SMALL-SCALE AQUACULTURE BUSINESS PLANNING IN CAMEROON

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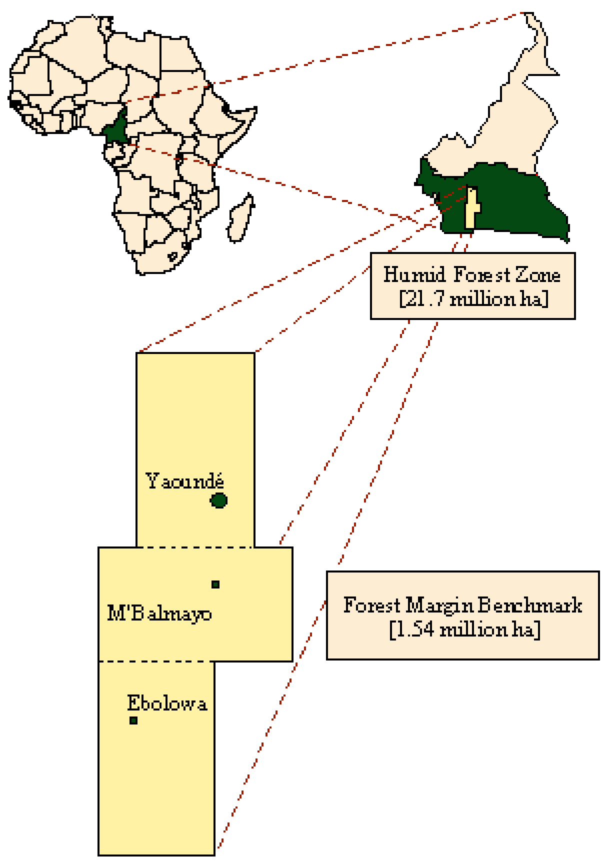
Abstract

In Cameroon, the principal objective set out for the aquaculture sector is to sustainably improve farmer incomes. To be profitable and sustainable investments in aquaculture businesses need to achieve a scale sufficient to allow for the purchase of inputs, the hiring of labour and the marketing of outputs for cash income. At present, political instability and poor governance in many African countries mitigate in favour of very large-scale farms that can absorb risk. However, within the range of possible scales, small and medium enterprises generate more employment and equitable economic growth than larger-scale investments. Participatory, on-farm, action research in Cameroon has elaborated a tool, the Aquaculture Business Planning Assistant, that can help governments and smaller investors identify the basic production system that can achieve a minimum profitable scale.

Figure 1. The Forest Margns Benchmark of South-Central Cameroon.



Introduction

To address the Government of Cameroon's aquaculture development priority of decreasing rural poverty, a five-year participatory action research study was undertaken by the WorldFish Center and L'Institut de Recherche Agricole pour le Développement (IRAD) to identify and alleviate critical constraints to the profitability of smaller scale aquaculture investments in the Forest Margins Benchmark of South-Central Cameroon (Figure 1).

IRAD is the key aquaculture research institute in Cameroon, and as such is responsible for the development and dissemination of appropriate technology for Cameroonian fish farmers. Over the last 30 years, there have been a number of aquaculture research and development projects that have led to the establishment of basic technology, but sustained adoption has been low. This project was undertaken to: 1) estimate the economic efficiency and profitability of the basic aquaculture technology to help understand why it is not meeting the needs of farmers and, 2) indicate possible alternative farm management strategies for sustainable aquaculture in Cameroon.

Materials & Methods

A series of seven participatory research/extension trials based on the methods of Brummett & Noble (1995) and Brummett et al. (2004) to establish the basic technology, productivity and prices for inputs and outputs. A Research-Extension Team (RET) in which a senior research scientist was employed at 25% of full time to guide joint learning exercises (participatory research projects) undertaken by farmers and extension agents working together. During five years of regular farm visits, they collected structured datasets on over 400 individual production cycles, based on the hypotheses posed in Table 1.

Multiple regression, with individual farmers as replicates, was used to analyse results (Zar 1974), which were then compared to datasets collected in on-station trials to guide interpretation. Data was loaded into a spreadsheet that uses average productivity values to calculate system profitability depending upon pond size, labour requirements, input and output prices and interest rates. Results were than taken back to the farm for validation and discussion. Outcomes were compared and used to prioritize target groups and technologies that could improve the performance of small-scale aquaculture.

Table 1. Hypotheses tested over seven cycles of participatory action research in Central Province, Cameroon.

Topic	**Number of Farmers**
H_o: Pond depth has a positive effect on tilapia production.	67
H_o: Flushing rate in barrage ponds is negatively correlated with fish production.	19
H_o: Pond productivity is proportional to compost size and recharge rate.	54
H_o: Composts of nutrient-rich *Tithonia diversifolia* and *Chromolaena odurata* improve pond productivity over mixed compost systems.	41
H_o: Introduction of predators (*Clarias gariepinus, Hemichromis elongates*) improves tilapia average weight at harvest and pond profitability.	130
H_o: Supplemental feeds comprised of pelleted agriculture by-products improve pond productivity.	61
H_o: Market access increases pond profitability.	32
H_o: Pelleted, complete diets and short production cycles improve profitability of tilapia monoculture.	2

Results

The production model promoted by IRAD for use by small-scale fish farmers based on a number of years of on-station research can be summarized as follows:

- **Production Unit:** 500 m^2 pond
- **Stocking Rate:** 2 *Oreochromis niloticus* (12 g) plus 1 *Clarias gariepinus*[1] (7g) per m^2
- **Inputs:** compost crib occupying 10% of pond surface area, charged with 4 tons wet organic matter per production cycle
- **Production Cycle:** approximately 300 days
- **Average Standing Stock at Harvest:** 2450 kg/ha

These farms are generally rural and sell fish into village markets where tilapia (minimum size 150 g) retail pond-bank for about xaf 700 per kg (xaf 500 = 1 USD) and catfish (minimum size 400 g) for xaf 1500 per kg.

Despite a number of research and extension projects aimed at improving the productivity and profitability of small-scale aquaculture systems in Cameroon, few of these have achieved sustainability. Typically, within a few months after the end of project subsidies, productivity collapses to background levels (approximately 300 kg/ha). Loading the parameters of this basic production system data into the spreadsheet produces the outcomes shown in Table 2. Interviews with farmers revealed that the profitability of this system is simply too low to justify the required investments in labour and management, even without costing inputs, amortization or family labour.

Increasing the pond size by an order of magnitude to 5000 m^2 (Table 3) raises profitability and return on investment (ROI) to a level most farmers accepted as sufficient motivation, but the labour required to cut and transport what now becomes 40 tonnes of wet organic matter probably exceeds the capacity of the family (i.e., unpaid labour). To cover the costs of hired labour sufficient to reduce the amount of compost that needs to be cut and transported to 200 kg/pers/day, the minimum pond size has to be increased to 10 ha to maintain similar levels of profitability (Table 4). However, ROI is now only 3%, and the total investment of nearly $50,000 is more than most small-scale farmers in Cameroon can afford. If financing is needed, the investment loses money, no matter how big you make it (Table 5). In any case, even at 1 ha, the 80 tonnes of wet organic matter per year is needed to load the compost crib and the 20,000 tilapia fingerlings needed for stocking are not available on most small farms. Basically, no matter how you manipulate the basic system, it appears impossible to make it profitable.

However, if urban markets can be accessed, wholesale prices for tilapia rise to xaf 1500 and catfish to xaf 2500 per kg. Even with increased transportation costs to cover marketing, a 2500 m^2 farm selling into the urban market makes an acceptable profit on 20 tonnes wet organic matter inputs and a total investment of about $1200 (Table 6).

[1] Included primarily as a predator to control excessive tilapia reproduction.

Once a farmer is connected to urban markets, other opportunities to increase production and profits present themselves. For example, if feeds are purchased, productivity and the number of production cycles per year can be increased. By shortening the production cycle, the amount of tilapia reproduction – and thus the overcrowding of ponds - declines along with the need for expensive catfish fingerlings. Removing the cost and logistical difficulties of obtaining catfish fingerlings, further improves the profitability of the system (Table 7).

Table 2. Budget (XAF) for the basic pond aquaculture technology package promoted for use by small-scale fish farmers in Cameroon (XAF500 = 1 USD).

	Quantity	Unit Price	Total Cost		Amount	% of Total
Investment				**amortization (yrs)**		
Pond Construction (m²)	**500**	0	0	10	0	0
Equipment			100,000	5	20,000	16
Stocking						
Tilapia	1,000	**0**	0		0	0
Catfish	500	**125**	62,500		62,500	51
Operations						
Feed (kg)	**4,000**	**0**	0		0	0
Labour (person-days)	**0**	3,000	0		0	0
Transport (round trip)	**2**	20,000	40,000		40,000	33
Total Production Costs (per cycle)					**122,500**	100
Revenues						
Tilapia (kg)	72	700			50,267	
Catfish (kg)	51	1,500			76,034	
Capacity Anticipated	**2,450**				**126,302**	
Total Investment			**202,500**			
Financing (% / month)			**0.00**		**0**	**Interest**
					3,802	**Net Per Cycle**
Cycle/Yr	**1**				**3,802**	**Net Per Year**
Production Total (T)	0.12				**2**	**% ROI**

Table 3. Budget (XAF) for the basic pond aquaculture technology package applied to a 5000 m^2 fish farm without hired labour (XAF500 = 1 USD).						
	Quantity	**Unit Price**	**Total Cost**		**Amount**	**% of Total**
Investment				**amortization (yrs)**		
Pond Construction (m²)	**5,000**	0	0	10	0	0
Equipment			100,000	5	20,000	3
Stocking						
Tilapia	10,000	**0**	0		0	0
Catfish	5,000	**125**	625,000		625,000	91
Operations						
Feed (kg)	**40,000**	**0**	0		0	0
Labour (person-days)	**0**	3,000	0		0	0
Transport (round trip)	**2**	20,000	40,000		40,000	6
Total Production Costs (per cycle)					**685,000**	100
Revenues						
Tilapia (kg)	718	700			502,672	
Catfish (kg)	507	1,500			760,345	
Productivity (kg/ha)					**1,263,017**	
Capacity Anticipated	**2,450**					
Total Investment			**765,000**			
Financing (% / month)			**0.00**		**0**	Interest
					578,017	**Net Per Cycle**
Cycle/Yr	**1**				**578,017**	**Net Per Year**
Production Total (T)	1.23				**76**	**ROI**

Table 4. Budget (XAF) for the basic pond aquaculture technology package applied to a 10 ha fish farm with hired labour but without financing (XAF500 = 1 USD).

	Quantity	Unit Price	Total Cost		Amount	% of Total
Investment				**amortization (yrs)**		
Pond Construction (m²)	**100,000**	0	0	10	0	0
Equipment			100,000	5	20,000	0
Stocking						
Tilapia	200,000	**0**	0		0	0
Catfish	100,000	**125**	12,500,000		12,500,000	51
Operations						
Feed (kg)	**580**	**0**	0		0	0
Labour (person-days)	**4,000**	3,000	12,000,000		12,000,000	49
Transport (round trip)	**2**	20,000	40,000		40,000	0
Total Production Costs (per cycle)					**24,560,000**	100
Revenues						
Tilapia (kg)	14,362	700			10,053,448	
Catfish (kg)	10,138	1,500			15,206,897	
Productivity (kg/ha)					**25,260,345**	
Capacity Anticipated	**2,450**				**700,345**	
Total Investment			**24,640,000**	**0.00**	**0**	Interest
Financing (% / month)					**700,345**	**Net Per Cycle**
Cycle/Yr	**1**				**700,345**	**Net Per Year**
Production Total (T)	24.50				**3**	**ROI**

Table 5. Budget (XAF) for the basic pond aquaculture technology package applied to a 40 ha fish farm with low interest financing (XAF500 = 1 USD).						
	Quantity	**Unit Price**	**Total Cost**		**Amount**	**% of Total**
Investment				**amortization (yrs)**		
Pond Construction (m²)	**400,000**	0	0	10	0	0
Equipment			100,000	5	20,000	0
Stocking						
Tilapia	800,000	**0**	0		0	0
Catfish	400,000	**125**	50,000,000		50,000,000	51
Operations						
Feed (kg)	**580**	**0**	0		0	0
Labour (person-days)	**16,000**	3,000	48,000,000		48,000,000	49
Transport (round trip)	**2**	20,000	40,000		40,000	0
Total Production Costs (per cycle)					**98,060,000**	100
Revenues						
Tilapia (kg)	57,448	700			40,213,793	
Catfish (kg)	40,552	1,500			60,827,586	
Productivity (kg/ha)					**101,041,379**	
Capacity Anticipated	**2,450**				**2,981,379**	
Total Investment			**98,140,000**			
Financing (% / month)			**1.50**		**17,665,200**	Interest
					-14,683,821	**Net Per Cycle**
Cycle/Yr	**1**				**-14,683,821**	**Net Per Year**
Production Total (T)	98.00				**-15**	**ROI**

Table 6. Budget (XAF) for the basic pond aquaculture technology package applied to a 2,500 m² fish farm selling fish into urban markets (XAF500 = 1 USD).						
	Quantity	**Unit Price**	**Total Cost**		**Amount**	**% of Total**
Investment				**amortization (yrs)**		
Pond Construction (m²)	**2,500**	0	0	10	0	0
Equipment			100,000	5	20,000	4
Stocking						
Tilapia	5,000	**0**	0		0	0
Catfish	2,500	**125**	312,500		312,500	63
Operations						
Feed (kg)	**20,000**	**0**	0		0	0
Labour (person-days)	**0**	3,000	0		0	0
Transport (round trip)	**8**	20,000	160,000		160,000	32
Total Production Costs (per cycle)					**492,500**	100
Revenues						
Tilapia (kg)	359	1,500			538,578	
Catfish (kg)	253	2,500			633,621	
Productivity (kg/ha)					**1,172,198**	
Capacity Anticipated	**2,450**				**679,698**	
Total Investment			**572,500**			
Financing (% / month)			**0.00**		**0**	Interest
					679,698	**Net Per Cycle**
Cycle/Yr	**1**				**679,698**	**Net Per Year**
Production Total (T)	0.61				**119**	**ROI**

Table 7. Budget (XAF) for an intensified pond aquaculture technology package applied to a 2,500 m^2 fish farm selling 150 g tilapia into urban markets (XAF500 = 1 USD).

	Quantity	**Unit Price**	**Total Cost**		**Amount**	**Percent of Total**
Capital				**Amortization (yrs)**		
Pond Construction (m²)	**2500**	**1000**	2500000	**10**	83333	10.06
Equipment			**100000**	**5**	6667	0.80
Stocking						
Fingerlings (number)	7500	**25**	187500		187500	22.63
Operations						
Feed (kg)	1284.375	**250**	321093.75		321093.75	38.75
Labour (person 8 hr days)	**100**	**1500**	150000		150000	18.10
Transport (return trips to market)	**4**	**20000**	80000		80000	9.65
Total Production Costs (per cycle)					**828594**	100.00
Revenues					**1284375**	
Fish Sales (kg)	856	**1500**				
Capacity Anticipated (kg/ha)	**3425**				**455781**	
Total Investment			**3,338,594**			
Financing (% per month)			**1.5**		**200316**	Interest
					255466	**Net Per Cycle**
Cycles per Year	3				**766397**	**Net Per Year**
Total Fish Production per annum (T)	2.57				**22.96**	**ROI**

Discussion[2]

Many rural development interventions, including in aquaculture, have been devised to help small-scale farmers, and many have achieved short-term success, but few have achieved sustainability (Martinez-Espinosa 1997, Moehl et al. 2006); once subsidies are withdrawn, projects collapse (Lazard et al. 1991, Erskine 1997). To understand this, one needs to understand how African farming systems function. In Cameroon, field observations and discussion with farmers revealed that, in rural areas, aquaculture is normally viewed as a secondary activity, after staple crop production (cassava, plantains) (Harrison et al. 1994). A fishpond is similar to chickens, goats, vegetable production and a number of crops where the bulk is consumed by the household and surpluses sold locally, in contrast to crops grown exclusively for cash (e.g., tobacco, cotton, coffee, tea, cacao) (Sanders et al. 1996). Investments for such systems are low, permitting many farmers to take advantage of correspondingly low, but fairly reliable yields. Rather than making tradeoffs and taking risks by allocating all of the farm resources to the one or two most profitable enterprises and keeping the money in the bank to buy food as needed, rural small-scale farmers tend to diversify by growing a number of crops simultaneously (often in mixed plots), thereby spreading the food production capacity of the farm over the entire year. This also has the effect of lowering overall risk of crop failure and subsequent famine (Lazard et al. 1991, Brummett & Noble 1995, Sanders et al. 1996).

The stability that comes from the complexity of the smallholder farming system in Africa makes it very difficult to change (Brummett 2002). Any reallocation of land, water, labour and/or capital to a new enterprise inevitably affects several or all other enterprises. Just as with natural ecosystems, feedback mechanisms tend to return any modified system to the previous equilibrium. Studies of smallholder farming systems in Asia have shown that a minimum improvement of 30% over existing technology is necessary to break out of this stasis (Gomez 1994). Without money to invest in revolutionary technology, the marginal and incremental improvements available for smallholders do not translate into large increases in farm profitability (Nerlove et al. 1996).

Sustainably putting more cash in the hands of the rural poor so they can break out of the cycle of poverty requires economic growth. However, the many years of projects aimed at improving the efficiency of African artisanal food production systems have improved productivity and efficiency, but without markets that can turn these changes into cash that can be reinvested in hired labour, purchased inputs and expansion, significant increases in rural wealth are unlikely (Winkelman 1998, Kuyvenhoven & Ruben 2002). Most projects have relied on local (village) markets to consume excess production, many of which are cash-poor and rely heavily on barter, increasing social capital (of particular importance in African societies with little or no social security system) but doing little in

[2] A more detailed discussion of the development implications of this research can be found in Brummett, R.E., J. Gockowski, V. Pouomogne & J. Muir. 2006. Targeting aquaculture development in Africa: a case study from Cameroon. Final Project Report NRE9800 605/522/003. UK Department for International Development, London (available from the authors).

terms of poverty alleviation. With no significant cash-flow being generated by the farm, there is no money to reinvest, bank or spend to create economic activity (Karim et al. 2006).

The constraints to business in rural Africa are substantial: poor infrastructure, unskilled labour, high transport and input costs and low access to technical expertise (Robbins 2000), favouring larger scale investments that can absorb risk. However, economists have shown that faster and more equitable economic growth can be achieved with a larger number of smaller-scale investments than a few larger ones (Lustig et al. 2002). Calculating the minimum investment size at which a business can be profitable is a common practice and shows that in most cases, very small-scale businesses cannot make enough money to justify the necessary management investment (Kuyvenhoven & Ruben 2002). Careful business planning and investment at a profitable scale is essential if fish farms are going to achieve sustainability and make lasting contributions to rural economic growth in Africa.

References

Brummett, R.E. & R.P. Noble. 1995. Aquaculture for African smallholders. ICLARM Technical Report 46. WorldFish Center, Penang, Malaysia.

Brummett, R.E. 2002. Realizing the potential of integrated aquaculture. In: N. Uphoff (ed). Agroecological Innovations: Increasing Food Production with Participatory Development. Earthscan, London.

Brummett, R.E., D. Jamu, J. Jere & V. Pouomogne. 2004. A farmer-participatory approach to aquaculture technology development & dissemination. Uganda Journal of Agricultural Sciences 9(1):530-536.

Erskine, J.M. 1997. Sustainability measures for natural resources. In: G. Shivakoti, G. Varughese, E. Ostrom, A. Shukla & G. Thapa (eds), People and Participation in Sustainable Development. Workshop on Political Theory and Policy Analysis, Indiana University, Bloomington, USA.

Gomez, A.A. 1994. Research-extension linkage: an important component of technology transfer and adoption. Journal of the Asian Farming Systems Association 2(2):197-204.

Harrison, E., J.A. Stewart, R.L. Stirrat & J. Muir. 1994. Fish farming in Africa – what's the catch? Overseas Development Administration & University of Sussex, UK.

Karim, M. M. Ahmed, R.K. Talukder, M.A. Taslim & H.Z. Rahman. 2006. Dynamic agri-business-focused aquaculture for poverty reduction and economic growth in Bangladesh. WorldFish Center Discussiion Series 1, WorldFish Cener, Penang, Malaysia.

Kuyvenhoven, A. & R. Ruben. 2002. Economic conditions for sustainable agricultural intensification, pp. 58-70, in: Agroecological Innovations; increasing food production with participatory development (N. Uphoff, Ed.), Earthscan Publications, Ltd, London.

Lazard, J., Y. Lecomte, B. Tomal & J-Y Weigel. 1991. Pisciculture en Afrique subsaharienne. Ministère de la Coopération et du Développement, Paris.

Lustig, N, O. Arias & J. Rigolini. 2002. Poverty reduction and economic growth; a two-way causality. Sustainable Development Department Technical Paper POV-111, Inter-American Development Bank, Washington, DC.

Martinez-Espinosa, M. (compiler) 1997. Report of the expert consultation on small-scale rural aquaculture. Fisheries Report 548. Food & Agriculture Organization of the United Nations, Rome.

Moehl, J., R.E. Brummett, B.M. Kalende & A. Coche. 2006. Guiding principles for promoting aquaculture in Africa : benchmarks for sustainable development. CIFA Occasional Paper 28, Food & Agriculture Organization of the United Nations, Accra, Ghana.

Nerlove, M., S. Vosti & W. Basel. 1996. Role of farm-level diversification in the adoption of modern technology in Brazil. Research Report 104. International Food Policy Research Institute, Washington, D.C.

Robbins, P. 2000. Review of market information systems in Botswana, Ethiopia, Ghana and Zimbabwe. Technical Centre for Agricultural and Rural Co-operation (ACP-EU), Wageningen, The Netherlands.

Sanders, J.H., B.I. Shapiro & S. Ramaswamy. 1996. The economics of agricultural technology in semiarid sub-Saharan Africa. Johns Hopkins University Press, Baltimore, Maryland, USA.

Winkelmann, D.L. 1998. CGIAR Activities and goals: tracing the connections. Issues in Agriculture. The Consultative Group for International Agricultural Research, World Bank, Washington, DC, USA.

Zar, J.H. 1974. Biostatistical analysis. Prentice Hall, Inc., Englwood Cliffs, New Jersey, USA.

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