Crop diversification options in the Senegal River valley

Increasing nutrition security and reducing poverty

Introduction

Crop diversification is considered as an important agronomic intervention for improving nutrition security and for poverty reduction in irrigated rice-based systems in the Senegal River Valley. Rice is generally cultivated in two cropping seasons: the dry season (the rice-growing period is from February to June) and the wet season (from July to November). Vegetables such as onions and tomatoes are cultivated mainly in the dry season (from November to April). However, there is limited information on their productivity and profitability and how they are affected by the introduction of new vegetables and crops in different seasons. From 2019, on-station and on-farm experiments have been conducted to evaluate the agronomic performance and profitability of different vegetables and other crops as potential candidates for diversifying rice-based systems.

Performance of vegetables and crops in on-station experiments

On-station experiments using 12 vegetables/crops (tomato, eggplant, African eggplant, okra, onion, roselle, mungbean, hot pepper, sweet pepper, cabbage, cucumber and watermelon) with 2–6 varieties per crop were conducted at the AfricaRice Research Station in Fanaye, Senegal, to identify the best performing crops and varieties in the dry and wet seasons for use in rotational systems. We included local check varieties of tomato and onion, with the other crops being new varieties shared by the World Vegetable Center and Tropicasem (private seed company). The yield range for varieties for each vegetable/crop is shown in Table 1. Tomato, onion, sweet pepper, cabbage and roselle had higher yields in the dry season than in the wet, whereas eggplant, African eggplant, okra and watermelon tended to have higher yields in the wet season. Cabbage and mungbean had similar yields in both seasons. Eighty farmers, including 41 women, were invited to the field to evaluate the tested crops before harvesting in both dry and wet seasons and the most promising varieties were selected based on farmer preferences. These included onion, tomato, okra, eggplant, African eggplant, cucumber, sweet pepper, hot pepper and mungbean. We identified new onion and tomato varieties with higher yields than local check varieties (Table 2).

Table 1. Range of yield and days to harvest across varieties for different vegetable/legume crops

Vegetable/ legume crops[1]	Dry season		Wet season	
	Yield (t/ha)	Days to harvest	Yield (t/ha)	Days to harvest
African eggplant	14–30	69–73	69–78	77–80
Cabbage	17–24	118–127	13–21	100–168
Eggplant	14–42	69–82	63–134	70–78
Cucumber	25–32	64–80	28–41	46–59
Hot pepper	15–31	119–130	11–49	91–129
Mungbean	1.4–4.0	76–80	1.4–2.5	47–55
Okra	9–16	64–71	19–36	36–98
Onion	13–39	109–123	15–23	129–148
Roselle	25–29	115–146	10–12	85–120
Sweet pepper	23–47	62–76	30–31	58–106
Tomato	32–73	80–99	21–30	65–70
Watermelon	0–99	95–104	60–159	65–74

1. Fresh yield, except for mungbean which was dried and yield evaluated at 14% moisture content.

Table 2. Yields (t/ha) of best-performing vegetable varieties

Crop	Varieties	Dry season	Wet season
Tomato			
Local most cultivated variety	Gempride F1	32	NA[1]
New best-performing tomato varieties	Kobra	73	24
	Kiara	59	25
	Rio Tinto	49	21
	Amiral	41	30
	Jampkt	38	28
	Mean	52	26
Onion			
Local variety	Orient	13	NA[1]
New best-performing onion varieties	Safari	34	22
	Victoria	39	21
	Violet de Galmi	24	23
	Mean	32	22
African eggplant			
	Keur M'Bir N'Dao	30	69
	Meketan	14	78
	Mean	22	73
Hot pepper			
	Kani Safe	15	20
	Yellow Big Sun	24	20
	Habanero	29	15
	Mean	23	18
Sweet pepper			
	Yolo Wonder	23	31
	Espartana	47	30
	Mean	35	31
Okra			
	Clemson Spineless	9	20
	Konni	9	25
	Batoumambé	12	20
	Indiana	16	36
	Aicha	13	21
	Mean	12	24

1. Not applicable. Due to poor germination, these varieties were not grown in the wet season.

Pilot testing together with farmers

After initial on-station experimentation was completed, promising vegetables were introduced to farmers in the wet season for piloting together with the Société Nationale d'Aménagement et d'Exploitation des Terres du Delta et de la Vallée du Fleuve Sénégal (SAED). Thirty farmers were asked to select vegetables to grow in their fields. They selected African eggplant (n=9), hot pepper (n=5), okra (n=12) and sweet pepper (n=4). None of them selected tomato or onion due to delays in preparation of nursery establishment. Field sizes ranged from 0.1 to 0.3 ha. Field management practices were not introduced to these farmers, and farmers used their own practices with their own financial resources. After harvesting, the farmers were asked about production of and income from their crops. In addition, 20 farmers were asked about productivity and income with rice cultivation in the wet season. On average across the farmers, African eggplant and okra had higher yields than other crops including rice, whereas gross income was higher for hot pepper and African eggplant (Table 3). We also conducted some pilot testing with farmers in the dry season, but data are not yet available.

Table 3. On-farm evaluation of vegetable varieties during the wet season

Crop	Variety	Number of farmers	Yield (t/ha)	Gross income (US$/ha)
African eggplant	Keur M'bir N'Dao	9	12.2	4757
Hot pepper	Yellow Big Sun	5	4.1	8186
Okra	Clemson Spineless	12	8.7	2089
Sweet pepper	Yolo Wonder	4	2.0	1091
Rice	Sahel 108	20	5.1	1227

Profitability evaluation

We conducted economic analysis using data from on-station experiments for yield of vegetables, typical rice yield, production cost and local market price to calculate net profit in different cropping systems. We selected tomato, onion, African eggplant, sweet pepper, hot pepper and okra for this analysis. For yield data from vegetables, we used data from the highest yielding varieties in each season in Table 2. The results showed the rice–rice cropping system had the lowest net profit among all the systems (Table 4). Furthermore, except for okra, the cropping system with cultivation of vegetables in the wet

season had a higher net profit than was achieved in the dry season. This is due to the higher price of vegetables in the wet season, except for okra and eggplant (see footnote to Table 4), and the higher profit from rice cultivation in the dry season resulting from higher yields. The price difference between the two seasons is due to the fact that the vegetables, except for okra and African eggplant, are mainly grown in the dry season in this region, so are more available in the market. For African eggplant, a higher net profit in the wet season is due to higher productivity (Table 2). Thus African eggplant and hot pepper seem to be the best options for wet season cultivation for increasing annual net profit. However, to enable farm and dietary diversification, improving cultivation practices for other vegetables that had lower yields in the wet season, thereby giving more stable and higher production, could help to develop more profitable rice–vegetable rotation systems.

Table 4. Economic analysis of rice–vegetable compared with rice–rice cropping system

Cropping system[1,2,3]	Wet season net profit (US$/ha)	Dry season net profit (US$/ha)	Annual net profit (US$/ha)	Annual net profit compared to rice–rice	% annual net profit increase compared to rice–rice
Rice (W*)–Rice (D)	274	790	1064	-	-
Rice (W)–Tomato (D)	274	3098	3372	2428	217
Rice (W)–Onion (D)	274	1742	2016	954	89
Rice (W)–African eggplant (D)	274	3789	4063	2999	282
Rice (W)–Hot pepper (D)	274	4180	4454	3390	319
Rice (W)–Sweet pepper (D)	274	3633	3907	2843	267
Rice (W)–Okra (D)	274	2175	2449	1385	130
Tomato (W)–Rice (D)	3676	790	4466	3402	320
Onion (W)–Rice (D)	3241	790	4031	2967	279
African eggplant (W)–Rice (D)	5530	790	6320	5256	494
Hot pepper (W)–Rice (D)	5569	790	6359	5295	498
Sweet pepper (W)–Rice (D)	4171	790	4961	3897	366
Okra (W)–Rice (D)	1556	790	2346	1282	110

1. W and D indicate wet and dry seasons, respectively.
2. Crop price in dry season (US$ = 640 FCFA): rice = 0.20, fresh tomato = 0.10, onion = 0.12, African eggplant = 0.26, hot pepper = 0.27, sweet pepper = 0.16, okra = 0.31.
3. Crop price in wet season: rice = 0.20, fresh tomato = 0.23, onion = 0.25, African eggplant = 0.10, hot pepper = 0.41, sweet pepper = 0.20, okra = 0.14.

Contact information

For more information, email Dr Ali Ibrahim: i.ali@cgiar.org

For vegetable seeds contact Tropicasem, email: tropicasem@organfe.sn