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Partial Budget Analysis of Nile Tilapia *Oreochromis niloticus* Cultured Within an Existing Agricultural Farm in Kuwait

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Abstract

The purpose of this study is to determine the profitability of culturing tilapia at the Public Authority for Agriculture and Fisheries (PAAF) Experiment Station and in three theoretical scenarios using existing alfalfa farm conditions. The three theoretical scenarios were designed using existing farm resources and cheaper construction materials. Farm 1 and the PAAF Experimental Station had the same amounts of tilapia production. Tilapia production in Farm 2 is double the tilapia production in Farm 1, while Farm 3 had the same production as Farm 2 but it received 50% feed cost government subsidy.

The results of this study show that profitability of culturing tilapia under existing alfalfa farm conditions is possible even at an annual production rate of 2,475 kg·farm. Higher profitability may be achieved by doubling the production of the farm to 4,950 kg·farm. With government subsidy on feed costs, additional income of about $7,574 per year per farm is possible if tilapia production is integrated into existing farms. Based on the results of this study, culturing tilapia could be a profitable means of increasing the productivity of an existing agricultural farm.

Introduction

Water is the most limited resource for crop production in Kuwait. Open field crop production is primarily conducted using underground brackishwater (3 to 9 ppt). Therefore, only crops that can tolerate the levels of salt in brackishwater are planted. According to Leclercq and Hopkins (1985), brackish groundwater for aquaculture requires large amounts of water, about 14 to 20 m^3 kg^{-1} tilapia. Therefore, brackishwater used to irrigate crops may first be used to culture fish. This integration increases the efficiency of water use as well as the utilization of farm facilities and labor. Such integration has been practiced in many countries as a means of increasing production and profit per unit area of land (Tan et al. 1973; Tagarino 1985; Bacon et al. 1993; Rakocy et al. 1993; Gupta et al. 1998; Horstkotte-Wesseler

1999). Another benefit of such integration is that waste materials from fish culture reduces expenditures on inputs and helps raise the production of other crops (Rajbanshi 1980; Bondari et al. 1983; Rennert 1992; Israel and Sevilleja 1993; D' Silva and Maughan 1994; McMurty et al. 1997).

An economic analysis of potential production systems and species for aquaculture development in Kuwait indicated that an integrated tilapia-crop farming system using a flow-through simple recycling system would be the most profitable system, even on a very small scale. A rate of return on operating costs of about 47.6% was predicted at a production level of 2.5 t·yr (KISR 1988). Hopkins et al. (1984) indicated that integrating tilapia culture with agricultural crops would improve the economic viability of both crops by spreading the cost and the usefulness of the water systems.

An integrated tilapia culture with alfalfa production without increasing the present utilization of groundwater was successfully demonstrated by Al-Ameeri et al. (1999). Annual production of 2,475 kg was obtained and effluent from tilapia tanks had no adverse effect on alfalfa production.

The purpose of this study is to determine the profitability of producing 2,475 kg of tilapia with the effluent used to produce alfalfa at the PAAF Experiment Station and three theoretical scenarios using existing gravity irrigated alfalfa farm conditions. Results of this study will assist farmers in determining their expected economic returns as well as help government officials in assessing means of subsidizing farm resources to improve farm profitability with the end in view of encouraging food production in the area.

Methodology

Fish culture facilities used by Ameeri et al. (1999) and their operation

A greenhouse and a pump house measuring 18.5 x 5.5 x 3.0 m and 2.0 x 3.0 x 2.5 m (L x W x H), respectively were constructed at the PAAF Experimental Station in Al-Wafra, Kuwait. Inside the greenhouse were two raceways, each with three fish tanks of different sizes; each tank is equipped with a sand filter. The fish tanks were elevated and arranged in tiers. The first, second and third fish tanks had capacities of 1.5, 4.5 and 6.0 m^3, respectively and measured 1.5 x 1.0 x 1.2 m, 4.5 x 1.0 x 1.2 m and 6.0 x 1.0 x 1.2 m, respectively. These tanks were made of fiberglass. A sand filter (2.0 x 1.0 x 0.6 m) was installed at the outlet of the third fish tank. Next to the sand filter, a reservoir (1.5 x 2.0 x 1.5 m) was provided to recycle the water back to the first fish tank during non-irrigating hours. A submersible pump was installed to enable recycling of water back to the first fish tank. Each raceway received a flow rate of 250 l·min or a total of 500 l·min for both raceways which is equivalent to the water pump output per farm. New water delivery time was from 0800 to 1600 h.

One air blower was used and another blower served as a back up. The reservoir tanks, air blowers and submersible pumps were inside the pump house. Each culture tank was supplied with air stones. PVC pipes and plastic tubings connecting the air stones to the air blower were installed. The oxygen provided by the air blower enabled the maintenance of oxygen levels from 2.0 to 2.5 mg·l only. To increase the oxygen to a desired level, aeration columns in the first tank and an agitator in the second tank of each raceway were later installed. An automatic feeder was installed in each fish tank. A back up generator had to be purchased due to the incidence of very high mortality caused by power failure during the culture period.

Fish culture techniques used by Ameeri et al. (1999)

Production schedule started with the stocking of *Oreochromis niloticus* fingerlings of 1.0 to 5.0 g in the first tanks in each raceway. Every 70 days, the fish were transferred to the next consecutive tanks while the first tanks were restocked with new fingerlings. After 210 days, the fish were harvested from the third tanks. With stocking and harvesting done every 70 days, five croppings are possible in a normal year. For the two raceways, approximately 500 kg·crop were produced or a total annual yield of 2,475 kg.

Commercially prepared tilapia sinking pellets (39% crude protein) by Provimi, Holland were given. Fish were fed at satiation rate using automatic feeders set to discard feed every three hours during daylight time. The average feed conversion ratio was 1.8.

Economic analysis

This is a partial budget analysis of tilapia culture integrated with existing alfalfa farms where irrigation water is first utilized to culture tilapia while the effluent is used to irrigate alfalfa during irrigation time then recycled during non-irrigation time. As such, only the costs and revenues from the tilapia culture operations are considered here. The total enterprise budget of the farm is not considered or included here. Calculation of the budget is based on the facilities and production techniques used by Ameeri et al. (1999).

The costs of constructing the facilities (greenhouse, pump house, fish tanks, sand filters, reservoir, water lines, air lines and diffusers, drainage system, etc.) for the culture of tilapia are recorded. Other capital costs, such as costs of sump pumps, air blowers, automatic feeders, weighing balance and agitators are likewise recorded. The costs of land and the construction of well and pump are not included in the capital cost of the tilapia enterprise since these are integral components of the existing alfalfa farm.

The following operational cost items are noted: fingerlings, feed, labor, chemicals and other supplies, and electricity. Depreciation cost is computed by dividing the cost by the life span of the equipment/facilities. Miscellaneous expenses is 5% of the operational cost. Profit is calculated by subtracting the total operational expenses from the fish sale revenues. Break-even cost per kilogram fish is determined by dividing the total expenses by the total fish production. The rate of return on expenses is determined by dividing the profit by the total operational cost multiplied by 100 while the rate of return on investment is derived by dividing the profit by the total capital cost multiplied by 100.

Only the actual time devoted to fish production such as feeding the fish and other chores related to culturing the fish are considered as labor costs, since under actual farm conditions, in addition to attending to the regular duty of producing alfalfa, the laborers also attend to the culturing of tilapia.

The farm gate price of $5.00 per kilogram of tilapia is based on the market selling price at Al-Wafra. Cost per fry is based on the estimated production cost of $0.23 (Ridha et al. 1998). Feed cost is $0.83 per kilogram.

A simple economic analysis was done to compare the profitability of the different scenarios in terms of profit, rates of return on operational expenses and investment, and break-even cost of tilapia culture in an alfalfa farm (Shang 1981). Economic analyses were conducted for the newly established tilapia farm at the PAAF Experimental Station.

These analyses were extended to three theoretical scenarios designated as Farms 1, 2 and 3, where the tilapia facilities were established in an existing alfalfa farm using cheaper construction materials and existing resources. In the three scenarios, the design, construction, and development of facilities are as follows: 1) plastic covered greenhouse and pump house instead of the corrugated roof used at the PAAF Experimental Station; 2) concrete tanks instead of fiberglass tanks; 3) no agitators since even after the agitators are introduced, tilapia production is the same as before the agitators are installed; 4) no weighing balance as the farm normally has one; 5) no automatic feeders as manual feeding of the fish would be more economically advantageous than using automatic feeders.

In Farm 1, tilapia production is similar to that at the PAAF Experimental Station. In Farm 2, production is double that of Farm 1. Theoretically, production can be doubled without increasing water consumption (500 l·min for 8 hr) in this system where a sand filter is used to remove solid wastes before the water is recycled (Muir 1982). In Farm 3, production is the same as Farm 2, but this received a government subsidy of 50% on the feed costs that started in 1998.

Results and Discussion

Capital costs

The costs of establishing the tilapia facilities at the PAAF Experimental Station in Al-Wafra, Farm 1 and Farm 2 are $56,895, $29,450 and $42,070, respectively (Table 1). The capital cost for Farm 3 is the same as that of Farm 2. The only difference between the two farms is in the operational expenses since 50% of the feed cost in Farm 3 is subsidized by the government. Although they produce the same amounts of fish yield (2,475 kg), the capital cost of the PAAF Experimental Station is almost twice that of Farm 1 since the former is designed primarily for research while the latter is for fish production.

The greenhouse and the pump house are the major items in the capital costs for all the farms. Other major items in the capital costs are the standby generator, fiberglass tanks and reservoirs, air blowers and automatic feeders.

Reduction in capital costs in Farm 1 is primarily due to the use of ordinary greenhouse design and materials usually utilized by crop farmers in growing vegetables (cost is only $8,250). This is approximately three times cheaper than what is used in the PAAF Experimental Station. Using tanks made of cement also reduced tank cost by approximately 60%. The non-inclusion of automatic feeders, agitators and balance also contributed to the reduction in capital costs.

For Farms 2 and 3, most of the capital cost items in Farm 1 are doubled except for the standby generator, air blowers and sump pumps, the capacity of which can support a doubled production.

Operational expenses

The total operational expenses for culturing tilapia at the PAAF Experimental Station, Farm 1, Farm 2 and Farm 3 are $13,396, $11,269, $20,725 and $17,176 respectively (Table 2). Considering the high capital costs of the PAAF Experimental Station facilities, its depreciation cost (34.58%) is the biggest operational cost item. Depreciation cost is correspondingly reduced by using cheaper construction materials for the construction of tilapia facilities and the non-inclusion of some equipment in Farms 1, 2 and 3. Although reduced, it is still considered as a major expense item, representing 16.96 to 23.26% of the total operational expenses.

With the reduction in depreciation costs in Farms 1, 2 and 3, fingerling cost became the largest operational cost item (30.38 to 39.87%), followed closely by feed costs (30.01 to 32.63%). With 50% government subsidy in feed costs, it was greatly reduced to 19.69% in Farm 3. Feed and fry costs represented more than 60% of the operational costs. Reducing the fingerling cost is therefore recommended to increase the profitability of the enterprise. The establishment of a National Tilapia Hatchery where fry is at a subsidized price will help reduce production costs further (Ridha et al. 1998).

Labor cost represents less than 12% of the operational costs. This is expected since a laborer who attends to the culturing of tilapia works only for a few hours. The labor cost is therefore computed based only on the actual number of hours spent for culturing tilapia. An average of two hours per day is spent by a laborer in producing 2,475 kg of fish. This indicates that only one-fourth of a laborer's time is required for culturing tilapia. With a monthly wage of $330, the labor cost is $82.50 per month.

The average electric power consumption for the operation of the air blower, exhaust fans, submersible pumps, agitators and fluorescent lights is 137 kW·day or 4,117 kW·month. The low cost of electricity is due to the very cheap cost of electricity ($0.67/100 kW).

Profitability

The economics of culturing tilapia at the PAAF Experimental Station, Farm 1, Farm 2 and Farm 3 are presented in table 3. At a selling price of $5.00·kg fish, the profits are -$1,021, $1,106, $4,024 and $7,574, respectively.

Table 1. Facilities and equipment costs of the tilapia facilities for the different scenarios.

Item	Life span (yr)	PAAF		Farm 1		Farm 2	
		Cost (US$)	Annual depreciation	Cost (US$)	Annual depreciation	Cost (US$)	Annual depreciation
Greenhouse and pump house	15	24,570	1,640	8,250	550	16,500	1,100
Standby generator	15	8,250	550	8,250	550	8,250	550
Air blowers	7.5	6,600	880	6,600	880	6,600	880
Tanks and reservoirs	15	7,460	497	2,900	193	5,800	387
Automatic feeders	10	3,320	332				
Pipes and fittings	15	2,260	151	1,155	77	2,310	154
Agitators	10	1,280	128				
Sump pumps	5	990	198	990	198	990	198
DO meter	10	990	99	990	99	990	99
Balance	10	860	86				
Airstones	10	165	17	165	17	330	33
Buckets	4	80	40	70	18	140	35
Scoop & cover nets	2	70	18	80	40	160	80
Total		56,895	4,633	29,450	2,621	42,070	3,516

Table 2. Operational expenses in culturing tilapia for the different scenarios.

Operational expenses	PAAF Annual cost US$	PAAF Annual cost Percent	Farm 1 Annual cost US$	Farm 1 Annual cost Percent	Farm 2 Annual cost US$	Farm 2 Annual cost Percent	Farm 3 Annual cost US$	Farm 3 Annual cost Percent
Fingerlings	3,424	25.56	3,424	30.38	6,848	33.04	6,848	39.87
Feed	3,381	25.24	3,381	30.01	6,762	32.63	3,381	19.69
Wage	990	7.39	990	8.78	1,980	9.56	1,980	11.53
Electricity	331	2.47	316	2.81	633	3.05	633	3.68
Depreciation	4,633	34.58	2,621	23.26	3,516	16.96	3,516	20.47
Miscellaneous	637	4.76	536	4.76	987	4.76	818	4.76
Total	13,396	100.00	11,269	100.00	20,725	100.00	17,176	100.00

Table 3. Profitability of culturing tilapia with alfalfa production in US$.

Items	PAAF Station	Farm 1	Farm 2	Farm 3
Fish sales	12,375	12,375	24,750	24,750
Expenses	13,396	11,269	20,726	17,176
Profit	-1,021	1,106	4,024	7,574
Break even cost	5.41	4.55	4.19	3.47
Rate of return on expenses, %	-7.62	9.82	19.42	44.11
Rate of return on investment, %	-1.79	3.76	9.57	18.01

Farm 1 = Tilapia facilities established in existing farm.
Farm 2 = Existing farm that doubled the production of Farm 1.
Farm 3 = Farm 2 with 50% subsidy on feed cost.

To break even, fish should be sold at $5.40, $4.55, $4.19 and $3.47·kg, respectively. With a negative profit in the PAAF Experimental Station, the rates of return on expenses and investment are likewise negative (-7.62 and -1.79%, respectively).

Since Farms 1, 2 and 3 are profitable, positive rates of return on expenses (9.82, 19.42 and 44.11%, respectively) and investment (3.76, 9.57 and 18.01%, respectively) are obtained. However, the rate of return on investment obtained in this study is lower than those reported by KISR (1988) due to the inclusion of the cost of the standby generator, a major capital cost item in this study.

Doubling the fish production in Farm 2 resulted in more than twice the rate of return on investment since the existing air blower, sump pumps and standby generator are capable of supporting the doubled production. On the other hand, the rate of return on expenses in Farm 3 resulted in more than twice than that of Farm 2 due to the 50% subsidy in the feed cost which is a major cost item. Balarin and Haller (1983), describing a similar set up at the Baobab Farm in Kenya, but using a flow-through system, indicated a rate of return on investment of nearly 25% of the total investment for a unit of over 75 to 100 t and that lower rates of return were obtained at lower production levels similar to those obtained in this study.

Farm 3 is the most profitable of the three farms. The higher rates of return on expenses and investment (44.11 and 18.01%, respectively) over Farms 1 and 2 indicate that subsidizing the feed cost, a major cost item, greatly helped in making the farm profitable. Similar results were obtained by Balarin et al. (1986) where the rate of return amounted to 40 to 70% of the total operational expenses.

Results of this partial budget analysis show that an additional income of about $7,574 per year per farm is possible in an existing farm producing 4,950 kg of tilapia per year with government subsidy in feed costs. This income from tilapia production represents about 30% additional income from alfalfa production. With rice and fish integration, income from fish production provided is estimated from 20% to even more than the income from rice production (Hickling 1961; Pongsuwana 1963; Tan et al. 1973; Tagarino 1985; Gupta et al. 1998).

Conclusion

The results of this partial budget analysis indicate that profitability under existing farm conditions is possible even at an annual production rate of 2,475 kg·farm. Higher profitability can be achieved by doubling the production of the farm to 4,950 kg·farm. With government subsidy on feed costs, additional income of about $7,574 per year per farm is possible if tilapia production is integrated into the farm. Based on the results of this study, culturing tilapia could be a profitable means of increasing productivity in an existing agricultural farm.

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