Plot Scale Nitrogen Balance of Newly Developed Lowland Rice at Kleseleon Village Malaka District, Nusa Tenggara Timur

Neraca Nitrogen pada Skala Plot Pada Sawah Bukaan Baru di Dusun Kleseleon Kabupaten Malaka, Nusa Tenggara Timur

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Abstrak*:* Percobaan in sangat penting tidak hanya untuk menetapkan dosis Urea di tingkat petani pada sawah bukaan baru di Kabupaten Malaka, tetapi juga untuk memperkirakan berapa Urea yang harus disediakan di tingkat Kabupaten. Penggunaan pupuk hayati Smart yang mengandung *Azospirulum sp*., *Bacilus sp.* dan *Pseudomonas sp.* dapat meningkatkan penambat Nitrogen, menghasilkan zat pengatur tumbuh, dan melepas fiksasi fosfor dan menghasilkan zat anti pathogen. Percobaan neraca hara nitrogen pada skala petak dilaksanakan di Dusun Kleseleon, Kabupaten Malaka, Propinsi Nusa Tenggara Timur pada tahun 2014. Tanah yang digunakan termasuk Ustifluvent dengan kelembaban tanah ustik. Lima teknologi yang diuji pada percobaan ini meliputi T0: Praktek Petani sebagai kontrol, T1: NPK pada dosis rekomendasi + Kompos jerami, T2: NPK pada dosis rekomendasi + Smart + Kompos jerami , T3: ¾ NPK pada dosis rekomendasi + Smart + Kompost jerami dan T4: NPK pada dosis rekomendasi + Smart + Kompos jerami, dimana N, P dan K diberikan dua kali. Keseimbangan N dihitung berdasarkan selisih antara nitrogen yang masuk ke lahan sawah dengan nitrogen yang hilang dari lahan sawah. Untuk menghitung nitrogen yang masuk ke lahan sawah diperlukan data kandungan N pada Urea, dosis pupuk Urea, kadar nitrogen dalam kompos, takaran kompos, air irigasi dan kandungan nitrogen pada air irigasi dan air hujan. Sedangkan nitrogen yang hilang dari lahan sawah meliputi hasil gabah dan produksi jerami serta kadar nitrogen pada gabah dan jerami. Hasil penelitian menunjukkan bahwa terjadi neraca nitrogen positif pada semua perlakuan. Mengingat bahaya pencemaran lingkungan, keuntungan agronomis dan ekonomis yang didapat, pemberian Urea sebaiknya 100 kg Urea kg ha^{-1} $musim^{-1}$, dengan menambah kompos jerami sebanyak 3000 kg ha^{-1} $musim^{-1}$.

Abstract. *This experiment was very important not only to determine Urea rate at farmers' level of newly developed lowland rice fields at Malaka District, but to predict how much Urea should be available in the District level as well. Application of bio fertilizer namely Smart that contains Azospirulum sp, Bacilus sp and Pseudomonas sp.can improve the Nitrogen fixation, produce growth regulator, release phosphorous fixation and produce anti pathogen. Study on plot scale nitrogen balance was conducted in Kleseleon village, Malaka District, Nusa Tenggara Timur in 2014. The soil was classified as Ustifluvent with ustic moisture regime. Five treatments were tested including T0: farmers practices, T1: NPK at recommendation rate + Rice straw compost, T2: NPK at recommendation rate + Smart + Rice straw compost, T3: ¾ NPK at recommendation rate + Smart + Rice straw compost and T4: NPK at recommendation rate + Smart + Rice straw compost, in which N, P and K were split two times. Nitrogen balance was computed according to the differences between nitrogen gains and losses. To quantify total nitrogen inputs, nitrogen content in Urea, dosage of Urea, rate of compost, nitrogen concentration in compost, irrigation water supply, and nitrogen concentrations in rain water were collected. Output parameters included rice grains yield, rice straw production, nitrogen concentrations in rice grains and rice straw. The results indicated that surplus nitrogen balances were taken place in all treatments including the farmer practices. Taking into account the environmental, agronomical and economical consequences, the recommendation of Urea fertilizer rate is 100 kg ha^{-1} $season^{-1}$, plus about 3000 kg manure compost ha^{-1} $season^{-1}$.*

Introduction

It is coming to realise that the Indonesian Agriculture challenge a head especially in food is not only producing more rice with limited land and water, but application of proper fertilizers as well. Based on assessment of phosphorus and potassium inputs and outputs of newly developed lowland rice in Kleseleon village, Malaka District indicated that surplus phosphorus and potassium

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range from + 1.74 to + 1.93 kg P ha^{-1} $season^{-1}$ and + 20.48 to + 31.72 kg K ha^{-1} $season^{-1}$, meaning that SP-36 and KCl applications rate are more than enough to substitute phosphorus and potassium removed by harvest product. The best rate is shown by NPK at recommended rate + smart + rice straw compost, in which N, P and K are split two times: 50 % given at planting time and 50 % is added at 21days after planting. To keep better rice production and to improve soil function, P and K fertilizers application rate as much as 100 kg SP-36 and 100 kg KCl ha^{-1} $season^{-1}$ should be maintained with at least 3000 kg straw compost ha^{-1} $season^{-1}$ (Sukristiyonubowo *et al.* 2016). Now, we continue to determine nitrogen inputs and outputs in Kleseleon village to have the appropriate N, P and K balances.

Application of bio fertilizer namely Smart is suitable for rice plants. It contains (1). *Azospirulum sp* function as nitrogen fixation and produce growth regulator, (2). *Bacilus sp*. and *Pseudomonas sp* can release phosphorous fixation and produce anti pathogen regulator, (3). *Streptomyces* sp that can increase growth, seed ripening and reduces inorganic fertilizer practice up to 50 – 75 % (Elsanti 2017, Personal communication).

Recently, to meet rice growing demand in Indonesia, development of newly developed lowland rice fields in outside Java and Bali Islands is becoming one of the priorities of agriculture development program. Highly weathered soils, especially Ultisols and Oxisols are mainly granted for extending newly opened lowland rice fields, besides potential acid sulphate soil. These soils have many shortcomings including acidic with have low natural level of major plant nutrients, but they have Al, Mn and Fe in toxic levels (Sudjadi 1984; Sukristiyonubowo *et al.* 2011; Sukristiyonubowo *et al.* 2015). Theoretically, the nutrients level of these soils can be effectively improved with mineral fertilizers. However, for the smallholder farmers for instance farmers living in transmigration areas the costs to purchase the mineral fertilizers are problematic. The chemical fertilizers insufficient quantity is beyond the financial reach of smallholder farmers. Therefore, practically to sustain rice production, proper management practices using proper inorganic fertilizers based on nutrients balances are recommended (Sukristiyonubowo *et al.* 2016; Sukristiyonubowo 2007). Thus, it is needed to assess nitrogen input given to the field and nitrogen taken away from the field to get suitable nitrogen management.

For agriculture commodities, nitrogen balance can be defined as the differences between nitrogen gains and losses. The nitrogen inputs include nitrogen coming from fertilizer, returned crop residues, irrigation, rainfall, and biological nitrogen fixation (Sukristiyonubowo *et al.* 2016; Sukristiyonubowo *et al.* 2010; Sukristiyonubowo 2007). According to Sukristiyonubowo *et al.* 2010; Sukristiyonubowo (2007) and Uexkull (1989), the nitrogen outputs include removal through harvested biomass, erosion, leaching, and volatilisation. When the nitrogen removal is not replaced by sufficient application of fertilizer, soil mining takes place and finally crop production do not reach its potential yields and reduces.

For most upland and wetland crops, nitrogen balance can be developed at different scales, including (a) plot, (b) field, farm or catchment, (c) district, province, and (d) country scale, and for different purposes (Sukristiyonubowo *et al.* 2016; Sukristiyonubowo *et al.* 2010; Lefroy and Konboon 1999; Bationo *et al.* 1998; Hashim *et al.* 1998; Van den Bosch *et al.* 1998a and 1998b; Syers 1996; Smaling *et al.* 1993; and Stoorvogel *et al.* 1993; Miller *et al.* 1976). Many studies indicate that at plot, farm, district, province, and national levels, agricultural production is characterised by a negative nutrient balance (Sukristiyonubowo *et al.* 2010; Sukristiyonubowo 2007; Nkonya *et al.* 2005; Sheldrick *et al.* 2003; Cho *et al.* 2000; Harris 1998; Van den Bosch *et al.* 1998b). In upland crop, a long-term nitrogen experiment at plot scale in the dry land sloping area of Kuamang Kuning, Jambi Province, Indonesia provided confirmation that the nitrogen balance in the plot without input is - 4 kg N ha^{-1} yr^{-1}. However, this do not occur in the plots treated with a combination of high fertilizer application rate and *Flemingia congesta* leaves planted in a hedge row system (Santoso *et al.* 1995).

This paper discussed the nitrogen balance of newly developed lowland rice field at Kleseleon Village, Malaka District, with the aim to evaluate nitrogen input – out of newly developed lowland rice field It was hypothesized that by determining the proper nitrogen fertilizer, N (urea), followed by P (SP-36) and K (KCl) balance fertilizers application rate every planting season will be adapted and adopted by the farmers.

Metodology

Similar to study on phosphorous and potassium balances, the assement of nitrogen balance at newly developed lowland rice was conducted in the Kleseleon Village, Malaka District, Nusa Tenggara Timur Province, in 2014. Soil type was Ustifluvent with ustic soil moisture regime. The site was relatively flat and developed in 2011. Five treatments were tested namely T0: Farmer practices (as control), T1: NPK at recommendation rate + Rice straw compost, T2: NPK at recommendation rate + Smart + Rice straw compost , T3: ¾ NPK at recommendation rate + Smart + Rice straw compost, and T4: NPK at recommendation rate + Smart + Rice straw compost, in which N, P and K were split two times: 50 % was given at planting time and 50 % was added at 21 day after transplanting. These treatments were constructed according to the fact that soil fertility status was classified as low with bases soil (pH between 8.02 and 8.20), low soil organic carbon, and the farmers do not apply proper nitrogen fertilizer. The treatments were arranged in Randomized Complete Block Design (RCBD) and replicated three times. The plot sizes were 5m x 5m with the distance among plot was 50 cm and between replication was about 100 cm. NPK fertilizer used originated from single fertilizer namely urea, SP-36 (Super Phosphate) and KCl (Potassium Chloride). Based on the direct measurement with Soil Test Kits, the recommendation rate was determined about 250 kg urea, 100 kg SP-36 and 100 kg KCl ha^{-1} $season^{-1}$, while the common farmer practices rate was 100 kg urea and 50 kg SP-36 ha^{-1} $season^{-1}$. The Urea and KCl were split three times namely 50% at planting time, 25 % at 21 DAT (days after transplanting) and the last 25 % was given at 35 DAT. Rice straw compost of about three tons ha^{-1} were broadcasted a week before planting. Only in the treatment T4, N, P and K fertilizers were applied two times: 50 % at planting time and 50 % was given at 21 DAT. In the farmer practices, N was split two time, 50 % at planting time and 50 % at 21 DAT, while for P was given one time at planting time. A week before broadcasting the compost, one kg composite straw compost were taken and analysed for its chemical contents. Bio fertilizer namely Smart was applied as seed treatment with the rate of 10 kg ha^{-1} or 10 kg Smart for 25 kg seeds. The detail treatments are presented in Table1.

Ciherang rice variety was cultivated as plant indicator. Transplanting was carried out in the beginning of March 2014 and harvest in the end of June 2014. Twenty-one-day old seedlings were transplanted at about 25 cm x 25 cm cropping distance with about three seedlings per hill.

Rice biomass production including grains, straw, and residues were measured at harvest. When water content in rice grains were 16 %, the rice plants was harvested, and for measurement the constant weight of rice grains yield the water content of 14 % was used. Sampling units (1m x 1 m plot), were randomly selected at every plot. Rice plants were manually cut about 15 to 20 cm above the ground surface. The samples were manually separated into rice grains, rice straw, and rice residues. Rice residues included the roots and the part of the stem (stubble) left after cutting. Fresh weights of rice grain, rice straw, and rice residues were immediately weighed at harvest at each sampling unit. In input-output analysis, the rice residue was not considered as an input, as it is always remained in the field

To quantify nitrogen gain, data included nitrogen content in urea, rate of urea application, amount of organic fertilizer, irrigation water supply, nitrogen concentrations in irrigation waters, and in rainfall were collected. The output parameters were rice grains yield, rice straw production, nitrogen concentrations in rice grains and rice straw.

IN-1 (contribution of inorganic fertilizer) and IN-2 (contribution of organic fertilizer) was calculated based on the amount of mineral and organic fertilizers added multiplied by the concentration of nitrogen in urea and compost, respectively. IN-3 (contribution of irrigation water) was estimated according to water input and nutrients content in irrigation water. Water input was the different between incoming water and outgoing water. Incoming water was calculated by mean of water debit multiplied with how long the farmer open and close the inlet and outlet during rice life cycle. As the nutrient concentration from the outlet was not measured, thus the contribution of irrigation water was predicted based on water input multiplied by the nitrogen content in incoming

Table 1. The detail treatment of NPK fertilization, bio fertilizer and rice straw compost under this experiment
Tabel 1. Secara rinci perlakuan pemupukan NPK, pupuk hayati dan kompos jerami pada percobaan ini

Code	Treatment	Urea	SP-36	KCl	Smart/ Biofertiliser	Straw Compost
		....................................kg ha^{-1}				....
T0	Farmer Practices (as control)	100	50	-	-	-
T1	NPK at recommendation rate + Rice Straw Compost	250	100	100	-	3000
T2	NPK at recommendation rate + Smart + Rice Straw Compost	250	100	100	10	2000
T3	¾ NPK at recommendation rate + Smart + Rice Straw Compost	187.50	75	75	10	2000
T4	NPK at recommendation rate + Smart + Compost, in which N, P and K were split two times: 50 % were given at planting time and 50 % was added at 21 day after planting	250	100	100	10	2000

water. In this experiment, the pounding water layer was maintained about three cm. The water debit was measured using Floating method with stop watch. Detail procedure can be seen in Sukristiyonubowo (2007) and (WMO 1984). IN-4 (contribution of rain waters) was estimated by multiplying monthly rainfall volume with nutrient concentrations in the rain water. In a hectare basis, it was counted as follow (Sukristiyonubowo 2007; WMO 1984):

$$\text{IN-4} = \frac{\text{A x 10.000 x 0.80 x B x 1000}}{1000 \text{ x } 10^6}$$

Where:

- IN-4 is nitrogen contribution of rainfall water in kg N ha^{-1} $season^{-1}$
- A is rainfall in mm
- 10000 is conversion of ha to m^2
- 0.80 is factor correction, as not all rain water goes in the soil
- B is nitrogen concentration in rainfall water in mg l^{-1}
- 1000 is conversion from m^3 to l
- 1000 is conversion from mm to m
- 10^6 is conversion from mg to kg

To monitor rainfall events, data from rain gauge and climatology station of Malaka were considered. Rain waters were sampled once a month from a rain gauge in 600 ml plastic bottles and was also analysed according to the procedures of the Laboratory of the Soil Research Institute, Bogor.

Theoretically, the nitrogen loss can be through harvested product (rice grain and rice straw), leaching and ammonia volatilization. Due to leaching and ammonia volatilisation was not yet measured, thus the nitrogen loss was calculated only from harvested product. Consequently, the total nitrogen output was bit underestimated. As all rice grains are consumed, OUT-1 (nitrogen loss from rice grains) was estimated based on rice grain yield multiplied with nutrient concentration in the grains. OUT-2 (nitrogen loss from rice straws) was calculated according to the total rice straw production multiplied with nutrient concentration in the straw. It was considered as output because all rice straw was taken out from the field for making compost and the compost will be applied for coming planting season.

For the laboratory analyses, a rice plant from every plot with the best tiller number from the fifteen samples of plant height (vegetative growth) was chosen. Plants were sampled at harvest and were collected from every plot, one hill per plot. After pulling out, the plant roots were washed with canal water. For the laboratory analyses, the samples were treated according to procedures of the Analytical Laboratory of the Soil Research Institute, Bogor. Samples were washed with deionised water to avoid any contamination, and dried at 70^0 C. The dried samples were ground and stored in plastic bottles. Nitrogen was determined by wet ashing using concentrated H_2SO_4 (97%) and selenium (Soil Research Institute 2009).

Result and Discussion

The nitrogen balance at plot scale was constructed according to the different between nitrogen inputs and nutrient losses.

Nitrogen Gains

The nitrogen input originated from application rate of urea (IN-1), compost (IN-2), irrigation water (IN-3) and rain water (IN-4) and their nitrogen contributions were presented in Table 2 and Table 3. The IN-1 (contribution of inorganic fertilizer) ranged from + 45.00 to + 112.50 kg N ha^{-1} $season^{-1}$ depending on the treatment. It can be said that the higher the rate of urea fertilizer, the higher the nitrogen contribution to the input (Table 2).

Meanwhile, the IN-2 (contribution of straw compost) was about + 20.40 to + 30.60 kg N ha^{-1}, from the average of nitrogen contents in rice straw compost of 1.52 %, 0.93

Table 2. The contribution of inorganic fertilizer (IN-1) and compost (IN-2) to nitrogen input

Tabel 2. Sumbangan pupuk nitrogen (IN-1) dan kompos jerami (IN-2) terhadap nitrogen yang masuk ke sawah

Code	Treatment	Rate and contribution of urea (kg N ha^{-1})		Rate and contribution of compost (kg N ha^{-1})	
		Rate	IN-1	Rate	IN-2
T0	Farmer Practices (as control)	100	45	-	-
T1	NPK with recommendation rate + Rice Straw Compost	250	112.50	3000	30.60
T2	NPK with recommendation rate + Smart + Rice Straw Compost	250	112.50	2000	20.40
T3	¾ NPK with recommendation rate + Smart + Rice Straw Compost	187.50	82.50	2000	20.40
T4	NPK with recommendation rate + Smart + Compost, in which N, P and K were split two times: 50 % were given at planting time and 50 % was added at 21 day after planting	250	112.50	2000	20.40

% and 0.60 % N. Hence, besides the application rate of organic fertilizer, the nitrogen concentration in compost will influence the contribution.

So far, the nitrogen input from irrigation water (IN-3) was about 23.76 kg N equivalent to about 55 kg urea and input from rain water was about 8.74 kg N, equal to about 20 kg urea (Table 3). The significant contribution of rain water to N input is also reported in Belgium (Demyttenaere. 1991). These data provided information that their contributions were considered significant to the input.

Table 3. The contribution of irrigation (IN-3) and rain water (IN-4) to nitrogen input (kg N ha^{-1} $season^{-1}$)

Tabel 3. Sumbangan air irigasi (IN-3) dan air hujan (IN-4) terhadap nitroigen yang diterima sawah (kg N ha^{-1} $musim^{-1}$)

Treatments	water input, $NH4^+$ and NO_3^- concentration				Rain Water		
	Water input (L)	$NH4^+$ (mg l^{-1})	NO_3^- (mg l^{-1})	IN-3 (kg N ha^{-1})	Rainfall (mm yr^{-1})	$NH4^+$ (mg l^{-1})	IN-4 (kg N ha^{-1})
T0-T4	15 x 10^6	0.77	0.92	23.76	1200	0.91	8.74

T0: Farmer Practices (as control)
T1: NPK at recommnendatin rate + Rice straw Compost
T2: NPK at recommendation rate + Smart + Rice straw Compost
T3:¾ NPK with recommendation rate + Smart + Rice straw Compost
T4: NPK at recommendation rate + Smart + Rice straw Compost (N, P and K were split 2x)

Nitrogen losses

To calculate the nitrogen loss, data of rice biomass production namely rice grains yield and rice straw production and nitrogen concentration in rice grains and rice straw were gathered. The nitrogen loss was estimated from nitrogen taken away by rice grains (OUT-1) as all rice grains were consumed and nitrogen taken out by rice straw (OUT-2). The nitrogen loss is presented in Table 4.

Output-Input Analysis

The N balance of newly developed lowland rice field is presented in Table 5. In general, the results indicated that inorganic fertilizer (IN-1) contributed considerably to total nitrogen input in all treatments. The amounts varied from + 45.00 to + 112.50 kg N ha^{-1} $season^{-1}$ depending on the treatment. In the NPK at recommended application rate (T1 to T4) treatments, IN-1 covered from 61 % to 68 % of total N. Meanwhile in the farmer practices treatment (T0), it contributed 58 % to the total N inputs. Therefore, it can be said that inorganic fertilizer is the most important nitrogen sources to manage newly developed lowland rice field. It also means that the needs for mineral fertilizer

Table 4. Rice biomass production including rice grains and rice straw of Ciherang variety and total nitrogen loss from rice grain (OUT-1) and rice straw (OUT-2)

Tabel 4. Produksi padi dan Jerami varitas Ciherang dan total nitrogen yang terbawa bersama hasil panen padi (OUT-1) dan produksi jerami (OUT-2)

Treatments	Biomass Production (t ha^{-1} season-^{1})		N concentration (%)		N loss (kg N ha^{-1} $season^{-1}$)		Total N loss
	Rice Grains	Rice Straw	Rice Grains	Rice Straw	OUT-1	OUT-2	
T0	3.22 a	2.48 a	0.94	0.80	30.27	19.84	50.11
T1	5.67 b	3.50 ab	0.95	0.91	53,87	31.85	85.72
T2	5.27 b	3.37 ab	1.01	0.88	53.23	29.66	82.89
T3	4.97 b	3.97 b	1.00	0.90	49.70	35.73	85.43
T4	4.88 b	2.97 a	0.97	0.87	47.34	25.84	73.18

T0: Farmer Practices (as control)
T1: NPK at recommnendatin rate + Rice straw compost
T2: NPK at recommendation rate + Smart + Rice straw compost
T3:¾ NPK with recommendation rate + Smart + Rice straw compost
T4: NPK at recommendation rate + Smart + Rice straw compost (N, P and K were split 2x)

may be greater in the newly opened lowland rice areas than in the other wetland rice fields since the soil function including nitrogen content in the newly developed lowland rice field was low.

Rice straw compost (IN-2) was also an important nitrogen source, covering from 12 to 17 % of total N, depending on the application rate (Table 5). The IN-2 inputs are getting more important, when less or no inorganic fertilizer are applied and more organic fertilizer is added, like in semi and fully organic rice farming systems. The N supplied by compost equal to 30 - 66 kg of urea and will be more when the compost application rate is increase.

Although the amounts of nitrogen coming from irrigation water (IN-3) was smaller compared to the amounts of nitrogen originating from inorganic fertilizer (IN-1) and more or less comparable with organic fertilizer (IN-2), the contributions of IN-3 to total N inputs were still important, covering between 14 % and 30 % of the total N input. Increasing of inorganic fertilizer and compost applications rate will reduce the role of IN-3 to the total N input, like in T1 and T4 treatments (Table 5). IN-4 (contribution of rain water) was about 8.74 kg N ha^{-1} and also an important nitrogen source, particularly for N during the wet season, covering from 6 to 12 % of the total of N input (Table 5).

With respect to the output, depending on the treatments, around 57 % - 64 % of total N was taken up by rice grains and the rest by rice straw. This means that N was rather equally removed by rice straw and rice grains and will not be the same when the rice grains increase.

Assessment of nitrogen input and output showed surplus or positive nitrogen balance for all treatments (Table 5). The surplus ranged between + 27.39 and + 89.88 kg N ha^{-1} season^{-1}, depending on the treatment. The nitrogen balances in the T1, T2 and T4 were more surplus than in the other treatments. This may be explained by the increasing of nitrogen fertilizer application rate. It should also be noted that the N output will even be higher, when NH_3 volatilisation and leaching are taken into account.

The positive N balances in all treatments also demonstrated that the application rates of inorganic fertilizer were more than adequate to substitute N removed by rice grains and rice straw harvest. However, we do believe that when the rice grains increase and NH_3 volatilisation and leaching losses are taken into account, the balance will change.

To avoid luxury consumption and to protect environment as well as to reduce the production cost, nitrogen fertilizer application rate could be maintained at least 100 kg of urea ha^{-1} season^{-1} like given by the farmers plus adding 3000 kg of compost to keep and to sustain a higher rice grains yield, at least it is higher than 5.67 tons ha^{-1} season^{-1}.

Table 5. Output-input analysis of nitrogen at study nitrogen balance at plot scale of newly developed lowland rice field at Kleseleon site, Malaka District, Nusa Tenggara Timur Province (kg N ha^{-1} season^{-1})

Tabel 5. Analisis input dan output nitrogen pada percobaan Keseimbangan Nitrogen pada skala plot di Dusun Kleseleon, Kabupaten Malaka, Propinsi Nusa Tenggara Timur (kg N ha^{-1} musim^{-1})

Treatments	N INPUT (kg N ha^{-1} season^{-1})					N OUTPUT (kg N ha^{-1} season^{-1})			N Balance
	IN-1	IN-2	IN-3	IN-4	Total N INPUT	OUT-1	OUT-2	Total N OUTPUT	
To	45.00 58 %	- -	23.76 30%	8.74 12%	77.50 100 %	- 30.27 60 %	- 19.84 40 %	- 50.11 100 %	+ 27.39
T1	112.50 64 %	30.60 17 %	23.76 13 %	8.74 6 %	175.60 100 %	- 53.87 63 %	- 31.87 37 %	- 85.72 100 %	+ 89.88
T2	112.50 68 %	20.40 12 %	23.76 14 %	8.74 6 %	165.40 100 %	- 53.23 64 %	-29.66 36 %	-82.89 100 %	+ 82.66
T3	82.50 61 %	20.40 15 %	23.76 17 %	8.74 7 %	135.40 100 %	- 49.70 59 %	-35.79 41 %	-85.49 100 %	+ 49.91
T4	112.50 68 %	20.40 12 %	23.76 14 %	8.74 6 %	165.40 100 %	- 47.34 57 %	-25.84 43 %	-83,18 100 %	+ 82.22

Conclusion

Assessment of nitrogen inputs and outputs of newly developed lowland rice in Malaka District indicated the surplus balance from + 27.39 to + 89.88 kg N ha^{-1} season^{-1}, meaning that Urea application rate is higher than the nitrogen taken out by harvest products. Regarding the environmental, agronomical and economic aspects, the rate can be similar to 100 kg Urea ha^{-1} season^{-1} like done by the farmers with adding rice straw compost 3000 kg ha^{-1}season^{-1}. Therefore, the N, P and K applications rate for newly developed lowland rice field were about 100 kg Urea, 100 kg SP-36 and 100 kg KCl ha^{-1} season^{-1} with about 3000 kg ha^{-1} season^{-1} straw compost to keep the best rice production and maintain soil function.

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