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A RECORD PRODUCTION FROM AN INTEGRATED FARMING SYSTEM UTILISING SEWAGE ENRICHED WATER

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ABSTRACT

The results of experiments conducted on a pond dyke (655m^2) in the Wastewater Aquaculture Division of the Central Institute of Freshwater Aquaculture, Rahara, during 1992-93 for maximising production through optimum utilisation of resources are communicated. Round the year intensive cultivation of okra *(Abelmoschus esculentus)*, amaranth *(Amaranthus gangeticus* and *A. viridus)*, water-bind weed *(Ipomea aquatica)*, Indian spinach *(Basella rubra)*, radish *(Raphanus sativum)*, amaranth *(Amaranthus viridis)*, cauliflower *(Brassica oleracia* var. *votrytis)*, cabbage *(Brassica oleracia* var. *capitata)* and papaya *(Carica papaya)* was undertaken using the treated sewage water from fish ponds for irrigation. The pond dyke yielded 5,626.5 kg vegetable which worked out to 85.9 tons per ha per year. Multiple cropping with these vegetables excluding papaya on a 460 m^2 dyke recorded a production of 4,926.5 kg at the rate of 107.1t per ha/yr. An improved yearly net return of about 35% over investment could be achieved through the selection of highly productive and pest resistant vegetable crops of longer duration for integration into the system. Introduction of this type of integrated farming would enhance the overall productivity and returns from farming.

INTRODUCTION

It is well known that to feed the vast population of India, production is to be increased through efficient use of land and water resources. These two resources are available in aquaculture farms where about one third farm area is kept in the form of pond dykes and roads for carrying out routine activities. Invariably, pond dykes get infested with deep rooted terestrial weeds causing inconveniance in farm activities. Sometimes poisonous snakes are also encountered. Besides, huge amount of recurring expenditure incurred for deweeding and cleaning of farm area reduces the profittability of aquaculture practices.

Reports are available on the cultivation of vegetables on pond dykes as a means of keeping the pond dykes clean and at the same time enhancement

of overall productivity from aquaculture farms (Roy *et al.*, 1992). Further studies on intensive farming carried out on a pond dyke have thrown light on production potential of fallow dykes utilising stabilised sewage effluent as source of irrigation and nutrients (Rai *et al.*, 1993). In the earlier studies during a year about 12-25 items of vegetables were tried on pond dykes requiring frequent ploughing and irrigation. In the present study to achieve higher production, only 8 items of pest resistant vegetables of comparatively longer duration were selected based on production performance of previous trials and keeping in view the fact that the dykes do not get spoilt due to repeated ploughing and irrigation. Economics of intensive vegetable cultivation on pond dykes for human consumption as well as fish feed for higher return from integrated farming system utilising sewage effluents are alsc dealt with in this communication.

MATERIAL AND METHODS

A pond dyke of size 87.3 x 7.5 m lying between two culture ponds of Wastewater Aquaculture Division of CIFA, Rahara, was selected for conducting agri-horticulture during 1992-93. Out of a total of 655 m^2 dyke area, intensive vegetable cultivation was done on only 460 m^2 (87.3 x 5.27 m) lying on the middle of the dyke while the peripherial area of 195 m^2 (87.3 x 2.23 m) was used for cultivation of papaya.

The cultivated species of vegetables were okra *(Abelmoschus esculentus)*, amaranth *(Amaranthus gangeticus)*, water bind weed *(Ipomea acuatica)*, Indian spinach *(Basella rubra)*, radish *(Raphanus sativum)*, amaranth *(Amaranthus viridis)*, cauliflower *(Brassica oleracia* var. *votrytis)*, cabbage *(Brassica oleracia* var. *capitata)* and Papaya *(Carica papaya)*.

After initial ploughing the area of plot for intensive cultivation was treated once with cowdung @ 10 ton/ha to maintain physical condition of the soil during preparation of the dyke for summer crop cultivation. Chemical fertilisers were also applied to maintain proper growth of the crops. Irrigation of the crops were done from adjacent sewage fed fish pond. As far as practicable the dyke was utilised through cultivation of different vegetables throughout the year using multiple cropping technique with single crop. For the present study only longer duration pest resistent vegetables items were selected for cultivation keeping in view productivity as well as suitability of items on pond dykes. Pesticide (Metacid) was used on vegetable field very carefully at low dose to avoid possible contamination in adjacent fish pond. Harvesting of long duratoin crops like amarnath (Note sag), Indian spinach (Pui) and water bind weed (Kalmi) was done through multiple clipping at every 10-15 days interval.

Regular record of data on expenditure incurred towards ploughing, seed, fertilisation, irrigation and harvest of crops was maintained for the dyke for the entire cultivation period. Labour cost was calculated based on the actual

Table 1 : *Details of intensive vegetable cultivation on fish pond dyke (655 m^2) of Rahara Research Centre during 1992-93*

Name of the vegetable	Area (m^2)	Period of cultivation (days)	Production (kg)	Selling rate (Rs/kg)	Sale value (Rs.)	Production/ha/ crop duration (t)	Production/ m^2/day (g)
Okra (crop-I)	120	03.02.92 to 08.05.92 (95)	140.1	3.0	420.3	11.675	12.3
Okra (crop-II)	120	19.05.92 to 05.09.92 (108)	212.3	3.0	637.9	17.680	16.4
Amaranth (Note sag)	32	09.03.92 to 19.08.92 (163)	297.0	2.0	594.0	92.810	56.9
Water bind weed (Kalmi)	55	09.03.92 to 08.09.92 (183)	689.3	1.0	689.3	125.330	68.5
Indian spinach (Pui)	46	09.03.92 to 26.08.92 (170)	364.8	1.5	1033.95	79.300	46.6
Radish (crop-I)	60	11.04.92 to 02.06.92 (52)	55.5	3.0	166.50	9.250	17.8

Table 1 : Contd...

Name of the vegetable	Area (m^2)	Period of cultivation (days)	Production (kg)	Selling rate (Rs/kg)	Sale value (Rs.)	Production/ha/ crop duration (t)	Production/ m^2/day (g)
Radish (crop-II)	60	10.06.92 to 13.08.92 (65)	28.2	3.0	84.60	4.700	7.2
Amaranth (Data)	127	11.04.92 to 03.06.92 (54)	501.1	1.0	501.10	39.460	73.1
Total (summer crop)	460		2288.3		4127.650	49.745/ha	
Cauliflower	220	03.09.92 to 27.11.92 (85)	423.5	4.0	1694.00	19.250	22.6
Cabbage (I)	220	28.09.92 to 26.12.92 (89)	556.4	2.0	1112.80	25.290	28.4
Cabbage (II)	440	03.12.92 to 25.02.93 (84)	1658.3	1.5	2487.45	37.690	44.9
Total (winter crop)	460		2638.20		5294.25	57.352/ha.	
Total (winter + summer)	460		4926.5			107.1/ha/yr	
Papaya	195	01.04.92 to 31.03.93 (365)	700.0	1.5	1050.00	35.900	9.8
Grand Total (Summer + winter + papaya)			5626.5		10471.90	85.901/ha/yr	

mandays deployed for cultivation multiplied by the prevailing daily contingent wage rate of Govt. of West Bengal. Systematic record of harvest data were maintained throughout the harvesting period. Prices of the harvested vegetables were those of the average wholesale price prevailing in the local market.

Summary of intensive vegetable cultivation and horticulture done on pond dyke are furnished in Table 1. It can be seen from the table that barring a few the entire season has been divided into two parts viz., the summer (March to August) and the winter (September to February) for cultivation. In summer multiple cropping with vegetables like okra, amaranth, water bind weed, Indian spinach and radish were practiced on small plots of the dyke simultaneously or one after another. Similarly during the winter season vegetable items like cauliflower and cabbage were cultivated. However, perennial crop papaya remained common for both the seasons. Two crops of okra were cultivated one after another on the same plot during the summer. Similarly during winter firstly the entire dyke was engaged in cultivation of cauliflower and cabbage in two equal halves. Before complete harvesting cabbage saplings were again transplanted on the fallow space left in between the two plants of cabbage as can be seen in item No.9 & 10 (Table 1). The process helped in harvesting of two crops of cauliflower + cabbage (1st crop) and cabbage (2nd crop) from the same plot during winter.

RESULTS AND DISCUSSION

It can be seen from Table 1 that during summer the highest production rate was recorded by amaranth (Data sag) (73.1g/m^2/day) followed by water bind weed (68.5g/m^2/day), amaranth (Note sag) (56.9g/m^2/day), Indian spinach (46.4g/m^2/day), radish Cr-I (17.8g/m^2/day) okra (12.3-16.4/m^2/day) and radish-Cr-II (7.2/m^2/day). Similarly among winter crops best performance was demonstrated by late varieties of cabbage (44.9g/m^2/day) followed by early varieties of cabbage (28.4g/m^2/day) and cauliflower (22.6g/m^2/day). Production rate of radish crop II was not encouraging because it was grown in off season. Highly satisfactory production for water bind weed, amaranth (Note) and Indian spinach could be achieved by resorting to single cropping and multiple harvesting technique. Multiple harvesting was possible due to inherent nature of these vegetables to get ready for next clipping within 2-3 weeks time of first harvest by clipping. During winter season cultivation was restricted to cabbage and cauliflower only which were reported to produce best (Rai *et al.*, 1993). The perennial crop papaya demonstrated comparatively poor production, yet this crop cannot be discarded because of the fact that this is grown at the periphery of the dykes where nothing can be grown without disturbing the soil and leaving sufficient space for netting operations.

Table 1 indicates that production rate of some of the items of vegetables were higher but sale values were

Table 2 : *Componentswise annual expenditure of extensive vegetable cultivation on fish pond dyke (655m^2)*

Items	Quantity/duration	Rate (Rs)	Expenditure (Rs)	Percentage of total cost	
Human Labour	300 mandays	18/mandays	5400.00	69.5	
Ploughing	5 hrs. 36 min. (4 times)	60 / hr.	336.00	4.3	
Seed / Seedlings					
i) Okra, amaranth, Indian spinach, waterbind weed seed	1.650 kg	92.40/kg.	152.50	2.0	11.6
ii) Cauliflower, cabbage & papaya seedlings	3175 nos.	23.50/100 nos.	746.10	9.6	
Manure/pesticide					
i) Cowdung	1500 kg.	0.15/kg.	225.00	2.9	13.3
ii) Fertilizer	125 kg.	6.20/kg.	775.00	10.0	
iii) Pesticide	100 ml.	28.00/100 ml.	28.00	0.4	
Irrigation	5 hrs./15 minutes (10 times)	20.00/hr	105.00	1.3	
	Total		7,767.60		

comperatively lower and *vice versa*. Under the circumstances, in order to identify and select the right vegetable after giving due weightage to both production and price worked out an index was by multiplying the production rate with the rate of sale (Table 1). Based on these indices amaranth (Note), amaranth (data), Indian spinach, water bind weed, radish (Crop-I), and okra (Crop-II) are recommend for cultivation during summer. Index value for okra (Cr-I) inspite of being lower cannot be ignored becaurse this crop is ideal for cultivation during premonsoon months, when no other crop can be cultivated to yield this level of production (Rai *et al.*, 1993).

From Table 1 it is clear that from the whole dyke area of 655 m^2 achieved a record high vegetable and fruit production of 5626.5 kg (85.9 t/ha/yr), but in reality out of 655 m^2 dyke area, vegetable cultivation was done on 460 m^2 only. If we take into consideration the vegetable production of 4926.5 kg (excluding papaya) grown on 460 m^2 only then the extrapolated production works out to be 107.1 ton/ha/yr. These achieved productions of 107.1 ton/ha/yr and 85.9 ton/ha/yr are 19.7 and 24.1% higher compared to the highest produced from the same dyke earlier (Rai *et al.*, 1993).

In the present case improvement in production could be achieved through selection of highly productive vegetable items for different seasons and efficient utilisation of dykes round the year. Besides, about 1,000 kg of cabbage and cauliflower leaves obtained during harvest from pond dyke, which are generally thrown away and about 10% of total harvest of water bind weed, Indian spinach and amaranth obtained during trimming and sorting for harvest were utilised as feed of grass carp.

Componentwise cost of vegetable cultivation is presented in Table 2 which shows that human labour constituted about 69.5% of total cost followed by manures and pesticide (13.3%), seed and seedling (11.6%), ploughing (4.3%) and irrigation (1.3%), Labour cost being the highest in total operational cost indicates the potential of employment opportunities in such integrated rural farming activities. Expenditure on manures and fertilisers could be reduced through integration of treated sewage water as irrigation. Metacid was used at low dose only in extreme circumstances to avoid toxic effect on fish pond.

In the present case the overall yearly net return on investment from vegetable cultivation on pond dyke has been found to be about 35% which is higher than the previous reported return of 29.9% (Rai *et al.*, 1993). This improvement in net return could be attributed to reduction in expenditure on ploughing and irrigation. These reductions were possible due to selection of pest resistant vegetable items of longer duration viz. okra, amaranth, Indian spinach and water bind weed during summer and cauliflower and cabbage as winter crop which in turn helped in achievement of higher production also.

Therefore, introduction of suitable vegetable cultivation on pond dykes along with the established low cost

sewage-fed fish culture will yield higher production and lucrative economic return from integrated farming system involving aquaculture and agri-horticulture.

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