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FLOATING AGRICULTURE MODEL FROM BAMBOO FOR RICE CULTIVATION ON SWAMP LAND AT SOUTH SUMATRA

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ABSTRACT

Water level is rather deep during rain season in swampland for about 3 to 6 months each year at South Sumatra. That's why there is no cultivation activity on this swampland at this time. The aim of this research was to design a raft made of bamboo which was used for rice cultivation and to find out the growth of rice on organic treated soil and untreated. Designing and making a raft took about 3 months because had to be on floating condition when the soil was added and water able to diffuse to the soil. The size of each floating bamboo raft was 300 cm x 150 cm. This research used 2 rafts where was one raft with organic fertilizer addition about 2 cm thick and the other was only mineral soil as medium. Characteristics of soil from swampland, organic compost and swamp water were analysed before using for treatment. Paddy's row were between 25 cm x 25 cm and 10 samples were taken from each raft, then data was analysed using T-test. The results show that organic fertilizer increased significantly plant height, maximum and productive rice tillers and rice weight. This was caused by organic fertilizer containning more nutrients than mineral soil from the swamp land. Due to without addition of mineral fertilizer and without watering during rice growth, then this floating rice cultivation are environmentally safe and less capital to do so. However, it needs further experiment about dosage and kind of composted organic matter, the age of bamboo raft and other plant rotation on this raft.

INTRODUCTION

Floating agriculture system have been practiced in Bangladesh and Myanmar since their ancestors. They grew variety of vegetables and paddy on this system and the bed for medium could last long time because they just added water weeds and black mud from base of the lake or swamp land. It is a useful method considering the economical, environmental and as well as social aspects. The production rate is high from this kind of agricultural practice. Farmers have been practicing the method mainly for two reasons. First, during monsoon, when most of the land is flooded, floating agriculture is the only alternative method of cultivation. Second during the winter season, farmers carry the floating bed to higher grounds where they break it and mix it with the soil to enrich the soil (Assaduzzaman, 2004 and Uga, 2010).

This method can be adapted in South Sumatra especially during monsoon when all swamplands are flooding and there is no crop or vegetable cultivation. If this system can be used thus farmer can grow rice or vegetable at least twice each year the this can increase their income. Since the acreage of swampland are about 296.899 ha (Subiksa dan Ratmini, 2008), then the potential of increasing rice and vegetable yields could be double or even more for horticulture.

In order to achieve this efford, first it needs to create a floating bed which can use bamboo tree, because these trees are available in South Sumatra and this hollow tree is floating in the water,

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as it's used to be as a raft for transportation or for the base of a house raft in Musi River. So it's possible making a floating bed from bamboo tree and planting paddy on it.

The purpose of this reasearch was to create a floating bed made of bamboo and to find out how well paddy could grow on this floating system with addition of organic compost and without it.

RESEARCH METHOD

This research was done in three steps *ie.*:

1. Designing and making bamboo rafts.
2. Soil preparation.
3. Planting.
4. Data collecting and analysing.

1). Designing and making bamboo rafts.

A raft used big bamboos for frame and small bamboos for the base, the frame was 300 cm length and 150 cm width. The arrangement of big and small bamboos show in Figure below.

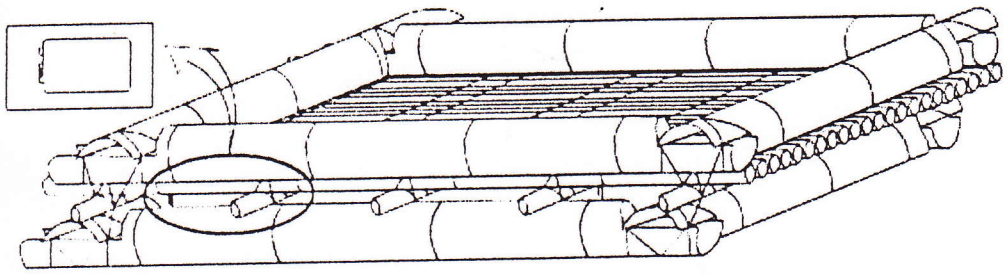

Figure 1. A bamboo raft using bigger bamboo for top and bottom frames.

A plastic containner was put in the bottom corner of a raft because water was still too deep in the raft, thus no other choice at that time, however it needs further investigation for not using that containner again for the shake of environment.

2). Soil preparation

The top soil sample was taken from swamp area for about one ton, then soil was dried and sieved using a 2 mm apurtur size siever. Soil water content was measured and put 200 kg air dried soil with 200 kg organic compost on one raft and 400 kg soil without compost on the other. The depth of soil with compost added was about 9 cm and about 7 cm without compost.

3). Planting paddy

Paddy (*Ciherang Variety)* was planted on a pan for nursary and at the age of 12 days was removed and planted on the raft with the distance between rows were 25 cm x 25 cm and one plant each hole, thus there were 55 plants in each raft. There was no addition of synthesized fertilizer thus nutrients for paddy's growth was depent on organic compost and swamp soil and water.

4). Data collecting and analysing

Properties and nutrient contents of organic compost, swamp soil and water were analysed in Soil Chemical and Biology Labaratory Agriculture Faculty, University of Sriwijaya.

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Table 1. Methods of soil, water and organic compost analysis

No.	Parameter	Method of analysis Method
1	Warna	Munsell' Color
2	Tekstur	Hydrometer
3	pH (H_2O 1:1)	pH-meter
4	Organic matter	Walkley and Black
5	N-total	Kjeldahl
6	P-Bray	
7	K, Na, Ca, Mg	EDTA-titration
8	KTK	NH_4OAc
9	Exch-Al and H	KCl-1N-leaching

Soil analysed in Chemical and Biology Laboratory, Agric. Fac Unsri.

RESULTS AND DISCUSSIONS

Results showed that all paddies grew very well on both rafts, however the addition of organic compost to soil significantly increased plant height, maximum and productive tillers, amount and weight of grain yield as showing below :

1. Plant Height and Maximum Tiller

Organic compost treated soil increased plant height significantly compared to without compost from the first to the 13rd week of paddy's growth (see Table below). This was due to organic matter containning very high Nitrogen (1.73%) on the other hand, swamp soil contained medium (0.30%) total nitrogen (see Appendix 1). This nutrient played important role in development of plant cel, so the more N in the medium the higher plant height.

Table 2. T-test of plant height at level of 5%

Age of paddy (week)	Plant height (cm)		t-test	t_{table}
	With Compost	No Compost		
1	31,90	28,80	4,49*	2,26
2	40,80	36,50	3,27*	
3	47,40	43,40	2,45*	
4	58,40	51,40	2,84*	
5	68,30	59,30	3,81*	
6	74,20	65,60	4,16*	
7	78,00	70,30	3,36*	
8	82,10	75,00	2,89*	
9	92,80	82,40	2,85*	
10	100,30	88,20	3,22*	
11	104,50	91,40	5,23*	
12	106,20	93,60	4,64*	
13	107,30	95,40	4,66*	

Note : * = Significantly difference at 0.005 level.

Compost treatment also increased maximum tiller significantly from 31,4 (without compost) to 40.6 tillers. Compost cotainned high N and very hight P, these nutrients had essential row in

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formation of proteins, nucleic acids, chlorophyll and growth hormones. A very low Nitrogen level would produce small cell and thick wall thus decreased plant height (Wild and Jones, 1988).

Table 3. T-test of maximum tiller at level of 5%.

Age of paddy (week)	Maximum tiller (cm)		t-test	t_{tabel}
	With Compost	No Compost		
1	3,60	3,10	1,63*	2,26
2	6,60	3,70	7,66*	
3	14,70	7,90	3,93*	
4	20,10	10,90	4,55*	
5	27,50	17,40	4,21*	
6	35,00	22,20	4,63*	
7	37,20	24,80	5,37*	
8	39,00	26,80	5,29*	
9	39,60	28,10	4,87*	
10	40,20	30,60	4,08*	
11	40,50	31,00	3,99*	
12	40,60	31,30	3,80*	
13	40,60	31,40	3,71*	

Note : * = Significantly difference at 0.005 level.

2. Productive Tiller

Result showed that organic compost also increased the amount of productive tiller to 12.8 from 9.2 (without compost). This meant that compost might have positive impact on tiller production because it contained high N and P (see Appendix 1 and 4) and two nutrient were important in the formation of panicle.

Tabel 4. T-test of productive tiller at level of 5 %.

No of sample	Productive tiller		t-test	t_{table}
	With Compost	No Compost		
1	18	13	3.06*	2,26
2	18	7		
3	11	9		
4	14	13		
5	10	10		
6	11	4		
7	7	6		
8	7	7		
9	11	9		
10	21	14		
11	18	13		
12	18	7		
13	11	9		
Average	12.8	9.2		

Note : * = Significantly difference at 0.005 level.

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The amount of productive tillers (12) for compost treated soil were similar with application of 20 g/l bio-phosphate and 9.5 tiller for without compost were rather similar with the application of 10 g/l bio-phosphate (Yafizham and Abubakar, 2010).

3. Grain Weight

The addition of compost to swamp soil increased significantly weight of grain yield from 5.06 ton/ha (without compost) to 6.61 ton/ha. This result showed that high cotainned N and P compost were very important to support plant growth. The intresting of this result was also high grain yield without compost, this meant this results were better than research was done by Bunoan, 1987 where the Urea application of 116 kg/ha produce only 4.6 ton/ha grain. Thus soil from swamp land and water could support rice plant growth on a raft without application of organic and anorganic fertiliser, due to high nitrogen content in swamp soil. Where according to Syam, 2010 that N total in the soil had correlated highly with rice yield.

Tabel 5. T-test of grain weight (g/cluster) at level of 5%.

Cluster sample	With compost (g/cluster)	No-compost (g/cluster)
1	47.36	41.43
2	50.86	14.69
3	53.36	38.84
4	36.97	32.86
5	43.35	27.62
6	24.89	13.29
7	31.26	30.28
8	31.51	28.96
9	37.58	35.39
10	56.33	52.92
Average	41.34 (6.61 ton/ha)	31.63 (5.06 ton/ha)
t-test	2,87*	
t_{table}	2,26	

Note : * = Significantly difference at 0.005 level.

Thus soil from swamp land and water could support rice plant growth on a raft without application of organic and anorganic fertiliser, due to medium to high nitrogen content in swamp soil (see Appendix 2). Previous swamp soil analysis also containned medium N (Naning, *et al.*, 2008), and according to Syam, 2010 that N total in the soil had correlated highly with rice yield.

CONCLUSIONS

It was concluded that floating rafts could be designed and built and paddy grew very well in the rafts with organic compost or without it, however organic compost increased significantly plant height, maximum and produktive tillers and grain weight. It needs further experiment about planting other crop in the raft and how long the raft can last.

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APPENDIX

Appendix 1. Swamp soil mixed with compost properties

Properties	Unit	Value	Criteria*
pH H_2O (1 : 1)	-	6,42	Rather acid
pH KCl (1 : 1)	-	4,71	-
C-Organik	%	5,57	Very high
N- Total	%	0,53	High
P-Bray I	ppm	101,10	Very high
K-dd	Cmol/kg	12,78	Very high
Na	Cmol/kg	0,38	Low
Ca	Cmol/kg	17,00	High
Mg	Cmol/kg	1,65	Medium
KTK	Cmol/kg	43,50	Very high
Al-ech	Cmol/kg	nd	Very low
H-ech	Cmol/kg	nd	Very low
Texture	-	-	Sandy loam
Sand	%	67,44	-
Silt	%	22,43	-
Clay	%	10,13	-

Note : nd = not detactable
• = Pusat Penelitian Tanah 1983

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Lampiran 2. Swamp soil properties

Properties	Satuan	Nilai	Kriteria*
pH H_2O (1 : 1)	-	6,31	Rather acid
pH KCl (1 : 1)	-	4,12	-
C-Organik	%	4,09	High
N- Total	%	0,30	Medium
P-Bray I	ppm	7,50	Very low
K-dd	Cmol/kg	0,38	Medium
Na	Cmol/kg	2,56	Very high
Ca	Cmol/kg	0,25	Verylow
Mg	Cmol/kg	0,08	Verylow
KTK	Cmol/kg	12,23	Low
Al-dd	Cmol/kg	nd	Very low
H-dd	Cmol/kg	nd	Very low
Texture	-	-	Sandy loam
Sand	%	64,74	-
Silt	%	23,47	-
Clay	%	11,78	-

Lampiran 3. Swamp water characteristics

Properties	Unit	Value	Criteria*
pH- H_2O	-	5,03	Acid
Na	Cmol/kg	7,00	Very high
K-dd	Cmol/kg	0,003	Very low
Ca	Cmol/kg	0,312	Very low
Mg	Cmol/kg	0.096	Very low

Lampiran 4. Nutrient content and pH of organic compost

Properties	Unit	Value	Kriteria*
pH	Unit	6,49	Rather acid
N- Total	%	1,73	Very high
P-Bray I	ppm	101,10	Very high
K- dd	Cmol/kg	32,01	Very high