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Economic Contribution of Fish Culture to Farm Income in Southeast Vietnam

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Abstract

Rural aquaculture is the farming of aquatic organisms with extensive and semi-intensive husbandry practised by small-scale rural households for their consumption and income. From a field survey in Southeast Vietnam, using enterprise budget analysis and nonparametric tests with indices of change, adoption, and agreement, this study justifies that rural aquaculture is a good option for rural development, making an important contribution to farm income with a high adoption rate among poor farmers. Fish farmers have gained an increased level of satisfaction by means of fish culture production growth along with corresponding economic gains. This enterprise continues to play an increasing important role in their livelihoods and has potential to develop further in the area.

Keywords Rural aquaculture - Fish - Income - Satisfaction - Nonparametric tests

Abbreviations AgI Agreement index - AI Adoption index - AIT Asian Institute of Technology - AOP Aqua Outreach Program - CI Change index - VND Vietnamese dong - UAF University of Agriculture and Forestry (recently Nong Lam University) - US$ United States dollar

INTRODUCTION

Aquaculture is considered an option for rural development because it can provide the basic needs of the rural poor (Jolly and Clonts 1993), an important opportunity to help solve problems of underdevelopment, poverty, and protein malnutrition of the poor (Bailey and Skladany 1991; Edwards 2000). According to Pillay (1990), this is largely because of the opportunities rural aquaculture offers for part- and full-time employment, which help in sustaining peasants and fishermen in rural areas while reducing the drift of populations to urban centers.

Defining rural aquaculture as "the farming of aquatic organisms by small-scale farming households using mainly extensive and semi-intensive husbandry for household consumption and/or income", Edwards and Demaine (1997) confirmed "the bottom line in adopting technical options for rural aquaculture is that they offer the farmer economic benefits." It is generally accepted that the behavior of small-scale farmers in developing countries is economic, although their evaluation of economic benefits may not be short term and monetary in nature but involve the minimization of risks. Nevertheless, irrespective of the economic or other benefits of large-scale aquaculture operations, greater emphasis is put on small-scale farming in developing countries (Edwards et al. 1996). Besides the relatively small size of land, often as small as 0.5–1.0 ha, small-scale farms are typically nutrient poor, have seasonal or unreliable rainfall, and are dominated by crops, with animals generally few in number as they depend on feeds from on or near the farm (Edwards et al. 1996).

In Vietnam, aquaculture has been considered an important economic sector due to its rapid growth and 30–40% contribution to total national fisheries production (FAO and NACA 1997). In 1999, the total agriculture area of this nation was 32,894,300 ha, of which only 336,500 ha (≈1%) was used for a total aquaculture production of 451,514 tons that included 305,517 tons of fish (Vietnam National Statistical Office 2000). In 2003, the area increased to 867,613 ha for aquaculture, which produced 1,003,095 tons with 559,960 tons from inland water (Fisheries Information Center 2004). Development of aquaculture is now helping the country in many ways through contributing to the national budget with exported aquatic products as well as improving rural farmers' livelihoods. Consistent with the goal of improving livelihoods for the poorest

groups in rural areas, one development project in South Vietnam, the University of Agriculture and Forestry–Aqua Outreach Program (UAF-AOP), was launched in 1994 (Tu and Giang 2002).

Being a branch of the Asian Institute of Technology–Aqua Outreach Program (AIT-AOP, Thailand), UAF-AOP has worked in Southern Vietnam since March 1994 in collaboration with the University of Agriculture and Forestry (UAF, recently named Nong Lam University, Ho Chi Minh City, Vietnam). Alongside its contributions to capacity building with regional educational institutions (Nielsen 2000; Korn 2000), UAF-AOP has attempted to develop and disseminate appropriate aquaculture technologies to small-scale farmers in remote areas of Tay Ninh, Binh Phuoc, and Long An Provinces (Tu 1999). One of the desired ways of AOP to reach its objectives is considering appropriate techniques in fish culture as an entry point to help small-scale farmers, especially the poorest in remote areas, to break the vicious circle of poverty.

There are some studies on the impact assessment of rural aquaculture programs that describe the efficiency of the dissemination processes of fish culture techniques in the Vietnam (e.g., Luu et al. 2002; Edwards et al. 2002; Phuong et al. 2002; Tu and Giang 2002; Duc 2002). However, all of these are only descriptive documents and have no appropriate statistical analysis. The economic contribution of rural aquaculture to farmers' livelihoods improvement has yet to be rigorously researched in Vietnam. In contrast to these studies, a recent study in the Mekong Delta by Nhan et al. (2007) concluded that poor farmers are unlikely to adopt fish culture. Using data from a field survey in Southeast Vietnam, the current study examines the contribution of rural aquaculture to income improvement and satisfaction of small-scale farmers who are poor, as defined by Edwards et al. (1996) and Tu (1999). Furthermore, the study gives evidence to justify fish culture as a meaningful entry point for economic development for poor farmers.

RESEARCH METHODS

The study area included the provinces of Binh Phuoc, Tay Ninh, and Long An in Southeast Vietnam, where fish culture was underdeveloped prior to 1995. This underdevelopment was caused by poor resources, infertile soil, and remote distance to the provinces' central cities. The poor farmers in the area have lived mainly from subsistence agriculture and irregular off-farm employment. Farmers in the area lacked cultivated land, capital, and technical expertise to run a

successful aquaculture operation. In addition, they are vulnerable to weather and disease risks (Tu and Duc *2003*). Therefore, rural aquaculture has been identified as one of the best alternatives to improve their quality of life.

The study area was the target area of UAF-AOP in Southern Vietnam. In this area, the program has selected the poorest farmers to take part in farmer-managed (on-farm) trials for appropriate techniques in fish culture. On-farm trials were initially implemented in the districts of Trang Bang (Tay Ninh), Dong Phu (Binh Phuoc), and Duc Hoa (Long An), and then extended to farmers in Chau Thanh (Tay Ninh), Phuoc Long (Binh Phuoc), and Duc Hue (Long An). Successful on-farm trials were accomplished by utilizing appropriate aquacultural techniques for this area and UAF-AOP staff used the techniques to train other poor farmers.

The survey was conducted in 2001 with structured questionnaires and in-depth interviews with 120 small-scale fish farmers, selected equally in four groups: trial, trained, spread-out and control, representing four different levels of farmers' involvement in aquaculture development activities. The trial group, 30 households selected randomly from a total of 56 on-farm trialists, had the highest level of involvement from UAF-AOP. The trained group consisted of 30 other small-scale farmers who were randomly selected and trained on fish culture technology by UAF-AOP staff. This group had a lower level of involvement in the program than the trial group because they accessed and adopted AOP's recommendations via off-site training courses without program staff working on the farm.

The spread-out group consisted of 30 farmers who had received information and technical advice from the trial group. This group had an indirect involvement in UAF-AOP because they had received technical recommendations through middlemen, the trialists. These farmers learnt aquacultural techniques from the trial group. The control or nonproject group included 30 small-scale households that had no involvement in AOP. These households were randomly selected in the same regions (districts or villages) as the trial group.

The enterprise budgets analysis method (Jolly and Clonts *1993*) was used to measure the economic contribution of fish culture to total household income of the farmers. Concepts of income measures include:

- *Gross income* is a preliminary measure of income. It assesses the performance of an enterprise purely in terms of the benefits it yields without considering the costs to produce them (Jolly and Clonts, 1993). Gross income thus equals volume of achieved products multiplied by average of farm-gate price. This volume includes all of sold, given and eaten shares of products, leading to two detailed measures of gross income:
    - *Gross cash income* includes all cash earnings from each source of income to explore the structure of all activities in the household. This income includes only the actual money earned per year without consideration of expenditure.
    - *Gross non-cash income* includes value of products used for household consumption or for other purposes that do not get money or pay-off. In this study the total gross non-cash income was demonstrated by given and eaten values.
- *On-farm income* includes revenues from farming enterprises conducted on farm land occupied by surveyed farmer.
- *Off-farm income* is earnings of all household members from laboring in neighboring farms.
- *Non-farm income* is earnings from manufacturing jobs, small-scale trading, services, government work, and so on.
- *Variable cost* includes all cost of inputs used in production, except cost of capital used for long period of time
- *Gross margin* for an enterprise is defined by subtracting variable cost from gross income.
- *Income per capita*, which measures income for each household member, was used to compare the economic effectiveness between farmer groups regardless of household size. Income per capita was preferred to income per household due to the fact that all household members are involved in creating and utilizing, consuming and/or spending money gained from the farming products and/or other income sources.

Microsoft Excel and SPSS for Windows were used to analyze the survey data. Statistical nonparametric paired Wilcoxon, Wilcoxon rank, and Kruskal–Wallis tests were used to examine the significance of differences in economic returns among the investigated groups and of changes in each of the groups for the investigated issues. These tests were chosen due to the fact that they do not require a normal distribution of the data.

Because of the adjacency of three study sites and the emphasis on the difference between farmers' involvement levels in UAF-AOP activities, which were also extension practices for aquaculture development in the area, differences between the provinces were neglected to avoid possible overlaps between this study and a previous work of Tu and Giang (*2002*) in the same area. The provinces thus serve as blocks in the statistical tests. The monetary unit employed is the Vietnamese dong (VND) with an exchange rate of 15,000 VND/US$ at the survey time.

Based on fish culture techniques recommended to trial and trained farmers, the survey attempted to collect data on the level (the percentage of recommended techniques) and extent (the number of farmers adopting the recommended technical package) to which the recommended techniques were adopted. Therefore, the adoption index (AI) was used to demonstrate the adoption levels of the farmers. Based on farmers' expression of their adoption levels of AOP's recommendations based on a Likert scale, ranging from 'very low adoption' to 'very high adoption', the AI was calculated according to Eq. 1. The higher the AI, the higher the level of small-scale farmers that accepted and adopted the recommendations of AOP staff.

$$\mathrm{AI} = \frac{\sum_{i=1}^{m} v_i f_i}{n}, \qquad (1)$$

where AI is the adoption index of the recommendation ($1 \leq \mathrm{AI} \leq 5$), and v_i is the weight value of the *i*th case, where $v = 1–5$ corresponds to technology adoption levels from "very low adoption" (1) to "very high adoption" (5), f_i is the frequency of the *i*th case, and n is the total number of respondents in each investigated group.

The change index (CI) was used to describe the improvement based on farmers' expressions. These expressions were quantified by scoring various change levels, from 'highly decreasing' to 'highly increasing', as described in Eq. 2, when the interviewees were asked to compare their status before and after their involvement in UAF-AOP activities for the first three groups (trial, trained, and spread-out). Farmers in the nonproject group were asked to compare their recent status with that in 1996. This time point of 1996 was selected to match with the time that UAF-AOP started its activities. $\mathrm{CI} > 0$ expresses an increase, and conversely $\mathrm{CI} < 0$ a decrease.

$$\mathrm{CI} = \frac{\sum_{i=1}^{m} v_i f_i}{n}, \qquad (2)$$

where CI is the change index ($-2 \le \mathrm{CI} \le 2$), and v_i is the weight value of the ith case such that $v = -2$ if highly decreasing, $v = -1$ if decreasing a little, $v = 0$ if no change, $v = 1$ if increasing a little, and $v = 2$ if highly increasing, f_i is the frequency of the ith case, and n is the total number of respondent in each investigated group.

Scaling and ranking tools were used to make qualitative psychological data quantifiable and one more index, the agreement index (AgI, Eq. 3), was used to explore the perception levels of small-scale farmers to psychological issues such as attitude to fish culture, satisfaction with aquaculture, and their livelihoods. Data for the calculation of AgI was collected from farmers' expression of their agreement levels when asked about issues, and then, being quantified by scoring various agreement levels, from 'strongly disagree' to 'strongly agree', as described in Eq. 3.

$$\mathrm{AgI} = \frac{\sum_{i=1}^{n} v_i f_i}{n}, \tag{3}$$

where AgI is the agreement index of farmers ($-2 \le \mathrm{AgI} \le 2$), v_i is the weight value of the ith case such that $v = -2$ if strongly disagree, $v = -1$ if disagree, $v = 0$ if acceptable, $v = 1$ if agree, and $v = 2$ if strongly agree, f_i is the frequency of the ith scale of each case, and n is the total number of respondents in each group in each province ($n = 10$ in this study).

RESULTS AND DISCUSSION

Diversity of farmers' income

The average household gross income in 2001 ranged from 18,323,720 VND/year (US$ 1,220/year) in the spread-out group to 24,144,640 VND/year (US$ 1,609/year) in the nonproject group. The average gross income of trialists was 21,342,450 VND/year (US$ 1,422/year), less than that of the nonproject group, but higher than those of the trained (22,599,030 VND or US$ 1,506/year) and spread-out groups. However, the difference of total household income among the groups was not statistically significant ($\chi^2 = 1.66$, $P = 0.645$). The results implied a narrowing income gap between the "rich" farmers (meaning the nonproject farmers) and the trial group, who were the poorest before involvement in the UAF-AOP (Tu *1999*).

On-farm income includes revenues from various enterprises such as cultivating rice, raising livestock, culturing fish, non-rice crop, and growing fruit trees, all of which create an annual cash income to the farmers (Fig. 1). Any enterprises that were just for consumption or self recreation, but not for cash earnings, were ignored in this study because they do not contribute to the farmers' income. Similar to the results for whole-household income, the Kruskal–Wallis tests did not find a significant difference between the groups in terms of income from farming enterprises. However, the average income figures from various sources gave a general impression of income differences among the four groups. At the whole-farm level, the nonproject farmers appeared to obtain the highest returns from their farming (Fig. 2), although the difference in terms of gross household income was not significant ($P = 0.818$) at the time of the study. This result is consistent with the approach of the UAF-AOP, which aimed to improve the income status of the poorest in rural communities (Tu *1999*).

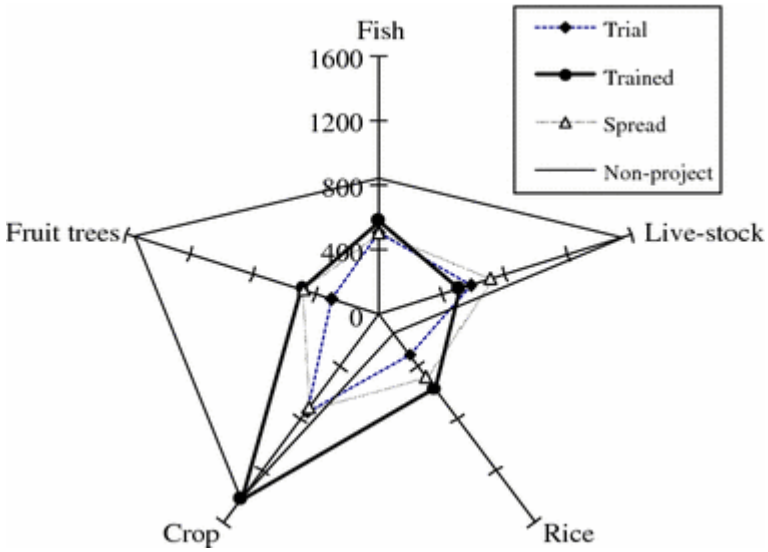

Fig. 1 Diversification in on-farm income (thousand VND/person/year)

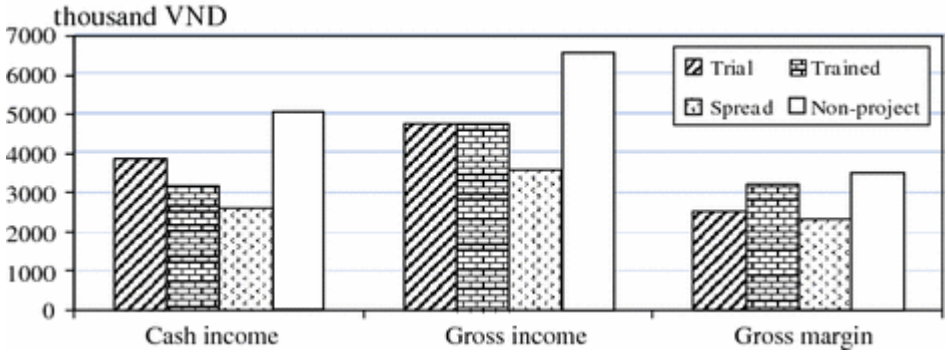

Fig. 2 On-farm income of surveyed farmers

Livestock husbandry

Livestock husbandry created gross incomes that yield high cash net profit to farm households. The nonproject group obtained the highest return from this enterprise, with an average cash income per capita of 3,238,730 VND/year, average gross income per capita of 3,981,060 VND/year, and a gross margin per capita of 1,544,270 VND/year. For the trial group, livestock also played an important role in the farmers' livelihoods with an average cash income of 1,832,220 VND/person/year and an average gross margin of 576,470 VND/person/year. The trial group obtained more income than the other groups involved in the AOP because they raised livestock, specifically pigs, to obtain fertilizer for the fish ponds regardless of the decreasing price of live pigs. Moreover, following recommendations of AOP staff, 11 farmers (36.7%) actively changed to keeping sows to meet both needs: fertilizing the fish pond and earning extra cash by selling piglets.

Rice cultivation

The extremely low rice prices created low cash incomes and gross margins as well as poor returns for this enterprise. The average cash income per capita was 1,000,000 VND/year in the trained group while it was under 500,000 VND/year in the other groups (470,260, 1,025,870, 408,630, and 493,300 VND/person/year respectively in the trial, trained, spread-out and nonproject groups). The gross margin was also very low at 309,710, 571,520, 481,310, and 144,822 VND/person/year, respectively.

Non-rice field crops

Among the four groups, nonproject farmers achieved the highest income from non-rice crop cultivation with an average gross margin per capita of 1,421,160 VND/year and cash income per capita of 2,138,370 VND/year. The trained group stood second, with an average gross margin per capita of 1,420,360 VND/year and cash income per capita of 1,758,120 VND/year. Meanwhile the trial group had a gross margin per capita of 750,930 VND/year and a cash income per capita of 1,320,370 VND/year while the spread-out group had the lowest returns from this enterprise with a gross margin per capita of 722,610 VND/year and a cash income per capita of 1,092,600 VND/year.

Fruit trees (horticulture)

The income per capita from this enterprise has rivaled rice in the ranking for farmers' income sources. The respondents in the nonproject group obtained the highest economic return from this enterprise with an average cash income (also gross income) per capita of 2,125,000 VND/year and gross margin of 1,550,000 VND/person/year.

Fish culture

Enterprise budgeting gave a picture of the costs and returns of this enterprise among the investigated groups (Table 1). Fish culture occupied the third position in terms of contribution to cash income to trial farmers with an average of 2,224,770 VND/household/year, although this number was lower than the amount earned by the spread-out and nonproject farmers. However, the trial farmers achieved a higher cash income per capita from fish (534,920 VND/person/year) than the trained and spread-out farmers, with an average cash income of 435,570 and 468,670 VND/person/year, respectively.

Table 1 Enterprise budgeting of fish culture by group (units: thousand VND)

	Trial	**Trained**	**Spread-out**	**Nonproject**	**All**
Variable costs	600.27	781.57	526.97	741.64	696.13
Pond preparation	182.41	184.59	152.08	78.12	151.89
Drying	5.00	19.00	14.33	0.00	9.58
Liming	113.70	56.43	30.83	27.43	57.85
Fertilization	1.63	11.67	4.93	17.96	8.75
Embankment	35.67	0.00	10.00	1.43	11.75
Water filling	2.33	7.83	0.00	0.00	2.54
Fingerlings	328.80	1920.77	361.87	480.18	781.57
Food	105.65	406.00	165.94	321.94	277.60
Fertilizer	46.65	128.00	53.50	130.00	74.55

	Trial	Trained	Spread-out	Nonproject	All
Gross output	2690.23	3259.18	3157.45	3903.84	3342.73
Cash income	2224.77	1934.20	2441.67	3296.79	2559.83
Eaten value	400.46	1212.80	546.70	486.99	661.48
Given value	65.01	112.18	169.09	120.06	121.42
Gross margin	2089.97	2477.61	2630.49	3162.19	2646.60

In terms of total income and gross margin, trial farmers obtained lower returns from fish culture than farmers from the other groups but there was no significant difference in the economic measures among groups. Moreover, the trial farmers had achieved a considerable increase in their income since their involvement in the UAF-AOP. Gross margins from fish culture (Table 2) were twice the figures recorded in 1997 by Demaine (*1999*). These results imply that the trial farmers had gradually earned more income relative to others in the same community.

Table 2 Average gross margin from fish culture of trial farmers

Year	**1997**		**2000**	
Project areas	**VND**	**US$**	**VND**	**US$**
Long An	266,000	21	697,900	47
Binh Phuoc	1,365,000	108	4,139,800	280
Tay Ninh (Trang Bang)	597,000	48	1,753,900	119
Tay Ninh (Chau Thanh)	809,000	64	1,110,400	75

Note: The data from the year 2000 in Tay Ninh is split into two figures for comparison with the data from 1997 from Demaine (*1999*)

The trial group also achieved a higher cash income per pond area (3,110 VND/m^2/year) relative to other farmers (Table 3). For the poor with limited land area, cash income plays a significant role in their life compared to other elements. Although their impression was positive for economic change, their real income from fish culture was rather low relative to other groups.

Table 3 Income measures of fish culture per pond area (units: 1,000 VND/m^2/year)

Group	Variable cost	Cash income	Consumed value	Value of product given away	Gross income	Gross margin
Trial	1.02	3.11	1.02	0.11	4.24	3.22
Trained	1.27	2.56	2.56	0.17	5.29	4.03
Spread-out	1.58	2.31	2.13	0.44	4.89	3.31
Nonproject	0.89	2.60	1.19	0.14	3.93	3.03
All	1.19	2.65	1.72	0.23	4.60	3.4
Kruskal–Wallis chi-square	1.3682	4.6020	2.9337	0.2634	2.7192	3.1000
P-value	0.7130	0.2034	0.4020	0.9668	0.4370	0.3765

Other income sources

Only 13 (10.10%) of the interviewed households had off-farm income and 19 (15.08%) had non-farm income, as many as 36 (30.00%) of them obtained income from wild fish resources, although income per capita was very low (from 40,960 VND/person/year in the trained group to 132.50 VND/person/year in the nonproject group) in comparison to other income. The low level of income, explained by the farmers, related to the fact that wild fish resources had decreased dramatically in recent years. The decline in wild fish resources encouraged many farmers to start fish culture, even in small ponds that used to be employed only for irrigation. Some farmers obtained off-farm income from laboring in neighboring farms. Others have left farming activities to obtain non-farm income from manufacturing jobs, small-scale trading, services, government work, and so on. There were also a few elderly farmers solely dependent on social welfare payments (retirees and wounded soldiers) or financial support from their children who had moved to provincial central towns or Ho Chi Minh City to earn more money.

Economic contribution of rural aquaculture to farm income

Rural aquaculture adoption

Fish culture was underdeveloped in the survey area prior to the implementation of UAF-AOP. However, pond areas increased considerably (Duc *2002*) after the UAF-AOP started its activities in the area.

In order to assess the adoption levels of fish culture in the trial and trained groups, the AI (Eq. 1) was employed. The higher the AI, the higher the level of adoption by small-scale farmers of the aquacultural techniques recommended by the UAF-AOP. All trial farmers had continuously implemented the recommendations due to benefits from fish production. The AI exhibited very high adoption levels in both the trial and trained groups. Trial farmers had a higher adoption level (AI = 4.0) than trained farmers (AI = 3.06). All farmers in the trial group had adopted the recommendations from 'intermediate' level up to 'very high' level, while 20% of the trained farmers had only adopted at 'low' or 'very low' levels.

The high adoption level in the trial farmers exhibited the effectiveness of UAF-AOP's efforts to improve the livelihoods of the poor in these resource-poor areas. Because the farmers in the trial group were the poorest in the study area, this finding rejects the previous finding of Nhan et al. (*2007*) in which they are likely to assert that the poor did not adopt aquaculture technology. The reasons for the failure of the project mentioned in Nhan et al. (*2007*) were also listed in their study: inappropriateness of the recommended technology and poor access to extension services. The failure of alien technologies introduction to rural households with inappropriate approaches was actually cautioned in a study by Phuong et al. (*2002*) in the Mekong delta region. Phuong et al. (*2002*) proposed a step-by-step approach and farmer-managed trials to assure the success of aquaculture extension programs in its target area. The success of the UAF-AOP in Southeast Vietnam was due to its application of such an approach during the implementation of the program, which consisted of a baseline survey to understand the advantages and constraints of an aquaculture development program in the target area and on-farm trials to test the appropriateness of the recommended technologies alongside upgrading the capacity of provincial extension agencies with farm visits, training courses, and study tours (Tu *1999*; Tu and Giang *2002*).

Excluding two nonproject households who practised monoculture of hybrid Clarias catfish, the 118 remaining households practising polyculture achieved quite high yields in fish culture in 2000–2001. The trial and spread-out farmers achieved the highest extrapolated yields (5.63 and

5.62 ton/ha) while the nonproject farmers had the lowest (4.62 ton/ha) yields, although the nonproject farmers harvested the highest fish production (491.6 kg/household) due to their larger ponds. The trained farmers also achieved quite a high yield (5.18 ton/ha). The difference in fish yield among the groups was not statistically significant ($P > 0.05$) but the changes in production was very significant ($P < 0.001$) in all four groups, showing the effectiveness of technical recommendations to improve fish yield in small-scale farms. The yields of trial farmers were meaningfully higher than those in 1997. Their average yields in 2000 were 3.21, 5.06, and 8.62 ton/ha, respectively for Long An, Binh Phuoc, and Tay Ninh provinces while the ones in 1997 were 2.70, 3.50, and 3.66 ton/ha (Tu and Giang *2002*). The effectiveness of AOP-UAF support can also be seen in the CI for fish production among the investigated groups in which the trial group achieved the highest CI of 1.17 while the trained and spread-out groups had lower CIs of 0.97 and 1.03, respectively. The nonproject respondents achieved a CI of 0.70, the lowest among the four groups. The difference in CI between the groups were statistically significant at the 90% confident level ($\chi^2 = 7.61$, $P = 0.0547$).

Income from fish culture

While incomes from livestock husbandry and rice cultivation were decreasing, the income from fish culture was expanding in on-farm income structure alongside increased income from non-rice farming and growing fruit trees (Fig. 3). The CI of cash income from fish culture in trial households was 1.13, much higher than those of the trained, spread-out, and nonproject groups (0.70, 0.67, and 0.50 respectively), indicating the efficiency of the UAF-AOP's support given to the farmers (Table 4). In three investigated provinces, Binh Phuoc province had the highest CI for all groups (Table 4), demonstrating the rapid increase of income from fish culture in small-scale farmers in this province. Income from this enterprise in households involved to AOP has changed significantly more than nonproject farmers.

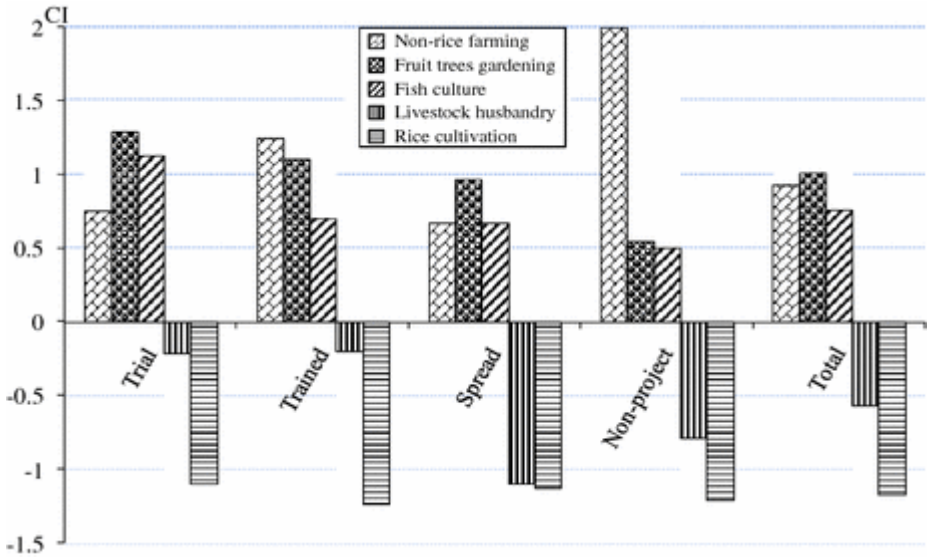

Fig. 3 Changes in on-farm incomes

Table 4 Change index of income from fish culture

Group	Long An	Binh Phuoc	Tay Ninh	All
Trial	0.70	1.70	1.00	1.13
Trained	0.50	1.20	0.40	0.70
Spread-out	0.50	1.10	0.40	0.67
Nonproject	0.60	0.10	0.80	0.50

Kruskal–Wallis chi-square = 7.84 (*P*-value = 0.0493)

Also CIs were used to describe changes in the proportion of fish sold from total fish production. A decrease in the proportions of fish eaten and given away (Table 5) showed that not only can small-scale farmers feed themselves but they also had fish surplus to trade for cash. Again, it appeared to be trial households who were showing the greatest changes in terms of the amount sold in comparison, with decreases in the proportion consumed. In circumstances where traditional on-farm income sources such as livestock raising and rice cultivation have been decreasing, the increasing cash income from selling fish suggested that fish culture has became a good way for earning money for small-scale farmers and a valuable means of diversification of income sources for their livelihoods.

Table 5 Change index of proportions in harvested fish use

	Sold		Eaten		Given	
	Change index	**Wilcoxon statistics**	**Change index**	**Wilcoxon statistics**	**Change index**	**Wilcoxon statistics**
Trial	1.20	−4.33 (<0.0001)	−0.83	−3.7 (0.0002)	−0.43	−2.97 (0.003)
Trained	0.73	−3.87 (0.0001)	−0.33	−1.67 (0.0941)	−0.40	−2.83 (0.0047)
Spread-out	0.83	−3.52 (0.0004)	−0.40	−2.13 (0.0329)	−0.47	−3.12 (0.018)
Nonproject	0.53	−2.82 (0.0048)	−0.40	−2.44 (0.0146)	−0.40	−2.22 (0.0267)
Kruskal–Wallis statistics	12.99 (0.0046)		7.03 (0.0710)		0.64 (0.8863)	

Note: In parentheses are *P*-values of statistical tests

Contribution of fish culture to total household income

The contribution of fish culture to total household income was analyzed with change indices calculated from farmers' assessments on changes in income from fish culture relative to total household income. The CI of the trial group once again indicated the increasing role of fish culture in farm income. The CI of the trial group was 0.90, significantly higher than other groups while the nonproject farmers' index was very small at 0.03. This evidence was also supported strongly from results in the Binh Phuoc province where the CIs of both trial and trained farmers were very high in contrast to the nonproject farmers' index, which was negative (Table 6). This negative change in the nonproject group of Binh Phuoc province was partly due to the development of other enterprises such as non-rice crops, and non-farm and off-farm income in the province.

Table 6 The change index of the role of aquaculture in household income

Group	Long An	Binh Phuoc	Tay Ninh	All
Trial	0.60	1.10	1.00	0.90
Trained	0.44	1.10	0.00	0.52
Spread-out	0.30	0.90	0.50	0.57
Nonproject	0.30	−0.30	0.10	0.03

Kruskal–Wallis statistics = 5.01 (*P*-value = 0.1704)

Rural aquaculture in farmers' perception

Role of fish culture in farmers' livelihoods

Sustainability of rural aquaculture depends on its contribution to improving income and the living conditions of farmers as well as on their satisfaction with this enterprise. In this part of the study, the role of fish culture was analyzed through AgI. For the previous 5 years, alongside the growth of the national economy, there had been great increase of income in rural households. In the study area, all respondents confirmed this increase with positive AgIs. However, the introduction of fish culture to the farmers did not create a significant contribution to the overall AgI. The economic contribution of fish culture was relatively small compared to other commercial non-rice crop farming and non-farm income acquired from work economic venture other than farming.

Positive AgIs indicated an improvement in rural living conditions, while the introduction of fish culture appeared not to be a significant contribution to this economic upturn. Nevertheless, fish culture has still played a role in improving the quality of household life, although at low levels of AgI. AgIs indicated that the role of fish culture in improving the quality of life was more important for trial farmers ($\mathrm{AgI} = 0.67$) than for the other groups ($\chi^2 = 6.62$, $P = 0.08$), expressing that the enterprise was an attractive entry point to improve their life quality (Fig. 4).

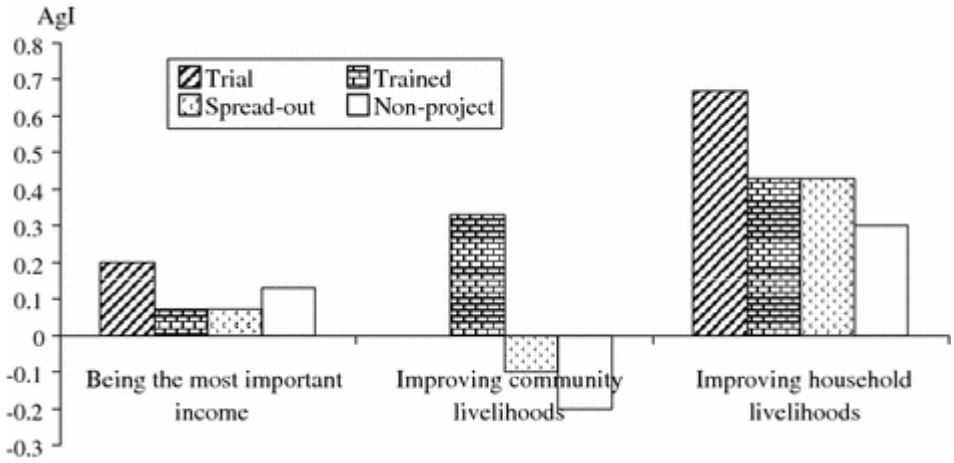

Fig. 4 Assessment of the contribution of fish culture to farmers' livelihood

Farmers' satisfaction with fish culture

Another criterion to describe farmers' perception of fish culture is their satisfaction in accepting this recently introduced enterprise. If the farmers were satisfied with fish culture, the enterprise would have great potential for development in the area. In the survey, all respondents expressed their satisfaction with fish culture with positive AgIs, and no significant differences were found between the groups ($\chi^2 = 2.63$, $P = 0.4528$). The spread-out and trial groups had AgIs of 1.17 and 1.10, respectively, which indicated a greater satisfaction than the AgI of 0.93 experienced by both the trained and nonproject groups.

Farmers' plans for expanding fish culture

Most respondents expressed their willingness to develop fish culture in the future because of benefits associated with fish culture. Although the Kruskal–Wallis test failed to find a statistical significant difference between the groups in terms of their willingness ($\chi^2 = 1.56$, $P = 0.6678$), the trial farmers with an AgI of 0.13 appeared to be more likely to expand fish culture than the other groups with AgIs of 0.03, 0.07, and 0.00, respectively, for the trained, spread-out, and nonproject groups. These AgIs expressed 'acceptable' attitudes, meaning that they would invest more in fish culture if there were more conducive conditions.

CONCLUSION

With the enterprise budget method and nonparametric statistical tests for change indices, it is confirmed that small-scale farmers in Southeast Vietnam gained a considerable increase in income from fish culture. Highly adopted by the farmers, fish culture was also proved to be a good option for rural development as it played an important role in improving the quality of life of poor farmers through improved food supply, and higher and diversified income, with increased fish production and yields. Benefiting from fish culture, all respondents expressed their satisfaction with this enterprise. Rural aquaculture was playing an increasingly important role in farmers' livelihoods and demonstrating great potential to be developed further in resource-poor areas of Vietnam.

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