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INTEGRATED CROP MANAGEMENT ON MAIZE PRODUCTION IN SHIFT OF CROPPING SYSTEM – A CASE STUDY OF HAU GIANG PROVINCE, VIETNAM

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ABSTRACT

The demonstration plots were conducted at Chauthanh A district, Haugiang Province, Vietnam in 2010 early wet season on 6 ha of 7 farmer fields as followed by rice-maize-rice cropping system in comparison with the triple rice cropping system to recommend farmers expanding areas and increasing farmers' productivity and profit. The two management practices of maize were included: (1) Farmer Practices (FP) with 67,000 plants/ha (75x20 cm) and farmer's fertilizer practices and farmer's pest management; and (2) ICM with high plant density of 76,000 plants/ha with spacing of 60x22 cm and NPK application as SSNM. N was adjusted by LCC. Pest management was followed by IPM and combined to bio-insecticides. Between the two cropping systems R-R-R and R-M-R, the grain yield of DS Rice, EWS rice, LWS rice were also collected; The incidence of insect pest and diseases and the change of soil property were evaluated. In such a condition of Haugiang, ICM in maize production the grain yield got higher than those of the FP at 0.46 t ha^{-1} and the net benefit was higher than VND 1,561 ha^{-1}. Rotation with maize in rice - based cropping system showed the priorities in increasing the grain yield of rice in LWS (0.13-0.24 t ha^{-1}); improving the contents of N, P, K and organic matter of the soil and reducing the incidence of BPH and small leaf folder in LWS rice. Consequently, farmers got higher grain yield from 2.88 to 3.45 t ha^{-1} and higher profit of VND 15.3-17.6 million /ha as compared to the triple rice crop's benefit. With these efficiencies, it should be expanded area of maize production in accompany by application of ICM.

Keywords: Farmer Practices (FP), farmer's fertilizer practices (FFP), grain yield (GY), Integrated Crop Management (ICM), rice-maize-rice (R-M-R), rice-rice-rice (R-R-R), Site-Specific Nutrient Management (SSNM)

INTRODUCTION

Mekong Delta has a potential in development the largest area of maize production. That is estimated about of 86,000 ha in 2006 and 136,000 ha in 2010, but up to now the maize area is only 35,600 ha, equal to 3% and the yield production occupies of 5% of the total of Vietnam. The study on maize also showed higher profit of 46% that farmers got from the cropping system of rice- maize- rice over the triple rice system (Chin 2008). Besides the increased profit, the cropping system of rice - upland crop - rice helps to cut down the main pest and disease that seriously damaged on rice as BPH and yellow stunt leaf disease (Du 2008). The shift of cropping systems is widen at Angiang with maize; Dongthap, Vinhlong, Cantho with soybean, but Haugiang is still less areas of them. So, the establishment and development of the demonstration plots of ICM as SSNM and improving planting density on maize production are needed and supported to expand the areas and properly change to rice-upland crop-rice in the rice- based cropping systems.

MATERIALS AND METHODS

The demonstration plots were conducted on six ha of seven farmer fields at Nhon Nghia A village, Chauthanh A district, Haugiang Province in EWS 2010 crop. It includes two management practices of maize: (1) FP with 67,000 plants/ha (75x20 cm) and farmer's fertilizer practices (FFP) and farmer's pest management; and (2) ICM with high plant density of 76,000 plants/ha (60x22 cm) and

NPK application as SSNM. N was adjusted by LCC. Pest management was followed by IPM and combined to bio-insecticides.

The maize variety of DK888 with 95-100 days growth duration was used for all the demonstration plots.

Data of grain yield was collected and calculated the economic efficiency of improvement of planting density and fertilizer application method followed by the procedure of IRRI (Fairhurst et al. 2005) and IPNI (2007). Other data of fertilizer rate, the prices of seeds, fertilizers for each crop and etc…were also recorded on both 2 cropping systems. The incidence of insect pest and diseases in three crops. The change of soil property as organic matter, N, P, K were evaluated before and after EWS.

RESULTS AND DISCUSSIONS

1. The effect of integrated crop management on maize production

1.1. Comparison the planting density and applied fertilizer rate between ICM and FP

There were the differences in fertilizer rates between ICM and FP on maize. ICM was applied higher fertilizer dose than FP, especially on nitrogen and phosphorus nutrients. The SSNM of ICM treatments included high N, P and K than those of FFP by 34 kg N/ha, 15 kg P_2O_5/ha and 2 kg K_2O/ha. That clearly explained for the need of high nutrients of maize in such a high planting density of ICM with 76,000 plants/ha as compared to 67,000 plants/ha of FP (Table 1).

Table 1. Planting Density and Fertilizer rate in 2 cropping systems of Rice-Rice-Rice and Rice-Maize-Rice in 2009-2010.

Crop	Rice-Rice-Rice (kg ha^{-1}) [a]			Seed rate/Planting Density	Rice-Maize-Rice (kg ha^{-1}) [b]		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
2009-10 DS	100	40	40	120 kg/ha	100	40	40
2010 EWS	90	40	40	76,000 plants/ha	**200**	**90**	**60**
	90	40	40	67,000 plants/ha	**166**	**75**	**58**
2010 LWS	80	50	40	120 kg/ha	80	50	40

[a] Rice as followed the NPK local recommendation [b] Maize as followed the ICM (SSNM/76,000 plants/ha (60x22 cm) in demonstration plots/and compared with FP (FFP/67,000 plants/ha (75x20cm))

1.2. The DK888 maize growth in crop rotation with ICM in 2010 EWS

With higher fertilizer doses that were applied at the right timing by SSNM, the nutrient need of plant was well-responded. The growth of maize at 10 DAS, 40 DAS, 65 DAS and 95 DAS had good manifestations on the difference of the leaf color, the number of survival young plant, the ears No/ha and the kernel No/ear ((Fig.1).

FP and ICM at 10DAS

ICM at 10DAS

FP at 40DAS

ICM at 40DAS

FP at 65DAS

ICM at 65DAS

FP at 95DAS

ICM at 95DAS

Fig.1. DK888 Maize growth at 10 DAS, 40 DAS, 65 DAS and 95 DAS in demonstration plots of EWS 2010 at Nhonnghia A, ChauthanhA, Haugiang.

1.3. Effect of ICM on yield and economic efficiency of maize production

There was the difference in grain yield of maize between ICM and FP. ICM got higher grain yield than those of FP at 7 demonstration plots from 0.32 to 0.65 t ha^{-1} and significantly differed with T_{test} = 50.26**. The mean increased grain yield was 0.46 t ha^{-1} that increased similar to 10.7% (Fig. 2).

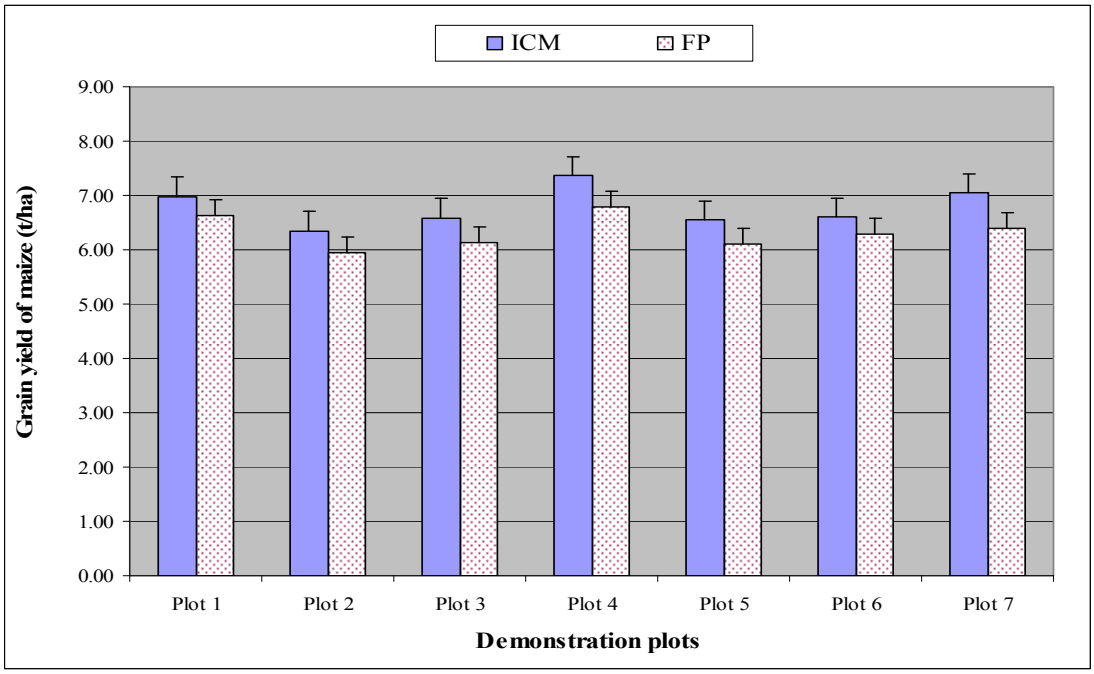

Fig. 2. Grain yield of maize DK888 at ICM compared to FP in demonstration plots of 2010 EWS at NhonnghiaA, ChauthanhA, Haugiang.

Table 2. Economic analysis of ICM and FP on maize production in demonstration plots at Chauthanh A, Haugiang in 2010 EWS.

Parameters	ICM	FP	Difference
Yield (t ha^{-1})	6.78	6.32	0.46
Gross benefit (VND ha^{-1})**	31,866,000	29,704,000	2,162,000
Total seed cost (VND ha^{-1})*	1,272,240	1,121,580	150,660
Total fertilizer cost (VND ha^{-1})*	6,038,350	5,188,132	850,218
Total pesticide cost ((VND ha^{-1})	1,000,000	1,200,000	-200,000
Labor cost (VND ha^{-1})	4,000,000	4,200,000	-200,000
Total cost (VND ha^{-1})	12,310,590	11,709,712	600,878
Net benefit (VND ha^{-1})	19,555,410	17,994,288	1,561,122

*Urea = VND 6,600 /kg, Super Phosphate = VND 3,500/ha, KCl= VND 12,000 /kg, Seed of maize= VND 62,000 /kg, ** Price for selling of maize = VND 4,700.

Analysis of economic efficiency of ICM and FP showed that the gross benefit of ICM was higher than that of FP due to higher attained grain yield. Besides that, the pesticide cost and labor cost of ICM were lower by VND 400 thousand ha^{-1} compared to FP, so the ICM net benefit was still efficient of VND 1.5 million ha^{-1} although the higher cost of fertilizer (VND 850 thousand ha^{-1}) and seed cost (VND 150 thousand ha^{-1}) were recorded (Table 2).

2. Effect of rotation of maize in rice –based cropping systems

2.1. Effect of rotation of maize on nutrient content of soil and grain yield of LWS rice 2010

The rotation of maize instead of 2010 EWS in rice-based cropping systems showed the priority on the increasing of grain yield of 2010 LWS from 0.13 to 0.24 t ha^{-1}. It got 4.14 -4.25 t ha^{-1} of LWS rice on the FP and ICM of EWS maize in R-M-R vs 4.01 t ha^{-1} in R-R-R (Fig. 3). This remarkable increase at the same fertilizer rate for rice in LWS2010 that is reasonably resulted from the nutrient improving of the soil such as N, P, K and organic matter (Table 3).

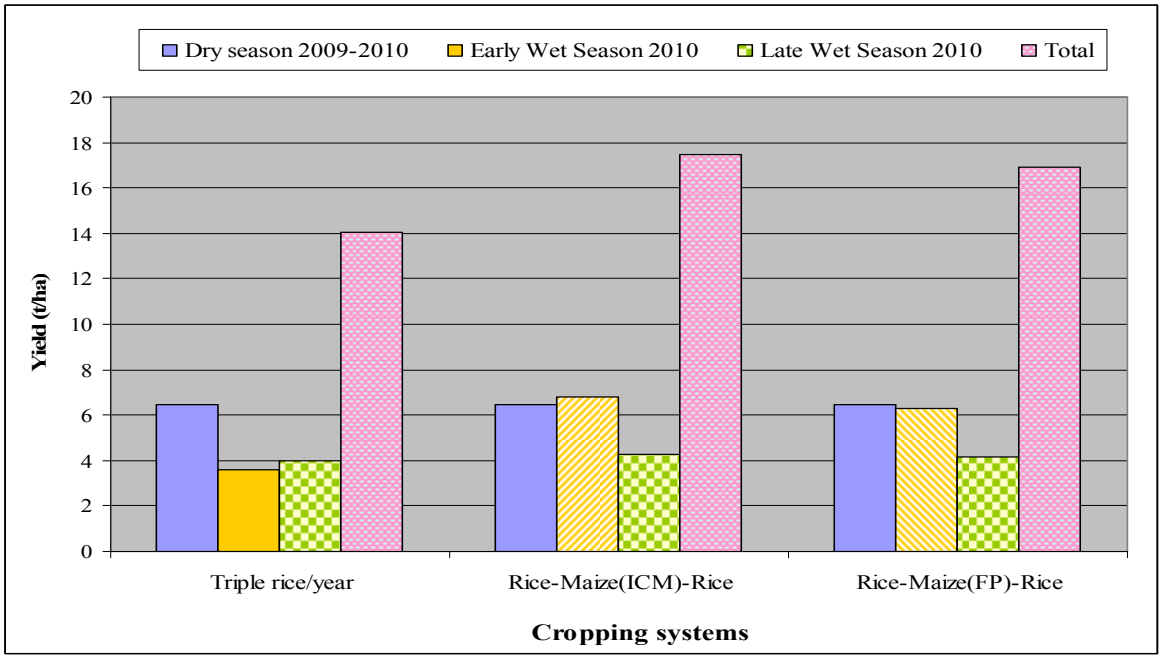

Fig. 3. Comparison of crop yield in two cropping systems: Triple rice/ year and Rice-Maize (with 2 management practices: ICM & FP) – Rice.

Table 3. Effect of treatments on the change of soil nutrient in two cropping systems (R-R-R and R-M-R)

Treatments	C%	N%	P_2O_5%	K_2O%
Before EWS (00-00-00)	3.848	0.260	0.080	1.208
After Rice EWS (90-40-40)	3.676	0.230	0.076	1.341
After Maize EWS-ICM (SSNM/200-90-60)	4.185	0.317	0.115	1.343
After Maize EWS -FP (FFP/166-75-58)	3.852	0.276	0.090	1.220
F	*	**	*	***Ns***
CV%	***4.6***	***12.6***	***17.8***	***7.8***
LSD5%	***0.192***	***0.042***	***0.020***	***0.123***

2.2. Effect of rotation of maize on insect pest and disease of 2010 LWS rice

Besides the priority of increasing the rice yield and farmer's benefit in the rice- based cropping system, the shift of maize instead of rice contributed to cut down the main pest injury as Brown Plant Hopper (BPH). The data in Table 5 showed the effectively reduced incidence of BPH and Small leaf folder (SLF) in LWS rice 2010.

In EWS 2010, application of ICM, incidence of insect pest and disease on maize also decreased. ***Ostrinia nubilalis, Bipolaris maydis, Rhizoctonia solani*** was significantly reduced although the damaged level was low (Table 5).

Table 5. Incidence of insect pest and disease (%) in 2 cropping systems (Triple rice and Rice-Maize-Rice)

Cropping system	***Rice - Rice – Rice***				
	Blast	**Sheath Blight**	**BPH**	***Small-LF***	***Big-LF***
DS Rice	48.6	0.9	46.9	34.4	35.4
EWS Rice	33.9	2.3	40.6	33.6	30.1
LWS Rice after EWS rice	17.6	3.2	27.2	22.1	16.3
LWS Rice after EWS Maize	17.4 ns	2.4 ns	23.7*	16.9*	15.8 ns
Cropping system	***Rice - Maize – Rice***				
EWS Maize	***Spodoptera mauritia Borsduval***	***Ostrinia nubilalis***	***Heliothis armigera***	***Bipolaris maydis***	***Rhizoctonia solani***
FP	***0.8***	***12.4***	***2.1***	***5.7***	***5.8***
ICM	***0.7 ns***	***7.6 ****	***1.5 ns***	***3.9 ****	***2.6 ****

2.3. Effect of rotation of maize on economic efficiency of rice-based cropping system

In maize production, ICM contributed to increase the profit of VND 1.5 million ha^{-1} (Table 2). In whole of the rice-based cropping system, ICM help to increased the grain yield of 0.57 t ha^{-1}

and gross benefit of VND 2,712 million ha^{-1} and net benefit of VND 2,311 million ha^{-1} although the total cost of ICM was higher than that of FP by VND 400 thousand ha^{-1} (Table 6).

On the economic efficiency, the R-M-R cropping system got the profit from VND 41.3 to 43.6 million ha^{-1} while the R-R-R cropping system only got VND 26 million ha^{-1}. This large difference in the shift of cropping system brought about the higher profit for farmers from VND 15.3 to 17.6 million ha^{-1}. Thus, growing of maize gave the benefit/cost ratio 5.3-5.8 fold of growing rice in 2010 EWS. That meant maize got the profit of VND 17.99 and 19.56 million ha^{-1} respectively for FP and ICM, while EWS rice got only the profit of VND 3.4 million ha^{-1} (Table 6). That result showed the same tendency of application of ICM on the shift of cropping systems at Chauphu, Angiang in 2008-09DS and 2009 EWS in the M-M-R cropping system (Khuong et al. 2010). With high efficiencies, we can recommend for expanding of maize production area in accompany by application of ICM.

Table 6. Comparison the economic efficiency of two cropping systems of the triple rice and rice-maize-rice at Chauthanh A, Haugiang in 2010.

Cropping systems	Crop	Yield (t ha^{-1})	Gross benefit ** (VND ha^{-1})	Total cost * (VND ha^{-1})	Net benefit (VND ha^{-1})
Triple rice **(R-R-R)**	DS Rice	6.47	25,880,000	11,329,800	14,550,200
	EWS Rice	**3.57**	14,280,000	10,886,320	3,393,680
	LWS Rice	4.01	20,050,000	11,961,590	8,088,410
	Total	**14.05**	**60,210,000**	**34,177,710**	**26,032,290**
Rice-Maize-Rice **(R-M-R)** and Maize with ICM	DS Rice	6.47	25,880,000	11,329,800	14,550,200
	EWS – Maize with ICM	**6.78**	31,866,000	12,310,590	19,555,410
	LWS Rice	4.25	21,250,000	11,761,590	9,488,410
	Total	**17.50**	**78,996,000**	**35,401,980**	**43,594,020**
Rice-Maize-Rice **(R-M-R)** and Maize with FP	DS Rice	6.47	25,880,000	11,329,800	14,550,200
	EWS – Maize with FP	**6.32**	29,704,000	11,709,712	**17,994,288**
	LWS Rice	4.14	20,700,000	11,961,590	8,738,410
	Total	**16.93**	**76,284,000**	**35,001,102**	**41,282,898**
Difference (VND ha^{-1})	Maize with ICM	3.45	**18,786,000**	**1,224,270**	**17,561,730**
	Maize with FP	2.88	**16,074,000**	**823,392**	**15,250,608**
R-M-R vs R-R-R	**ICM vs FP**	**0.57**	**2,712,000**	**400,878**	**2,311,122**

*Urea = VND 6,600 /kg, Super Phosphate = VND 3,500 /ha, KCl= VND 12,000 /kg, Seed of maize= VND 62,000 /kg, Seed of rice = VND 6,000 /ha, ** Price for selling of rice = VND 4,000 VND/kg in 2009-10 DS0 and 2010 EWS: = VND 5,000 kg in 2010 LWS. Price for selling of maize in 2010 EWS = VND 4,700.

CONCLUSSION

- In such a condition of Haugiang, with ICM in maize production, the grain yield got higher than that of the FP as 4.6 t ha^{-1} and the net benefit was higher than VND 1,561 ha^{-1}.
- Rotation of maize in rice - based cropping system showed the priorities in increasing the grain yield of rice in LWS (0.13-0.24 t ha^{-1}); improving the contents of N, P, K and organic matter of the soil and reducing the incidence of BPH and small leaf folder in LWS rice. Consequently, farmers got higher grain yield from 2.88 to 3.45 t ha^{-1} and higher profit of VND 15.3-17.6 million /ha compared to the triple rice crop's benefit.
- With high efficiencies, it should be expanded area of maize production in accompany by application of ICM.

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Ảnh hưởng của quản lý cây trồng tổng hợp trong sản xuất bắp lai và chuyển dịch cơ cấu cây trồng hệ thống nền lúa - Một trường hợp nghiên cứu ở Hậu Giang, Việt Nam

Các mô hình trình diễn áp dụng quản lý cây trồng tổng hợp (ICM) được thực hiện ở huyện Châu Thành A, tỉnh Hậu Giang, Việt Nam trong vụ Xuân Hè 2010 trên 7 ruộng nông dân trên cơ cấu lúa-bắp lai- lúa so với cơ cấu 3 vụ lúa/năm nhằm mục đích gia tăng năng suất, thu nhập cho nông dân và khuyến cáo mở rộng diện tích luân canh cây màu trong hệ thống nền lúa. Hai biện pháp quản lý cây trồng thử nghiệm là (1) Kỹ thuật canh tác của nông dân (FP) với mật độ cây bình thường 67.000 cây/ha (khoảng cách 75x20 cm) và bón phân theo nông dân (FFP), quản lý sâu bệnh theo nông dân; (2) Quản lý cây trồng tổng hợp ICM với mật độ cây cải tiến 76.000 cây/ha (khoảng cách 60x22 cm), bón phân theo địa điểm chuyên biệt (SSNM), phân đạm điều chỉnh theo bảng so màu lá, quản lý sâu bệnh theo IPM và thuốc sinh học. Giữa 2 hệ thống cây trồng 3 vụ lúa/năm và 2 lúa-1 bắp, năng suất lúa ĐX 2009-2010, lúa Xuân Hè 2010 và lúa Hè Thu 2010 cũng đã được thu thập. Tỷ lệ các sâu bệnh hại chính, sự thay đổi đặc tính đất cũng được đánh giá. Trong điều kiện của tỉnh Hậu Giang, áp dụng ICM trong sản xuất bắp lai đã nhân được năng suất cao hơn FP là 0,46 t/ha và lợi nhuận cao hơn được 1,561 triệu đồng/ha. Luân canh bắp lai XH trong hệ thống nền lúa đã cho thấy các ưu thế như gia tăng năng suất lúa HT, cải thiện hàm lượng dinh dưỡng N, P, K, chất hữu cơ trong đất; giảm thiệt hại do rầy nâu và sâu cuốn lá nhỏ trong vụ lúa HT sau khi trồng bắp lai XH2010. Kết quả là nông dân đạt năng suất trong hệ thống lúa-bắp-lúa cao hơn hệ thống 3 lúa được 2,88-3,45 t/ha/năm; lợi nhuận cao hơn được 15,3-17,6 triệu đồng/năm. Với những hiệu quả cao đạt được, khuyến cáo mở rộng diện tích sản xuất bắp lai nên được áp dụng đồng bộ với biện pháp quản lý cây trồng tổng hợp.