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Case Report

Trial on Hybrid Method of Rice Cultivation (HYMERIC) in Mwea, Kenya

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Abstract. A new rice cultivation method called Hybrid Method of Rice Cultivation (HYMERIC) was introduced in Timor-Leste in 2009 for the first time. This new method was tried at Mwea Irrigation Scheme in Kenya in 2010 main season (short rain). In a word, this HYMERIC is a modification of "Rice Cultivation by Using Broadcastable Seedlings" which was introduced by Dr. Seizo Matsushima in 1975 (Matsushima 1980) using nursling seedlings (Hoshikawa 1994). The features of this method are; utilizing local materials such as husk charcoal, minimum cost of seedbed and transplanting, high number of productive tillers, and eventually low-cost high yielding could be anticipated. As a result of the trial and the measurement of whole harvested rice, 6,000 kg ha^{-1}, 6,160 kg ha^{-1} and 7,333 kg ha^{-1} were obtained by normal puddling, normal puddling in economic scale and minimum tillage, respectively. Besides, four samples were harvested from each treatment by three-diagonal method, and those results were analyzed statistically. Harvested area for each sample was 4 m^2 (2 m × 2 m). The analysis indicated that there was a high coefficient correlation between number of hills per m^2 and yields. All in all, regression curve was obtained. HYMERIC method could be used by small scale poor farmers.

Key words: CARD, Cultivation Method, HYMERIC, Kenya, Rice

要旨　東ティモール国で開発された新しい稲栽培法をケニア国ムウェア灌漑計画地区で試行した。星川により概念確立された乳苗を、松島により開発された投げ植え移植法により田植えする栽培法である。形態的には直播と移植の折衷案に近く、従ってHybrid Method of Rice Cultivation (HYMERIC) と命名された。現地調達可能な籾殻燻炭等の資材を使用し、苗作り・田植え労力を大幅に削減でき、最大の有効分げつ数確保が容易であるため低コスト・高収量が期待できる点が同法の特徴である。2010年小雨期期、陸稲ネリカ品種を使用しHYMERICが試行された。結果は通常代掻き法により6,000 kg ha^{-1}、経済規模における同法により6,160 kg ha^{-1}、不耕起栽培により7,333 kg ha^{-1}が得られた。この全刈り収量の他、三斜線法により各プロットから4サンプルが収穫され、統計分析の結果、平米当たりの株数と収量の間には高い正の相関関係が立証され、回帰曲線が得られた。

1. Introduction

Rice cultivation was introduced in Kenya in 1907 from Asia. It is currently the third most important cereal crop after maize and wheat. It is grown mainly by small-scale farmers as a commercial and food crop. About 95% of the rice grown in Kenya is from irrigation schemes established by Government while the remaining 5% is produced under rain-fed conditions. National rice production over the last ten years has been in the range of 60,000 to 100,000 metric tones per year against a consumption of 400,000 metric tones. The deficit is met through imports.

The Ministry of Agriculture of Kenyan Government recently launched National Rice Development Strategy (NRDS) with the coordination of Coalition for African Rice Development (CARD). Setting the target at 178,580 metric tons of paddy production until 2018, NRDS covers

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most of the fields related to the rice sub sector in order to promote rice. However, constraints to increase rice are so complicated that rice farmers hesitate to increase their capital to rice production. One of the reasons for impedance in rice expansion is low competitiveness of local produced rice with imported rice which is cheap and high quality.

This current farmer's dilemma motivated the Ministry of Agriculture to pursue low cost and high yielding rice cultivation method. Hybrid Method of Rice Cultivation (so-called HYMERIC) is one of the promising ways to solve the problem. The method was introduced and tried at Mwea Irrigation Agricultural Development Centre (MIAD) in Kenya at short rain season in 2010. This paper tries to give the idea of HYMERIC and analyze the results of the trial.

2. Outline of the method

In a word, this HYMERIC is a modification of "Rice Cultivation by Using Broadcastable Seedlings" which was introduced by Dr. Seizo Matsushima in 1975 (Matsushima 1980). There are two major modifications from original method, i.e. (1) seedling-box is not used, and (2) using nursling seedlings (Hoshikawa 1994). Each cultivation practice is explained as follows;

2.1 Seed treatment

There is no special difference as other methods as this method also uses sprouting seeds which are uniform and vigorous. Optimum germination degree is about one millimeter white bud coming from lemma, which might take one day for soaking seed and two days for germination treatment (incubation).

2.2 Seedbed preparation

Carbonized husk (Husk charcoal) is used for bedding on top of ordinary seedbed and no other material is used for seedbed. Two to three centimeters thickness of charcoal bed is appropriate (see Photo 1). Sowing should be as dense as 2 kg of seed per m^2 that will cover whole seedbed such that no bed is seen at all (see Photo 2). Seeds are to be covered by same rice husk charcoal with the thickness of one centimeter.

2.3 Broadcast transplanting with guide

After two to three days, sprouting is coming up from covered bed. This sprouted seeds, or seedlings, should be broadcasted with a guide of 25 cm or 30 cm width (see Photo 3, 4 & 5). Four days seedlings are already too long and tangled each other, eventually broadcasting become difficult. Two days seedlings are most suitable for broadcasting. In case of using guide, it takes two days to finish one hectare by two persons including uprooting, however, one day may be enough without using the implement (guide).

Photo 1. Rice husk charcoal bedding.

Photo 2. Rice seeds sown on the rice husk charcoal bedding.

2.4 Land preparation

Main field should be carefully puddled and leveled as any other rice cultivation method, and no other special method is necessary. However, deliberate land preparation promises uniform growth and eventually assures high yield. If land is well leveled, zero tillage method could be applied.

2.5 Seedling stand

Almost all broadcasted seedlings are lying down just after broadcasted. Nevertheless, they start standing vigorously from the next day after broadcast and most of them stand completely within three to four days. Since each seedling has roots and sprout, it may not sink in mud, which will keep out of seed rotten. Calper (calcium per oxide: Ca_2O_2) is not necessary to be coated in order to give oxygen to broadcasted seedlings. This is a salient advantage of this cultivation method.

Photo 3. Transplanting guide used for the trial.

Photo 4. Nursling seedlings 3 days after sowing, sprout can be observed and ready to broadcast.

Photo 5. Broadcasting two days-old seedlings with transplanting guide.

Photo 6. Rice seedlings 3 weeks after broadcasting.

Photo 7. Rice seedlings 4 weeks after broadcasting.

2.6 Water management of the main field

It is recommendable not to irrigate the field until all seedlings stand that is about three to four days. However, flush water may be tolerable because young seedlings are resistant to submergence for sometime. Same irrigation method as other cultivation methods should be applied in case of normal lowland rice varieties and minimum irrigation for NERICA varieties. Intermittent irrigation may ameliorate rice field in order to supply oxygen to root zone.

2.7 Tillering ability

Tillering can be observed two weeks after broadcasted. It starts from the second leave of rice plant. Therefore, high proportion of productive tillers than non-productive tillers could be expected in this cultivation method (see Photo 6 & 7). That is to say, more panicles per hill can be expected that assure high yield eventually.

3. Pre-conditions

3.1 Countermeasure for weeds – planting in line

Just broadcasting of seedlings without planting guide may be acceptable when herbicide could be used. However, herbicide is not recommendable where negative impact is anticipated for environment as well as human beings. Combination of line planting and weeder is practical and recommendable. Therefore, a guide will be useful for line planting in such a case.

Table 1. Major farm operations conducted for each plot

Days from transplanting[1)]	Minimum tillage plot (A)	Normal puddling plot (B)	Normal puddling plot (C)
-15	Application of round-up		
-7	Soaking seed		
-7	Irrigation		
-4	Nursery preparation, sowing seed		
-4		Puddling	
-1	Drainage		
0	Transplanting by broadcast		
5	Flush irrigation		
14	Start of intermittent irrigation		
15	Basal fertilization		

[1)] Transplanting date was 24th September 2010.

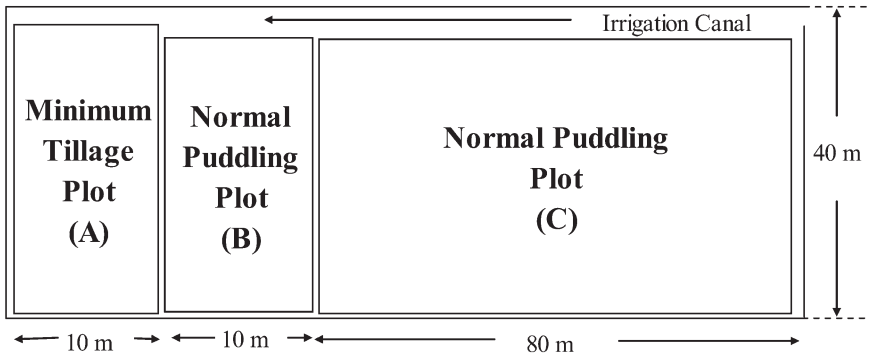

Figure 1. Plot allocation for the trial.

3.2 Land preparation

If rice field is not uniform in topography, lower part will be submerged and rice plant may be retarded to grow or damaged fatally. Therefore, mechanized land preparation means, especially with rotary cultivator, is appropriate. Land preparation by animal traction may not assure uniform topography so that plant growth is not as expected.

4. Field trial

4.1 Procedure

The trial was conducted at the onset of short rain season. Seed of NERICA 4 was sown on 20th September 2010 at MIAD farm as shown in Table 1. One whole plot was subdivided into three smaller plots, i.e. minimum tillage plot (A), normal puddling plot (B) and the same treatment with bigger plot (C) as illustrated in Figure 1.

Minimum tillage plot was sprayed with Round-up (the main active ingredient is the isopropylamine salt of glyphosate) 15 days before transplanting in order to clean the field. The other cultivation methodology including fertilization was followed to the standard method of Mwea Irrigation Scheme Area.

<Fertilization>

* N, P, K (25 kg N, 25 kg P, 25 kg K ha^{-1}) at basal application
* 25 kg N ha^{-1} at tillering stage (15 days after transplanting)
* 25 kg N ha^{-1} at booting stage (20 days before heading)

<Seed amount>

* 20 kg of NERICA 4 was sown to 10 m × 1 m (2 kg m^{-2})
* Seed from three quarters of the seedbed (15 kg) was used for one acre (35.7 kg ha^{-1})

4.2 Results

Yield data was obtained from the measurement of whole harvested rice. The harvest operation of whole plot started on 20th January and finished on 25th January 2011. Against the anticipation, Plot A (minimum tillage plot) yielded highest compared to other treatments. Actual yield

from each plot are; Plot A = 7,333 kg ha^{-1}, Plot B = 6,000 kg ha^{-1}, Plot C = 6,160 kg ha^{-1}.

Beside the measurement of whole harvested rice, yield of 4 m^2 (2 m × 2 m) was measured. Plants were harvested from 4 portions per plot by three-diagonal method (objectively random method). Number of hills per m^2 and grain weight were measured and adjusted for 14 percent grain moisture contents. All the results of sample measurements are shown in Table 2. Unlike in the case of whole harvested rice, yield was higher in normal puddling plots than the minimum tillage plots. This inconsistent result may be due to uneven fertility of the soil and rough topography of the trial field.

According to statistical analysis of the trial results, it is obvious that there is quite high positive correlation between number of hills per m^2 and yield. The correlation coefficient (r) was as follow;

r =0.882514746

The result of t-test of significance was as follow;

t =12.61828181

Since the value of t with degree of freedom 10 at P=0.001 is 4.59, it could safely be concluded that there is a high positive correlation between number of hills per m^2 and yield. Meanwhile, regression coefficient was calculated and the result is as follow;

b (Regression coefficient) = 20.45627066

Since the average yield is 7,538 kg ha^{-1}, a = 7,538, and the average number of hills per m^2 is 48.5, $\bar{x}$ = 48.5. All in all, regression curve is expressed as follow (see Figure 2);

$$y \text{ (regression curve)} = a + b\,(x - \bar{x})$$
$$= 7{,}538 + 20.5 \times (x - 48.5)$$

4.3 Future issues

Although positive correlation between number of hills per m^2 and yield is confirmed, ideal number of tillers per m^2, or most suitable number of tillers per m^2 in order to obtain highest yield is remain unclear yet from this trial. The plot with highest yield with 11,090 kg ha^{-1} was achieved by 96.8 hills per m^2. There is no doubt that the regression curve will be bent down by increasing number of hills per m^2 from certain point. It remains as future issue and another trial should be carried out to clarify most ideal number of hills per m^2, or seed amount per ha, in order to obtain highest yield of NERICA 4 at short rain season. Although the ideal number of hills per m^2 may differ according to the season, short rain or long rain, or by soil fertility or fertilization method, relatively higher numbers, i.e. 80–90 per m^2, may be desirable. If seedlings stand rate after broadcast is assumed to be 70%, 115–130 grains number (seed) per m^2 or 33 kg–38 kg seed amount per ha is required (1,000 grains weight of NERICA 4 is 29 grams). Cost analysis remains unclear and further study may be essential in this field. Simple cost comparison with ordinary transplanting method may be beneficial.

Table 2. Number of hills per m^2 and yield of rice grown by Hybrid Method of Rice Cultivation (HYMERIC) under minimum tillage and normal puddling conditions

Plot	Sample number	Number of hills per m^2	Yield (kg ha^{-1})
Minimum tillage plot (A)	1	36.8	6,893
	2	34.3	5,553
	3	43.3	8,199
	4	36.0	5,419
Normal puddling plot (B)	1	96.8	11,090
	2	49.0	7,035
	3	56.0	8,443
	4	56.0	9,450
Normal puddling plot (C)	1	42.3	7,064
	2	34.0	6,615
	3	44.8	7,596
	4	52.5	7,103
Average		48.5	7,538

[1)] Size of harvested area was 4 m^2 (2 m × 2 m).

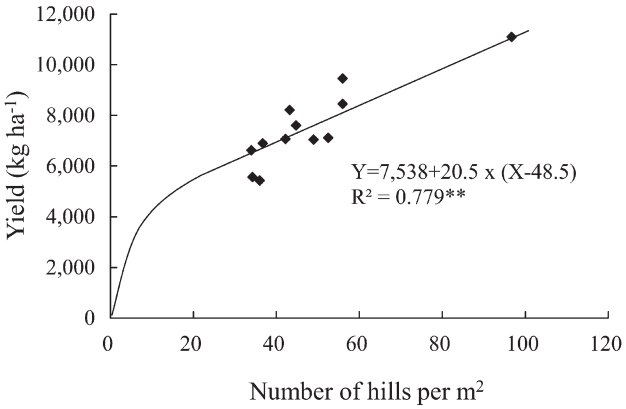

Figure 2. Relationship between yield and number of hills per m^2. ** significant at P<0.01

5. Conclusion

Hybrid Method for Rice Cultivation (HYMERIC) with NERICA is easy, low-cost and high yielding. Considering slightly higher yield than the conventional cultivation method in Mwea irrigation scheme that is 5.0–6.0 t ha^{-1} (Mati 2011), HYMERIC could be an alternative cultivation method in Kenya. The trial at Mwea in 2010 verified this constant performance. This method may suite for second crop in Irrigation Scheme Areas where irrigation water is

not sufficient. Therefore, this method should be promoted to the farmers in Mwea and other irrigation scheme areas where there is shortage of irrigation water in second crop. However, experiment on sowing density and cost analysis may be required in order to stabilize HYMERIC method.

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