Preliminary studies in rice-fish culture in a rainfed lowland ecology in Ghana

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SUMMARY

Mixed farms of rice and fish are yet to receive attention in Ghana, despite lowland rice being grown under inundation in most areas nationwide. In a preliminary study, Nile tilapia (*Oreochromis niloticus*) was successfully cultured in a rainfed lowland rice farm, although no additional care was provided for fishes. The highest yielding rice variety produced 4.8 t/ha (480 kg/1000 m²) which was commensurate with previous yields at the same location. Parent fish yield of 121 g/fish for a period of 139 days was also commensurate with yield from fish ponds. This excluded yield of fish progeny. With proper management, fish yields would greatly complement that of rice.

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RÉSUMÉ

DARTEY, P. K. A., BAM, R. K. & OFORI, J.: *Les études préliminaires de la culture de riz-poisson dans une écologie de la plaine pluviale au Ghana.* Les champs mixtes de riz et de poisson restent encore à reçevoir une attention au Ghana malgré le fait que le riz de plaine étant cultivé sous l'inondation dans la plupart de territoire à travers tout le pays. Dans une étude préliminaire, la tilapie du Nil (*Oreochromis niloticus*) était élevée avec succès dans la plaine pluviale d'un champ du riz malgré le fait que aucun soin supplémentaire n'était fourni aux poissons. La variété du riz de rendement plus haut produisait 4.8 t/ha (480 kg / 1000 m²) qui était de même mesure que les rendements antérieurs aux mêmes emplacements. Le rendement de poisson parental de 121 g / poisson obtenu sur une période de 139 jours était aussi de même mesure que le rendement dans les étangs à poissons. Ceci était à l'exclusion de rendement de la progéniture de poisson. Avec une bonne gestion, les rendements de poisson pourraient considérablement être les compléments de ceux du riz.

Introduction

An inland valley at Kumasi (07°35' N; 01°38' E) is served by a small perennial stream which is easily diverted onto a bunded field for agricultural use. The height of the water table in the field is a function of the height of the bund, but can be up to 60 cm above ground level. All year rice cultivation or rotation with other crops is possible, as drainage rather than water availability is the problem. Pisciculture simultaneous and/or rotational to main and/or ratoon rice is also feasible. Rice-fish mixed farming is yet to receive wide attention in Ghana, and literature on its practice locally is lacking.

Symoens & Micha (1995) edited comprehensive literature on agro-pisciculture. Increased rice yields, provision of animal protein, improved soil fertility, and weed, pest and disease control are some of the benefits to be derived from the practice (Cagauan, 1995).

Some factors to be considered in rice-piscicultural studies include the species of fish (e.g., omnivorous, carnivorous or herbivorous), fish sex, the culture system (mono or poly), fish initial weight and density, and time of fish introduction. A minimum depth of 30 cm is required for growth of Nile tilapia (Sollows, 1992). Sollows (1992) also recommends a stocking rate

of 300/1000 m².

The study aimed at screening and selecting promising rice varieties for multi-locational stability trials, and at showing the possibility of culturing Nile tilapia simultaneous and/or rotational to the rice.

Materials and methods

Twenty-three lowland rice varieties received from the West African Rice Development Association and the International Rice Research Institute, and previously evaluated in 1995, were used in the study. Seeds were nursed on 2nd May 1996 and transplanted 27 days later onto a bunded field (dimension 50 cm × 20 cm = 1000 cm²) in a randomized complete block design of three replicates. Plot size and plant spacing were 10 m² and 20 cm × 20 cm, respectively. Transplanting density was 2 plants/hill. Fertilizer rate of 45-60-30 kg NPK/ha was applied 5 days after transplanting (DAT) with additional 45 kg N/ha topdressed 40 DAT. Weeds were hand-picked twice at 15 and 42 DAT.

A sump (refuge) 18 m long × 1 m wide × 0.6 m deep was constructed adjacent to the field and connected to it *via* three ducts. This allowed movement of water and fish between the field and refuge. Nile tilapia supplied by the Department of Fisheries of the Ministry of Food and Agriculture were introduced 59 DAT at a density of 1/m², with individual fish weight being about 10 g. Introduced fish were harvested 139 days later.

Results and discussion

Fig. 1 shows grain yield of rice entries (E.No.) and their designations. Eight varieties (E.Nos. 2, 4, 7, 10, 12, 15, 16, and 19) produced bronzing symptoms characteristic of susceptibility to iron toxicity and will not be further evaluated. Variety E.No. 19 is recommended as the susceptible check for iron toxicity in future varietal trials.

Nine varieties (E.Nos. 1, 3, 5, 6, 8, 9, 13, 18, and 22) will undergo multi-locational stability trials as they yielded higher than E.Nos. 11, 14, 17, 20, 21, and 23 (although in a few cases differences were not statistically significant). The latter entries will not be further evaluated.

Rice yields of up to 4.8 t ha⁻¹ are commensurate with those obtained for these varieties in previous years, and by the check variety (E.No. 23) previously evaluated at the same location. It is, therefore, reasonable to conclude that fish was not detrimental to rice yields.

It was observed that fish produced several schools of fry some of which were fairly mature at the time of harvest (Fig. 2). The average weight of 121 g (standard deviation = 13), actual length of 17.8 cm (standard deviation = 0.9), and standard length of 14.2 cm (standard deviation = 0.9) (Table 1) were obtained after harvesting 20 parent fish (excluding their progeny which were conspicuously smaller in size). No fish mortalities were

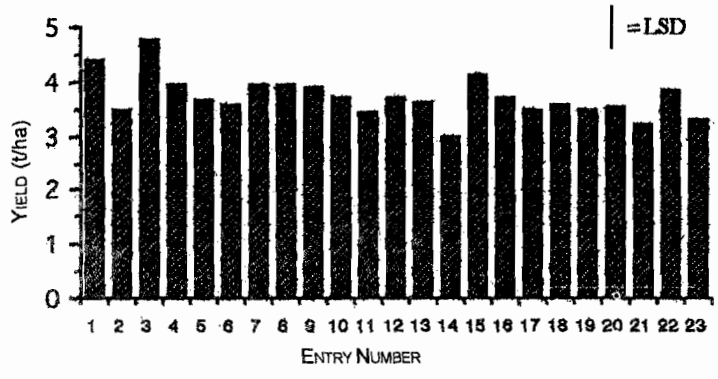

Fig. 1. Yield of rice varieties (CV = 11.59).

Varietal designations

1 = TOX 3100-37-3-3-2-1
2 = RP 1641-144-11
3 = ITA 330
4 = IR 41431-12-3-3-1-1
5 = LAC 23
6 = IR 33356-22-3-1-2
7 = RP 1641-31-5-113
8 = TOX 3118-47-1-1
9 = TOX 3100-37-3-3-2-9
10 = RP 1822-4-2-2-3
11 = IR 33461-39-3
12 = RP 1822-15-2-3
13 = TOX 3100-37-3-3-2-4
14 = IR 51463-BP3-160-2-2-3-1-2
15 = RP 1491-24
16 = TOX 3093-4-5-4-2-1
17 = TOX 3093-4-9-3-2-3
18 = RP 2107-14-12
19 = TOX 3255-78-2-3-2
20 = RP 1855-402-7-2
21 = TOX 3091-30-1-1-2-2
22 = ITA 320
23 = TOX 3027-43-1-E3-1-1-1

Fig. 2. Parent fish (left) with first progeny (middle) and second progeny (right). Third progeny (fries) are not shown. Progeny in the middle were gravid at the time of harvest. Scale: 1:2.3.

TABLE 1

Rice Yields for Graph, Fish Weights and Fish Lengths

E.No.	*Yield*	*Fish weight*	*Fish actual length*	*Fish standard length*
1	4.39	108.05	16.6	12.1
2	3.48	126.17	18.2	14.3
3	4.79	117.84	17.4	14.3
4	3.96	124.09	18.1	14.6
5	3.66	150.89	19.5	16.0
6	3.57	127.55	18.6	15.1
7	3.94	121.47	18.1	14.5
8	3.93	133.01	18.5	15.0
9	3.92	109.59	18.0	14.1
10	3.71	135.59	18.0	14.0
11	3.43	133.21	17.9	13.8
12	3.70	115.90	17.3	14.4
13	3.62	105.81	17.5	14.2
14	2.97	111.81	17.6	14.0
15	4.13	96	15.2	12.0
16	3.72	123.94	17.5	14.5
17	3.47	127	18.1	14.2
18	3.56	101.81	16.6	12.9
19	3.47	125.35	18.2	14.6
20	3.51	125	18.1	14.6
21	3.23			
22	3.86			
23	3.29			

observed, and the field may, therefore, have accommodated higher stocking rates. Fish yields would also have been higher if progeny (especially fries and fingerlings) had been considered.

A simple comparison of income from rice relative to that from fish is as follows: For the highest yielding rice variety (E.No. 3~ITA330) which produced 4.8 t/ha (480 kg/1000 m^2), ¢270,000 would have been realized from sale of paddy at a peak price of ¢562.5/kg.

The 1000 parent fish would have a total weight of 121 g × 1000 = 121 kg. At a price of ¢1500/kg (L. A. Kumah, personal communication), ¢181,500 would have been realized from sale of the parent fish alone. Unlike rice, harvesting of fish could be timed to coincide with periods when maximum income would be realized, as water is permanently available in this lowland. Therefore, when properly managed, income from fish could contribute substantially to that from rice.

Conclusion

Rice-fish culture has been successfully demonstrated for a rainfed lowland ecology. For similar valley bottoms and sites with irrigation facility, the most essential requirement apart from fingerling availability is the willingness to initiate it.

The species of fish used, the culture system (mono), fish initial weight and density, time of introduction, and time of harvest, among others, were arbitrarily chosen. Finding their optima to increase fish yields whilst simultaneously advancing rice varieties for this ecology forms the basis of future work.

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