probability of discharge of 20% (Q20), cropping pattern and intensity that can be applied are: Paddy (100%) - Paddy (100%) - Crops (71%). Cropping intensity is 271%, with arable crops are corn, MT-2 and MT-3 are a corn / soybean / peanut. Time water deposits is 18.02 MCM in dam reservoir.

Conclusion The water balance analysis on discharge conditions mainstay of irrigation patterns increased cropping intensity SRI, MT-2 of paddy by 17%, while the MT-3 *palawija* crops 24%. The remaining deposit is 10.80 MCM in dam reservoir, whereas the conventional pattern is only 1 MCM.

SUMMARY AND CONCLUSION

The summary and conclusion from this study are as follows:

a) The water demand for agriculture include evapotranspiration, land preparation, percolation and infiltration, replacement of the water layer, water-inundation, effective rainfall and efficiency channels.

b) Water demands of each planting period I (first) is 3156 m3/ha for SRI pattern, whereas the conventional pattern 6369 m3/ha. For the planting period II (second) in 6100 m3/ha SRI pattern, whereas the conventional pattern 11734 m3/ha.

c) By applying the pattern of SRI paddy cultivation, the dam function in the service of achieving the cropping intensity has an average of 266% with cropping patterns: paddy (100%) - paddy (73%) & other crops / *palawijo* (27%) – other crops (66%).

d) Water balance in the discharge conditions leading SRI patterns is the presence of plant period I deposit for next year is 10.80 MCM in dam, whereas the current cropping pattern save only 1 MCM.

e) Given that the SRI Paddy Cultivation has many advantages (water-saving, cost-effective, and high production) is expected to be spread more widely applied.

RÉSUMÉ ET CONCLUSION

Le résumé et la conclusion de cette étude sont les suivants:

a) Le besoin d'eau pour l'agriculture incluent l'évapotranspiration, la préparation des sols, la percolation et d'infiltration, le remplacement de la couche d'eau, l'eau des inondations, des pluies et des modes d'efficacité.

b) Le besoins en eau de chaque période de plantation I (première) est 3156 m3/ha pour le modèle SRI, alors que le modèle conventionnel 6369 m3/ha. Pour la période de plantation II (deuxième) en 6100 m3/ha modèle SRI, alors que le modèle conventionnel 11734 m3/ha.

c) En appliquant le modèle de l' SRI la culture du riz, la fonction de barrage dans le service de la réalisation de l'intensité culturale a une moyenne de 266% avec les modes de culture: riz (100%) - riz (73%) et d'autres cultures / palawijo (27 %) - d'autres cultures (66%).

d) l'équilibre de l'eau dans les conditions de rejet leader modèles SRI est la présence de la période de plantes-je déposer pour l'année prochaine est de 10,80 MCM barrage, alors que le modèle actuel de culture enregistrer seulement 1 MCM.

e) Étant donné que le SRI Paddy, la culture a de nombreux avantages (économies d'eau, rapport coût-efficacité, et la production élevée) devrait être plus largement appliquée.

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