

# Surface runoff and soil erosion in oil palm plantation of management unit of rejosari, PT Perkebunan Nusantara VII, Lampung

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**Abstract.** Soil and water conservation measures particularly water harvesting is very important in dry area of oil palm plantation. This research aims to study effectiveness of bund terrace and cover crop of *Nephrolepis biserrata* on surface runoff and soil erosion in oil palm plantation of Management Unit of Rejosari, PT Perkebunan Nusantara VII, Lampung. Soil erosion plots of 300 sqm with multislot divider were erected within blocks in Afdeling I and III of Management Unit of Rejosari, PT Perkebunan Nusantara VII, Lampung. The treatments were no bund terrace and *N. biserrata* (G0T0), with bund terrace but no *N. biserrata* (G1T0), no bund terrace but with *N. biserrata* (G0T1), and with bund terrace and *N. biserrata* (G1T1). Split block design in randomized block of research design was applied. The application of bund terrace and cover crop of *N. biserrata* significantly decreased surface runoff and soil erosion in harvested oil palm plantation. Cover crop of *N. biserrata* is more effective decreasing surface runoff and soil erosion than application of bund terrace.

## 1. Introduction

Nowadays oil palm plantation area in Indonesia is more than 12 millions hectare and mostly scattered in Sumatera and Kalimantan, partly in Sulawesi, and few in Jawa and Papua islands. Most of the oil palm estate company have not or limited, in fact implemented appropriate soil and water conservation measures. Therefore, people used to complain the oil palm company affecting flood and dried its environment. Some researches, however, show that applying bund terrace with vertical mulch could decrease surface runoff and soil erosion [1], [2], [3] due to incremental soil moisture and longer available when no more rainfall occurred. Meanwhile, [4] stated that some private oil palm companies have planted *N. biserrata* as cover crop. *N. biserrata* is weed that prefers shading where it grows well in harvested oil palm and it is possibly to be cover crops. In oil palm estate, *N. biserrata* is very useful since it could keep soil moisture in its environment. Moreover, *N. biserrata* is very suitable planted in long dried plantation (*dryspel*) that decrease the production of fresh fruit bunch until 20 percent in the following year.



This research aims to study effectiveness of bunch terrace and *N.biserrata* on surface runoff and soil erosion in oil palm plantation of Management Unit of Rejosari, PT Perkebunan Nusantara VII, Lampung.

## 2. Methodology

The research was carried out from August 2014 until May 2015 meanwhile measurement of surface runoff and sediment of eroded soil had been done in the beginning of rainfall season in October 2014 until April 2015.

The research was conducted in Management Unit of Rejosari, PT Perkebunan Nusantara (PTPN) VII, Natar municipality, District of South Lampung. Soil erosion plot was erected in Afdeling I (without bund terrace) and afdeling III (with bund terrace). Afdeling I consists of blok 296 (planting year 2005), blok 415 (planting year 1996), blok 457 (planting year 2001). Afdeling III consist of blok 295 (planting year 2005), blok 375 (planting year 1996), blok 377 (planting year 2001). Soil eroion plot of 300 sqm with *multislot divider* was constructed in the blocks wherein planting year as replication. Every plot is completed with sediment collector of 5 x 1 x 1 cum size and overflow collector of  $\pm 785$  litres volume. The treatment consists of plots of without bund terrace and *N.biserrata* (G0T0), with bund terrace but no *N.biserrata* (G1T0), without bund terrace but with *N.biserrata* (G0T1), and with bund terrace and *N.biserrata* (G1T1). Split block design in randomized block of research design was applied.

## 3. Result and discussion

Effectivity of bund terrace measure and cover crop of *N. Biserrata* in decreasing surface runoff is depicted in table 1 [5]. Percentage of surface runoff is ratio of surface runoff to rainfall amount in particular period. Effectiveness in decreasing surface runoff is relatively difference of a certain treatment with control treatment.

**Table 1.** Effect of bund terrace and *N.biserrata* on surface runoff in Management Unit of Rejosari, PTPN VII Lampung Selatan, October 2014 – April 2015.

Treatment	Surface runoff (mm/tahun)	Rainfall (mm/tahun)	Percentage of surface runoff (%)	Treatment effectivity (%)
G <sub>0</sub> T <sub>0</sub>	717.0a	1207.0	59.4	-
G <sub>0</sub> T <sub>1</sub>	143.2c	1077.0	13.3	80.0
G <sub>1</sub> T <sub>0</sub>	262.6b	923.0	28.5	63.4
G <sub>1</sub> T <sub>1</sub>	30.9d	1096.0	2.8	95.7

Different letter in the same coulum is significantly different of  $\alpha = 5\%$ ; G<sub>0</sub> = no bund terrace; G<sub>1</sub> = with bund terrace; T<sub>0</sub> = no *N.biserrata*; T<sub>1</sub> = with *N.biserrata*

Table 1 shows that portion of rainfall as surface runoff is significantly decreased by treatment of bund terrace and *N.biserrata*. Surface runoff of 59.4% of rainfall was found in the plot of no bund terrace and no cover crop of *N. biserrata* (G0T0). Application of bund terrace and the cover crop (G1T1) significantly and effectively decreased surface runoff until 2.8% from its rainfall. Meanwhile, surface runoff resulted from treatment of with bund terrace but no cover crop (G1T0) and without bund terrace but with cover crop (G0T1) were 28,5% and 13,3% of rainfall respectively, and it was significantly different with control (G0T0). Combination of bund terrace and cover crop treatment is the most effective (95.7%) decreasing surface runoff. The figures indicated that cover crop of *N.biserrata* is more effective decreasing surface runoff than bund terrace treatment. Research of [6] indicated that soil and water conservation measure i.e. bund terrace completed with vertical mulch in its ditch significantly reduced surface runoff [3] and erosion. Either bund terrace or silt pit application could storage annual soil moisture higher than no application of it in Management Unit of Rejosari, PTPN VII Lampung [7]. Positive effect of the applied treatment was able to prolonge soil moisture for

oil palm needed during dry season. [4] found plots that was planted *N. biserrata* retained soil moisture relatively stable until 90 cm depth particularly kept during dry season. Eventhough since 2005, there researches of [8], [9], [10], [3] have shown that the implementation of soil and water conservation effectively reduced run-off and increased the soil moisture storage and production of oil palm in Management Unit of Rejosari, PT Perkebunan Nusantara VII. Lampung. Similarly research of [11] showed that silt pit could increase soil moisture effectively in oil palm plantation.

The effect of bund terrace and cover crop of *N. Biserrata* on soil erosion is described in tabel 2. Effectivity of applied treatment to reduce soil erosion was indicated by the relative difference of particular treatment from control treatment. Measurement of soil erosion from collected sediment of the plot was only after heavy raining that transported soil sediment during rainy season [12].

**Table 2.** Effect of bund terrace and *N. biserrata* on soil erosion in Management Unit of Rejosari, PTPN VII Lampung Selatan, October 2014 – April 2015.

Treatment	Soil Erosion (ton ha <sup>-1</sup> )	Effectiveness in reducing Erosion (%)	Total Rainfall (mm)	No of Rain (day)
G <sub>0</sub> T <sub>0</sub>	56.4a	-	1168.8	44
G <sub>0</sub> T <sub>1</sub>	2.3c	95.9	1048.7	43
G <sub>1</sub> T <sub>0</sub>	29.8b	47.1	1134.4	43
G <sub>1</sub> T <sub>1</sub>	0.8d	98.6	1069.2	43

Different letter in the same coulum is significantly different of  $\alpha = 5\%$ ; G<sub>0</sub> = no bund terrace; G<sub>1</sub> = with bund terrace; T<sub>0</sub> = no *N. biserrata* ; T<sub>1</sub> = with *N. biserrata*

Treatment of bund terrace and cover crop of *N. biserrata* effectively and significantly reduced soil erosion (table 2). Application of bund terrace and cover crop (G<sub>1</sub>T<sub>1</sub>) could reduce soil erosion up to only 0.8 ton/ha, while application of bund terrace without cover crop (G<sub>1</sub>T<sub>0</sub>), without bund terrace but with cover crop (G<sub>0</sub>T<sub>1</sub>), and without bund terrace and cover crop (G<sub>0</sub>T<sub>0</sub>) eroded soil as much as 29.8 ton/ha, 2.3 ton/ha, and 56.4 ton/ha respectively. Cover crop of *N. biserrata* and bund terrace could retard surface runoff (table 1) that transported soil particles fewer. Surface runoff will be retarded and infiltrated more deeply by the cover crop [13], and finally reduce soil erosion effectively [14]. In the contrary, without the soil and water conservation measures, rainfall will detach soil surface particles and transported by surface runoff as soil erosion [15]. Table 2 shows that *N. Biserrata* (G<sub>0</sub>T<sub>1</sub>) is more effective in reducing soil erosion than bund terrace measure (G<sub>1</sub>T<sub>0</sub>) though the treatments significantly reduced soil erosion. Similarly, the researches of [3], [16] have shown that the implementation of soil and water conservation effectively reduces soil erosion [17], and economically feasible increases production of oil palm in Management Unit of Rejosari, PT Perkebunan Nusantara VII. Lampung. Even, [18] reported % soils is fully protected from erosion by ridge terrace and cover crop, whereas [19] found the treatment reduced soil erosion 1.8 times more effective than without treatment. Bund terrace was able to reduce soil erosion by 80-90% compared to control treatment [20].

#### 4. Conclusion

1. Application of bund terrace and *N. biserrata* as cover crop significantly decreased surface runoff and soil erosion in harvested oil palm plantation.
2. *N. biserrata* as cover crop was more effective individually in reducing surface runoff and soil erosion than bund terrace measure in harvested oil palm plantation.

## References

- [1] Muslim A S 2008 Efektivitas teras gulud dan rorak dalam mengendalikan aliran permukaan dan erosi pada perkebunan kelapa sawit di unit usaha Rejosari, PT. Perkebunan Nusantara VII, Lampung [skripsi] (Bogor (ID): Institut Pertanian Bogor)
- [2] Murtalaksono K, Siregar H H and Darnosarkoro W 2007 Model neraca air di perkebunan kelapa sawit (water balance model in oil palm plantation) *Jurnal Penelitian Kelapa Sawit* **14** 21-36
- [3] Murtalaksono K, Darnosarkoro W, Sutarta E S, Siregar H H and Hidayat Y 2009 Upaya peningkatan produksi kelapa sawit melalui penerapan teknik konservasi tanah dan air *J. Tanah Trop.* **14** 135-142
- [4] Ariyanti M, Yahya S, Murtalaksono K, Suwanto and Siregar H H 2016 Water Balance in Oil Palm Plantation with Ridge Terrace and *Nephrolepis biserrata* as Cover Crop *J. Tropical Crop Science* **3** 35-40
- [5] Ariyanti M 2016 Peranan Tanaman Penutup Tanah *Nephrolepis biserrata* pada Teknik Konservasi Tanah dan Air terhadap Neraca Air di Perkebunan Kelapa Sawit. [disertasi] (Bogor (ID): Institut Pertanian Bogor)
- [6] Brata K R, Sudarmo and Djojoprawiro P 1992 Pemanfaatan sisa tanaman sebagai mulsa vertikal dalam konservasi tanah dan air pala pertanian lahan kering di tanah Latosol Darmaga. Jurusan Tanah. (Bogor: Fakultas Pertanian IPB)
- [7] Pratiwi I 2008 Pengaruh guludan dan rorak terhadap produksi kelapa sawit di unit usaha Rejosari PTPN VII Lampung Selatan [skripsi] (Bogor (ID): Institut Pertanian Bogor)
- [8] Murtalaksono K, Siregar H H, Sutarta E S and Hidayat Y 2006 Effect of soil and water conservation on surface runoff in oil palm plantation (case of Rejosari. Lampung). Proceeding of International Oil Palm Conference on Optimum Use of Resources, Challenges and Opportunities for Sustainable Oil Palm Development. Denpasar, Bali. 19-22 June. p.340-343
- [9] Murtalaksono K, Sutarta E S, Siregar H H, Darnosarkoro W and Hidayat Y 2008a Penerapan teknik konservasi tanah dan air dan upaya penekanan aliran permukaan dan erosi di kebun kelapa sawit. *Dalam* Prosiding Seminar dan Kongres Nasional MKTI VI, Jakarta. p. 165-171
- [10] Murtalaksono K, Darlan N H and Sudarmo 2008b Aplikasi Teras Gulud dan Rorak Bermulsa Vertikal dalam Upaya Peningkatan Produksi Kelapa Sawit. *Dalam* Prosiding Seminar dan Kongres Nasional MKTI VI. Jakarta. p.39-50
- [11] Bohluli M, Sung C T B, Hanif A H M and Rahman Z A 2014 Silt Pit Efficiency in Conserving Soil Water as Simulated by HYDRUS 2D Model. *Pertanika J. Trop. Agric. Sci.* **37** 321 – 330
- [12] Asbur Y, Yahya S, Murtalaksono K, Sudradjat and Sutarta E S 2016 The roles of *Asystasia gangetica* (L.) T. Anderson and ridge terrace in reducing soil erosion and nutrient losses in oil palm plantation in South Lampung, Indonesia. *J. Tropical Crop Science* **3** 49-55
- [13] Bunch R 2012 Restoring the Soil. A Guide for Using Green Manure/Cover Crops to Improve the Food Security of Smallholder Farmers. (Canada: Canadian Foodgrains Bank)
- [14] Clark A 2007 Managing cover crops profitably Third Edition. Baltimore (US): The Sustainable Agriculture Network (SAN) under cooperative agreements with the Cooperative State Research, Education, and Extension Service, USDA, the University of Maryland and the University of Vermont
- [15] Arsyad S 2010 *Konservasi Tanah dan Air* (Bogor: IPB Press)
- [16] Murtalaksono K, Darnosarkoro W, Sutarta ES, Siregar HH, Hidayat Y and Yusuf MA 2011 Feasibility of soil and water conservation techniques on oil palm plantation. *Agrivita* **33** 63-69
- [17] Idjudin A A 2011 Peranan konservasi lahan dalam pengelolaan perkebunan *Jurnal Sumberdaya Lahan* **5** 103-116

- [18] Nursa'ban M 2009 Kajian erosi pada DAS Cisanggarung bagian hulu di kabupaten Kuningan, Jawa Barat *Geomedia* 717-34
- [19] Satriawan H, Fitri R, Nuraida and Erlita 2011 Kajian Erosi pada Agroforestry Berbasis Pinangdan Kakao di Kecamatan Juli Kabupaten Bireuen *In "Precision Agriculture Proceeding"* Medan, November 25, 2011
- [20] Widomski M K 2011 Terracing as a Measure of Soil Erosion Control and Its Effect on Improvement of Infiltration in Eroded Environment. In D. Godone (Ed), *Soil Erosion Issues in Agriculture*. ISBN: 978-953-307-435-1, InTech, Available from: <http://www.intechopen.com/books/soil-erosion-issues-inagriculture/terracing-as-a-measure-of-soil-erosion-control-and-its-effect-on-improvement-of-infiltration-in-erod>