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SUSTAINABILITY AND LIVELIHOOD OPPORTUNITIES FOR MANGROVE-SHRIMP FARMERS IN THE COASTAL AREAS OF SOCTRANG PROVINCE

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ABSTRACT

This study is aimed to assess the sustainability of the integrated mangrove shrimp system and livelihood improvement opportunities for farmers in the coastal areas. A baseline assessment (focus group discussion-3 groups of 24 participants and households' interviews of 35 farmers) and on-farm studies were carried out. Data and indicators related to sustainability including natural, financial and environmental aspects were gathered and analyzed. Study results show that the integrated mangrove shrimp was sustainable system overtime. It has very low production costs and investment that suits to farmers' existing resources. Farmers invested 3.6 ± 0.9 million VND per hectare of water surface a year, which could earn a net revenue approximately 24 million VND/ha/year. Beside shrimp as a primary main product, several secondary products such as crab and other aquatic animals are harvested as well from the system. Livelihoods and income sources of farmers in coastal areas could be improved through intervening farming techniques and diversifying livelihood activities. Along with the above achievement, the system is currently facing problems and challenges. Of which, inaccessibility to good quality shrimp seeds, diseases on shrimp, sedimentation, climate change impacts, and policies of timbering limitation, were key limiting factors to the integrated mangrove shrimp system. So far, technical intervention and flexible management on mangrove forest need to be considered and adjusted.

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1 INTRODUCTION

Mekong Delta is one of the areas most impacted by climate change in Vietnam, in particular on settlements, and aquaculture and agricultural production zones located in coastal areas. Evidence of impacts includes ocean warming, sea level rise, typhoon and tidal increase, which causes inundation, floods, erosion, saline intrusion and some cases diseases on crops. Mangrove forest areas in the Mekong Delta cover approximately 100 thousand ha, distributed over coastal alluvial sediments, estuarine

basins and in inland valley swamps. The mangrove is mainly located in the provinces of Ca Mau (58,285 ha), Bac Lieu (4,142 ha), Soc Trang (2,943 ha), Tra Vinh (8,582 ha), Ben Tre (7,153 ha), Kien Giang and Long An. Common mangrove flora encompass *Avicennia marina* (Mắm trắng), *Rhizophora apiculata* (Đước), *Lumnitzera racemosa* (Cóc), *Cerriopstagal* (Dà), water coconut and other species, and create a suitable habitat for birds, e.g. *Anastomus oscitans*, and other valuable aquatic animals.

As elsewhere, mangrove forest in Soc Trang plays an important role in protecting coastal banks and estuary, limiting erosion and typhoon impacts, and conserving biodiversity (Pham Trong Thinh, 2009), defending specific coastal upland crop areas, supplying timber and various non-timber products including medicinal materials. In fact, mangrove forest systems in Soc Trang are habitat, living environment and livelihood opportunities for a major part of local population such as the poor and landless farmers.

In recent years, mangrove forest has been degraded and impacted by many human activities such as deforestation for farming and aquaculture, wood exploitation, and deforestation to harvest soil worm. In the years 1980 to 1995, more than 72,825 ha of forest land was converted, an average of 4,855 ha annually (5% a year). To address and deal with above context, many projects and policies on protection and development of coastal mangrove ecosystems in Soc Trang have been running, including a policy on forest land allocation for farmers and community based mangrove forest management. However, threats to the mangrove ecosystem in the Soc Trang persist because timber and aquaculture provide temporary and seasonal benefits (not whole year) and farmers' strategies and livelihood activities are various and unsustainable. The study aims to assess the productivity and resilience of integrated mangrove-shrimp farming system in the coastal areas of Soc Trang province via increasing aquatic productivity in mangrove-aquaculture farming system and identifying opportunities for income generation to further improve livelihoods of farmers. The results of study provide scientific evidences and references to developing

adaptive strategies and resilience to climate change impacts in the coastal areas of Soc Trang in particular and of the Mekong Delta in general.

2 RESEARCH METHODS

The study was undertaken through two activities: a baseline assessment and field trials. These were done in Giong Noi and Huynh Ky hamlets, Vinh Hai commune, Vinh Chau district, Soc Trang province between April 2013 and April 2014 (Figure 1).

2.1 Baseline assessment

The baseline assessment was carried out in the study area to understand problems and challenges related to local socio-economic, environmental and technical issues of the integrated mangrove-shrimp farming system. Moreover, via the baseline assessment, priority solutions for the system improvement were identified and developed that would be tested through field trials.

Three groups (1: farmers < 40 years old; 2: farmers 40-60 years old; 3: farmers > 60 years old) of 24 experienced farmers were invited to participate in Focus Group Discussions to identify problems and challenges to the mangrove-shrimp farming system, as well as to develop feasible solutions for improving the system. Participatory approaches such as problem and solution trees techniques were used.

Further, 35 farmers in the three indicated groups above were interviewed individually. The interview content focused on household farming activities, livelihoods, and factors related to productivity of the system.

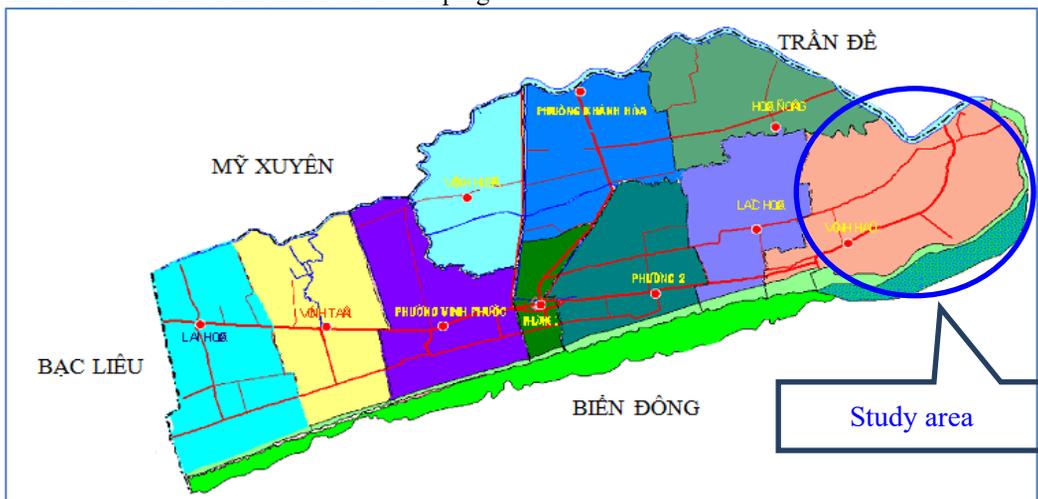


Fig. 1: Study area in Vinh Hai commune, Vinh Chau district, Soc Trang

(Source: Vinh Chau district people' committee, 2010)

2.2 Field trials

Based on the results of the baseline assessment, productive and adaptive techniques were designed to improve productivity and resilience of the integrated mangrove-shrimp system. Then, the priority of designed technique was examined and proposed to be tested through field trials.

The field trials were implemented in eight selected farms, divided in two groups (Table 1). Four control farms that applied traditional farming techniques were randomly selected. The four selected pilot farms applied the following improved techniques:

- Partly shrimp ponds cleaning/improvement
- Low shrimp seed density releasing with many supplement times in a season (≤ 5 shrimp-post larvae/m²)
- Post larvae shrimps were nursed (1-1.5 months) prior to release into the forest
- Pesticides and high toxic chemicals were not allowed to be used in the system

In contrast, the control farms didn't clean ponds, shrimp seeds density was higher than 6 individuals per m², and post larvae shrimps weren't nursed and allowed to use pesticides and chemicals.

2.3 Data collection and analysis

Collected data included aspects regarding farming and livelihood activities, financial efficiency, technical, natural, policies and environmental issues. Production costs and revenue data were recorded using a household farming diary.

Sustainability (integrated mangrove-shrimp system) of the pilot farms applying adaptive techniques was compared to control farms applying traditional farming techniques. Moreover, requirements and conditions to enlarge and out-scale the system were also considered and assessed through local verification workshops.

Collected data were analyzed on the following points.

- Status, problems and challenges to the system
- Priority solutions and adaptive techniques
- Indicators and effectiveness of adaptive technique about below aspects
 - + Environmental
 - + Technical
 - + Economic
- Requirements and measures to enlarge the tested adaptive techniques.

Table 1: Land use structure of pilot and control integrated mangrove-shrimp farms in the study location

Unit: ha

	Farms*	Mangrove forest land**	Canal shared (%)	Homestead land (%)	Cash crop land (%)	Total land
Pilot farms	1	35.00	35.0	0.35	0.20	35.55
	2	19.00	30.0	0.40	0.40	19.80
	3	10.00	40.0	0.35	0.30	10.65
	4	24.00	20.0	0.25	0.40	24.65
	Mean	22.0 ±0.6	31.3 ±4.5	0.34	0.33	22.7 ±4.5
Control farms	1	16.0	37.5	0.40	0.20	16.60
	2	9.0	27.8	0.35	0.60	9.95
	3	21.0	47.6	0.25	0.33	21.58
	4	17.0	17.6	0.30	0.00	17.30
	Mean	15.8 ±2.1	32.6 ±5.6	0.33	0.28	16.4 ±2.1

*: Land allocated via the forest land allocation contract signed between farmers and the state mangrove forest management unit (Soc Trang Forest Ranger, Soc Trang DARD). **: including mangrove forest area and water surface area

Besides, data from other projects and surveys also involved in this study with attached references.

3 RESULTS AND DISCUSSION

3.1 History of the mangrove-shrimp system in Soc Trang

There was no mangrove belt from Vinh Chau Town to Vinh Hai Commune in the years of 1904, 1952, and 1965. The coastline was characterized by sand dunes until the reforestation program in the

1990s. These facts were confirmed by villagers for the zone between Au Tho B Hamlet and Vinh Chau Town (Olivier Joffre, 2010, p.25). Mangrove planting has been carried out along the coastal zone of Soc Trang Province since the 1980s (Klaus Schmitt, 2009). However, most farmers have settled in the study area between 1998 and 2000, when the provincial policy on forest land allocation for farmers was executed.

The received forest land was very wild and needed much investment, particularly labor-force, to establish a settlement, and to protect, take care and manage new planted forest. At present, nearly two third of household members are in labor age, and their main livelihood activities are in aquaculture, forestry and agriculture. Mangrove-shrimp system needs frequent labor for farming activities such as daily care-taking, draining and monthly harvesting. Besides mangrove-shrimp farming, farmers also cultivate upland crops (on the dikes of the system) and do other activities to improve their living conditions (Figure 2).

3.2 Key characteristics of mangrove-shrimp farmers

Baseline assessment results show that the average age of mangrove-shrimp head-household farmers was 47 years old; the eldest was 64 and the youngest 31, representing different generations in the community. On average, a household had four members and the number of female and male was about the same (Table 2).

Table 2: Key characteristics of surveyed farmers

Characteristics	Max	Min	Mean	SE
Age	64	31	47	4.25
Family members	8	2	4	0.72
Male members	6	1	2	0.53
Main labours	7	2	3	0.67

Data presented in Figure 2 show that the average land area per household was very large compared

to the average in the Mekong Delta (GSO, 2012). More than 60% of the land was mangrove forest composed of different kinds of species of various ages. Despite forest land occupying a large area, it doesn't generate relevant income for farmers because selective exploitation of forest for timber is not allowed under the local regulations. This means farmers couldn't earn direct income from timber, but utilize forest service such as collecting wild fishes, crabs, honey and other aquatic animals (OAA).

In an integrated system, the economic return of mangrove-shrimp systems is optimal for a mangrove coverage of 30-50%, i.e. the pond covering 50 to 70% of the farm (Binh *et al.*, 1997). In the study location, the shrimp-ponds area was approximately 32% of the total farm land. Farmers' land use structure was mainly decided when they received the land allocation from the government. Farmers only practiced farming based on the allocated land-uses. This resulted in similarity between pilot and control farms in land use structure.

Consuming available products such as wild fishes and vegetables is a common practice in the study location. The land use structure also indicates that farmers in the study area diversified their income and livelihood activities based on allocated land areas. Many farmers cultivated vegetables on land areas around their house (home garden). It not only provides more income, also improves household's nutrient regime while saving food costs.

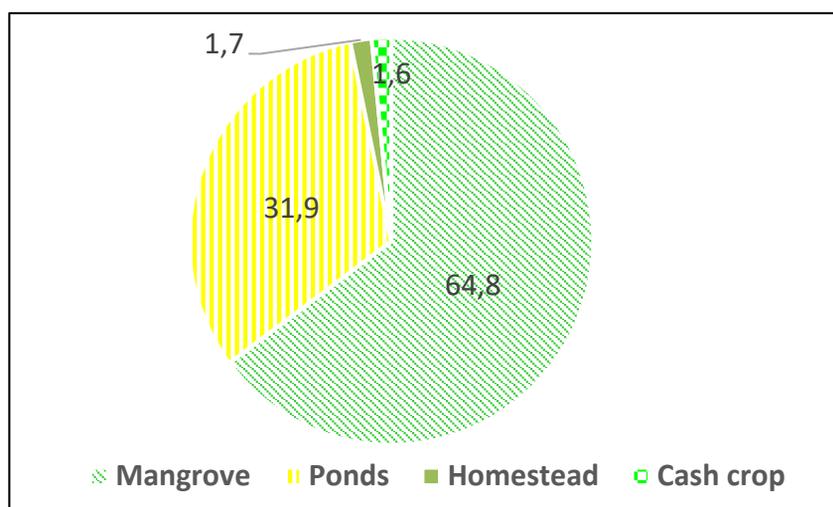


Fig. 2: Farmers' current land use structure in the study area (%)

3.3 Seasonal calendar

Overall, the seasonal calendar depends on changes of water salinity (‰) in a year. Based on the annual water salinity regime, associated with rainfall dis-

tribution and temperature conditions, farmers arranged land use and cropping seasons (Figure 3). High air temperature occurred in March and April. In these months, shrimp mortality occurred which might be related to temperature shock. To over-

come and avoid the problem, farmers nurse the post larvae in a short time (to help them gradually adapt with new living environment) instead of releasing them directly into the mangrove forest-shrimp system right after buying.

Nursing post larvae required supplementary feed. This allows shrimp growing quicker and having a better resistance to environmental changes and impacts, as well as better adaptation to the new living environment. The amount of feed needed for post larvae was small and depended on shrimp density and age.

After releasing the shrimp in the shrimp-forest system, industrial feeds were not provided. Farmers let water from the canal into the ponds and shrimp's feed was aqua-organisms. When shrimp got adult, farmers pumped out the water to harvest the shrimp. Then they cultured the next shrimp crop. Along with constraints related to shrimp farming, farmers raised constraints such as changes in prices, increasing investment costs and diseases in the shrimp.

Activities/impacted events	Months in a year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Post larvae nursing												
Shrimp releasing												
Cash crop cultivation												
High temperature			◆	◆								
Highest salinity in a year				◆	◆							
Diseases on shrimp						◆	◆				◆	
Market price fluctuation						x	x	x	x	x		
Funds required for key farming activities			x					x				

Fig. 3: Seasonal calendar of the integrated mangrove-shrimp system and key impacted events on the system in study area

3.4 Challenges to the integrated mangrove-shrimp system

Farmers in the study area have been facing many challenges including technical, policy, financial and natural conditions. Focus group discussion results show that several of these problems were out of reach of farmers and existed for a long time.

Technical challenges

- Shrimp died due to temperature shocks, changes in water environment and diseases. In fact, this is main and frequent challenge to not only the mangrove-shrimp system in Soc Trang province, also all shrimp farming systems in the Mekong Delta.
- Farmers have limited accessibility to good quality shrimp seeds because seed suppliers are far from their farms. Moreover, farmers used to buy cheap and thus poor quality shrimp seeds.
- Farmers don't have facilities to inspect quality of shrimp seeds when buying from suppliers, and the latter have no certification system. In some case, shrimp seed suppliers confirm quality of seeds, but farmers doubted the statements because their shrimp died shortly after releasing.

Policy challenges

- The first is inflexible regulations for mangrove management of local authorities, particular in limiting farmers to undertake forest timbering and shrimp pond's cleaning. This caused decrease in shrimp productivity and puts farmers' livelihoods at risk.
- The second is unclear duration on forest land allocation for farmers (production forest). In the agreement between farmers and the Soc Trang Forest Ranger, farmers are allocated forest land to conserve and develop mangroves, they can use water surface for farming. Unfortunately, the duration of land allocation was inexplicit mentioned, therefore farmers have no motivation to conserve the mangrove forest.
- Currently, forest has no benefits to farmers because forest needs at least ten more years to get adult.

Financial challenges

- Farmers had limited financial capital to invest. Most farmers were poor, their livelihood is based mainly on shrimp products, and they have not much savings from the farming activities. In some cases, limited financial resource resulted farmers in delayed shrimp releasing and shrimp farming season, which reduces shrimp productivity.

- Farmers had limited accessibility to state and other banks because their forest land was not recognized as property and could not serve as collateral for loans.
- In recent years, input prices (i.e. seeds) have been increased, which lead to increased production costs. Ultimately, farmers have low net revenue.
- Unfortunately, shrimp's selling price was fluctuated in past years. Moreover, shrimps in the system are not certified as organic products, therefore the additional value is not considered.

Natural challenges

- Temperature was very high in the dry season and abnormal rain causing sudden changes in water environment (salinity, temperature);
- Fresh water come early, which reduces the salinity thus limits shrimp farming time;
- Water environment was polluted due to industrial shrimp farming;
- Natural aquatic resources were declined in serving farmers' livelihoods;
- Shrimp ponds had been deposited of sedimentation;
- The decomposition of mangrove leaves dropped in the pond that caused a bad environment for shrimp growth.

In studies on mangrove-shrimp system, Pham Van Khang (2008), Nhuong *et al.* (2006) and Gowing *et al.* (2006) found several similar challenges in Ben Tre, Ca Mau and other places in the Mekong Delta. The natural and technical challenges are more common and important. Regarding policy issues, flexible policies were applied in Ca Mau, farmers received forest land from state companies who representing the government to manage forest; farmers could exploit the mangrove trees to gain benefits under contract and management of the state forest companies. Hereby, mangrove is exploited in a rotational system, and every year an area up to 10% of their total planted mangrove areas delivers good timber products. Then, farmers replant new mangrove on harvested area. Farmers could share 90% of the benefits from mangrove exploitation, and only pay decorative amount of 10% to the state companies. According to the Government Decree¹ No 2, 163, and 181, the People's

¹Decree No. 02/CP dated 15/3/1995; Decree No. 163/1999/NĐ-CP dated 16/11/1999 on forest land allocation for organisation, individuals, households to sustainable use for forestry purposes, and Decree No. 181/2004/NĐ-CP dated 29/10/2004 on guidance for Land law implementation 2003.

Committee of Kien Giang and Ca Mau provinces launched two decisions respectively (25/2011/QĐ-UBND Kien Giang dated 28/07/2011; 06/2013/QĐ-UBND Ca Mau dated 11/07/2013) related to forest land allocation, hereby, farmers can get from 90% of the benefits from mangrove exploitation and forest services. Additionally, this policy was confirmed by forest managers in Ca Mau, Kien Giang and Ben Tre provinces at the National workshop on Agriculture and Environment based the climate change adaptation strategies in the Mekong Delta held on last 23rd May 2014. By this way, famers could improve their livelihoods based on forest production and therefore they have motivation to conserve and develop mangrove forest.

3.5 Opportunities for system development

Along with already discussed challenges, the system has several advantages and opportunities for development. The focus group discussion results could be summarized as follows:

- Farmers and mangrove managers were aware that the mangrove-shrimp aquaculture was the main livelihood for farmers who lived in the forest zones;
- Besides shrimps, the integrated mangrove-shrimp also provided incomes from other aquatic animals, especially fishes and crabs, and from vegetables;
- Farmers were supported by international organizations (GIZ), Universities, Institutes and local authorities (DARD, DONRE²) via programs, studies and projects relating to mangrove forest management;
- Changes in forest management policies are required to allow farmers using effectively the forest and the ponds, and to improve the productivity. Fortunately, local policy makers agree on this and also on the need to specify the duration of forest land allocation. Besides, considering technical solutions to increase the additional value of the system, for example through organic certification of products (shrimps, OAA) is necessary.
- Decision No. 1565/QĐ-BNN-TCLN (DARD) dated 08/07/2013 on approving the proposal for restructuring Forestry sector. This decision allocates more funds to study on added values from forest services, job generation, poverty reduction and

² DARD and DONRE (Department of Agriculture and Rural Development and Department of Natural Resources and Environment respectively)

livelihood improvement for forest protectors, farmers;

– Resolution No. 30-NQ/TW (Political Ministry) dated 12/03/2014 on innovation, development and effectiveness improvement of forestry and agricultural companies. This Resolution gives many opportunities for agroforestry system development, particular in mechanism, institutional and policies related to forest land allocation. (land measurement, land use right certification, land hiring and allocation).

Based on challenges and opportunities, the needs assessment recognized and proposed the following techniques to be tested in trials.

- Ponds cleaning to improve shrimp productivity;
- Releasing of additional shrimp seeds for selective harvest;
- Shrimp seeds nursing before releasing.

Similar to Soc Trang, mangrove-shrimp farmers in Ca Mau, Kien Giang and Tra Vinh provinces use the techniques of releasing additional shrimp seeds. However, many farmers do not nurse post larvae in clear ponds prior to releasing shrimps into the mangrove. Moreover, training on shrimp cultivation for farmers is very essential because farmers need to improve their farming practices when changing traditional farming practices to new adaptive techniques on mangrove-shrimp. The new technique might contribute to improving productivity and resilience of the system and therefore sustain farmers' livelihoods.

Table 3: Changes of impacted factors on mangrove-shrimp system in study area

Impacted factors	2009	2010	2011	2012	2013
Overall climate conditions	▼	▲	▲	▲	=
Disease pressure on shrimp	▼	=	▲	▲	=
Overall water quality	=	▲	▲	=	▼

Notes: ▼ negative impacts; = normal conditions; ▲: positive impacts (Source: Focus Group Discussion, 2014)

According to farmers' knowledge the climate conditions, the disease pressure on shrimp and the water quality varied year by year (Table 3). From 2009 to 2012 all factors were well, but water quality was bad in 2013 which might have reduced shrimp yield.

Farmers indicated four priority issues related to policy (Table 4). On top of this list were articles in the forest land allocation contract, including shrimp-ponds cleaning. Currently, farmers don't have a clear indication on the time they may stay and cultivate mangrove-shrimp system on the allocated forest land. Moreover, the benefits from their forest management work were low. Further, farmers also want to clean the shrimp-ponds to increase the effectiveness of the system via increased productivity of shrimp and OAA. Moreover, mangrove timbering and ponds ratio share, were a concern, and bordering mangrove needed to be timbered to reduce shade and fall of leaves in the mangrove-shrimp system.

Table 4: Farmers' evaluation and suggestion to improve productivity of the system

Concerns	Current	Evaluation	Suggestion
1. Forest land allocation (ha, mean)	22ha / household	Quite suitable	Clearly define farmers' right, responsibility and land allocation duration
2. Shrimp-ponds cleaning	Not allowed	Not suitable	Should be allowed under local forest ranger's management
3. Mangrove timbering	Not allowed	Not suitable	Should be allowed with non-economic mangrove
4. Pond ratio shared (%)	±30	Too small	Increase up to 35-40

3.6 Mangrove-shrimp farmers' livelihoods

Along with the mangrove-shrimp system, farmers diversified their livelihood activities. The production of cash crops such as root onions was a major source to household income. Average net income from root onion production was 100 million VND/ha/year in 2013 (Table 5). This activity provides cash frequently to household. However, cash crop cultivation requires inputs such as labors, input materials (pesticides, fertilizers), while the planted area per household was limited to about

0.33ha. Moreover, the economic efficiency of cash crop such as root onion varied and depended on market demands and selling price. To illustrate, in 2013 cash crop production gave a net income of about 100 million VND/ha, but it gave only 23 million VND/ha in 2012. This difference is due the higher selling price in 2013, 15,100 VND/kg compared to 6,600 VND/kg in 2012 (Table 5).

The cash crop cultivation in the study location faced two key challenges. First, it used pesticides and fertilizers threatening the shrimp in the ponds.

Second, cash crop cultivation used ground water for irrigation; if this cropping expands and is practiced over a long period, the ground water degradation is probable. In other words, this livelihood activity is a short-term solution and farmers are

encouraged to identify either other income earning activities and just have a home garden to improve their daily diet and health, or another freshwater source.

Table 5: Cost and income from cash crop production

	<i>in mil VND/ha/year, ton/ha/year</i>							
	Labour	Seeds	Pes+Fer	Others	Total costs	Yield	Income	Profit
2013	42.92±1.7	42.33±3.3	21.38±1.8	6.30±0.1	112.93±4.1	13.44±0.7	214.69±10.1	101.75±8.7
2012	24.41±0.6	11.75±0.5	20.25±0.1	6.56±0.3	62.97±0.4	12.28±0.1	85.98±3.8	23.02±3.7

Notes: cash crop is root onion, yield (ton/ha), selling price in 2012 is 6,600 VND/kg; in 2013 is 15,100 VND/kg; cultivated duration from April 2013 to April 2014 was counted for year 2013; Pes+Fer is pesticides + fertilizers

For farmers in similar conditions in the Mekong Delta, mangrove-shrimp plays an important role in their livelihood, but its weight varies between provinces (Figure 4). The share of mangrove shrimp system in total income was more than 40%, nearly 60%, and more than 70% in Soc Trang, Tra Vinh, and Ca Mau and Bac Lieu, respectively. The remaining shares come from cash crop, agricultural/aquaculture services and off-farm activities. In Tra Vinh (Duyen Hai) and Soc Trang (Vinh Chau), mangrove-shrimp system is located on sandy soils (Arenosols) well suited for cash crops. Root onion, daikon, and other vegetables are popular in Soc

Trang, while cassava, sweet potato, groundnut, soybean and derris, are popular in Tra Vinh. In contrast, the systems in Ca Mau (Ngoc Hien) and Bac Lieu (Dong Hai) are in areas not suitable to cash crop production, particularly due to lack of water for irrigation.

In Ca Mau, the farmers draw their key income from the mangrove-shrimp products including shrimps, OAA and timber. This community based mangrove forest management approach successfully improved farmers' benefits from forest and increased their pleasure to live in and conserve mangrove forest.

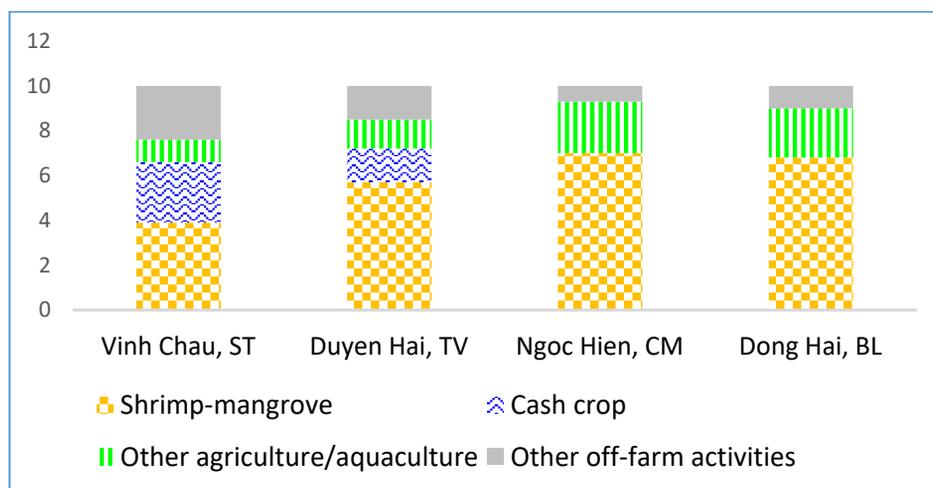


Fig. 4: Mangrove-shrimp farmers' livelihood activities contribute to household income in Soc Trang (ST), Tra Vinh (TV), Ca Mau (CM) and Bac Lieu (BL) provinces*

Data from field surveys in 2014 (ICRAF project) and compiled and calculated by the Authors. Unit was %, 10=100%

3.7 Financial analysis of the integrated mangrove-shrimp system

The difference in total costs, productivity (both shrimp and OAA), gross income and net income was quite high within the pilot farms (Table 6). With total costs was 3.6 ±0.9 million VND/ha/year, farmers could earn a net income of approximately

24 million VND/ha/year. OAA contributed more than shrimp to farmer's income: about 45% to both gross and net income of the integrated mangrove-shrimp system. The annual benefit cost ratio of the mangrove-shrimp system was very high, because the system required low operational cost for farming, which suited to the current financial situation of the farmers.

Table 6: Costs and income of 4 pilot mangrove-shrimp farms in Vinh Hai

Unit: mil VND/ha of pond

Farms	Total costs (mil. VND/ha)	Shrimp yield (kg/ha)	OAA yield (kg/ha)	Gross income (mil. VND/ha)	Net income (mil. VND/ha)
1	2.74	55	111	20.09	17.36
2	3.33	50	123	21.83	18.51
3	6.48	140	143	36.57	30.09
4	1.73	103	145	30.43	28.70
Mean-pilot	3.57±0.9	87±18.5	131±7.1	27.23±3.3	23.66±2.9

Similar to pilot farms, within control farms the production costs, productivity, and both gross and net income varied little (Table 7). Shrimp yield was 73 kg/ha/year contributing about 50% to both gross

and net income of the system. Meanwhile, OAA yield was approximately 99kg/ha/year, thus providing the remaining 50% to the gross and net income.

Table 7: Costs and income of 4 control mangrove-shrimp farms in Vinh Hai

Unit: mil VND/ha of pond

Farms	Total costs (mil. VND/ha)	Shrimp yield (kg/ha)	OAA yield (kg/ha)	Gross income (mil. VND/ha)	Net income (mil. VND/ha)
1	4.7	89.6	108.6	18.8	14.10
2	4.2	69.3	88.2	13.6	9.43
3	5.0	76.3	119.3	22.5	17.50
4	3.0	57.0	80.3	14.9	11.85
Mean-control	4.2±0.3	73.1±5.3	99.1±7.0	17.5±1.6	13.2±1.3

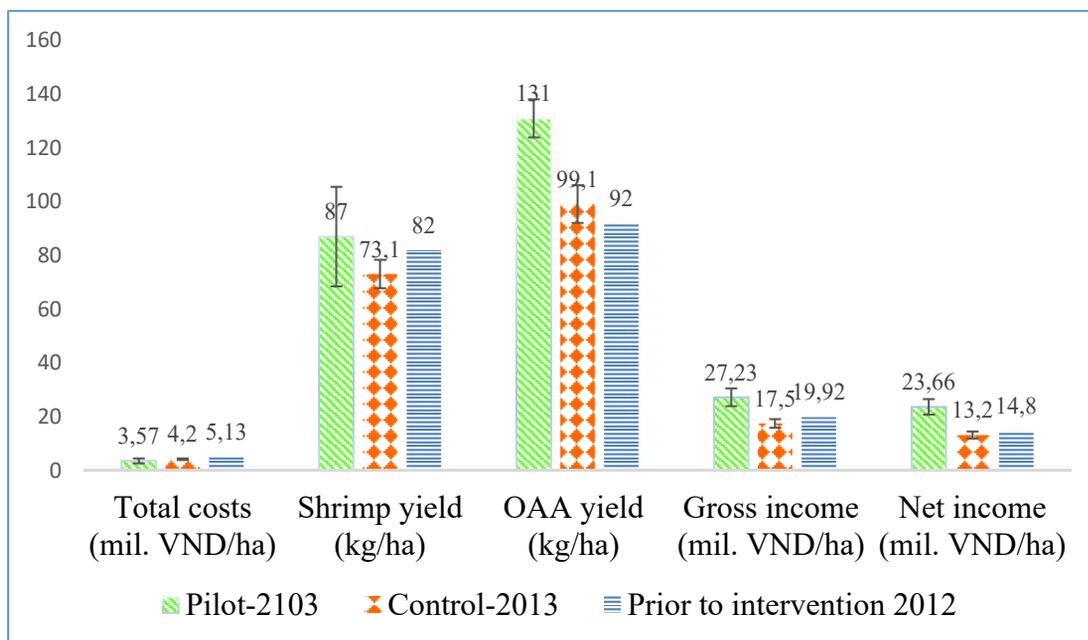


Fig. 5: Comparing cost, yield and income between pilot, control and prior to intervention

The total production costs of the pilot farms were lower compared to both the control farms and themselves before intervention in 2012 (Figure 5). In contrast, shrimp and OAA yields, and both gross and net incomes of pilot farms were higher than both the control farms and their results prior to intervention. This confirms that adaptive techniques have effectively improved the productivity

of the system. Particularly, shrimp and OAA yields in pilot farms have increased gross and net incomes. The pond’s cleaning, post larvae nursing and additional shrimp seeds supply improved the yield of shrimp and OAA.

Despite the improvements in shrimp and OAA yields in the pilot farms, they are lower than in other locations in the Mekong Delta. In Ca Mau,

the yield of integrated mangrove-shrimp system is 228 kg/ha/yr (Ha *et al.*, 2012), and Nga (2011) recorded 170 ±11 kg/ha/yr. Pascal Raux and Denis Bailly (2008) reported mangrove-shrimp yields of 66, 77, 170 and 83 kg/ha/year in Binh Dai (Ben Tre), Can Gio (HCM city), Duyen Hai (Tra Vinh) and Vinh Loi (Bac Lieu), respectively. Those data indicate that the shrimp yield is various between locations and years. Actually, shrimp yield depends on many factors such as post larvae density, water environment, pond depth and seed quality. In this study, shrimp yield in pilot farms have improved compared to control farms and prior to intervention. Hence, the changes impacted directly on the shrimp yield, and the interaction within and between the various factors may have contributed to improve the shrimp yield.

3.8 Assessment on sustainability and feasibility of the integrated mangrove-shrimp system

Sustainability of the system was inspected into 3 dimensions encompassing social, economic and environmental fields. Data analysis results show that there are 9 indicators concerned by farmers that contributed to sustainability of the system, ranking from 74% to 100% of respondents (Figure 6). Of which, safe to land (soil) and water, low production costs, clean products provided and livelihoods diversification are main factors. The key limitations are that the system gives lower yields compared to intensive shrimp systems and it needs larger land areas for farming. In contrast, the system has many advantages and benefits that is suitable to community resources (labor, investments, farming scale and techniques and so on). Therefore, it is encouraged and promoted to develop and scale up in the study areas.

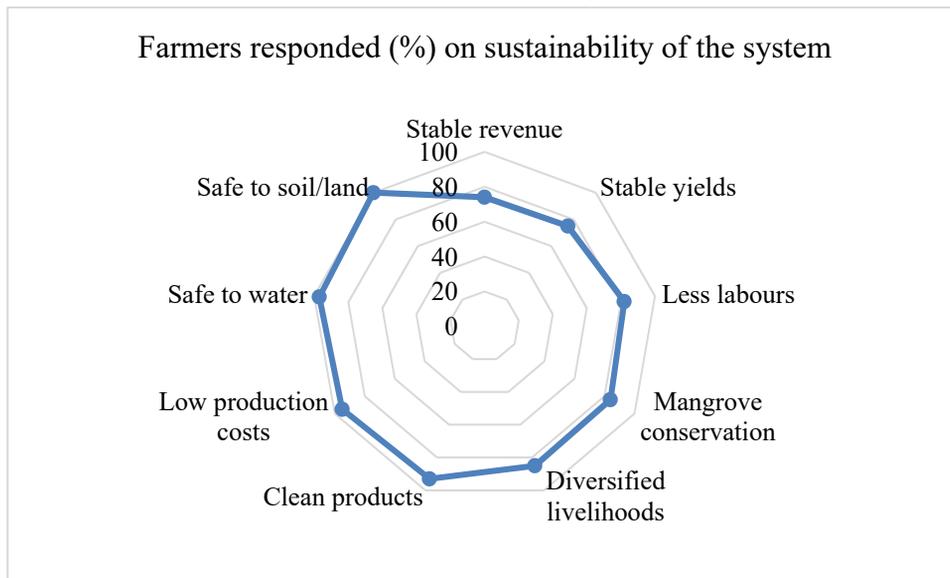


Fig. 6: Assessment on sustainability of the integrated mangrove shrimp system

In term of out-scaling of new techniques, it depends on many aspects such as natural conditions where the techniques will be applied, acceptance of people who apply the techniques and so on. In some case, it requires essential conditions about institutional and policy in the local. The opinions of farmers and local authorities on feasibility and out scaling of the integrated mangrove-shrimp system were consistent (Table 8). Overall, the adap-

tive techniques could be applied and expand to places in Soc Trang having the similar natural conditions to study locations. However, barriers are the current policies on mangrove forest management, particularly the bans on shrimp ponds cleaning and mangrove timbering. To solve those problems, adjustment and flexible application of policies in mangrove forest management are necessary.

Table 8: Sustainability and feasibility of the integrated mangrove-shrimp system

Adaptive techniques	Tech	Eco	So	Env	Required conditions for application and expansion	Rank
Shrimp pond cleaning	Strongly yes	Strongly yes	Strongly yes	Strongly yes	Under local authorities' control; Cleaning is recommended by shrimp farming experts; Farmers have to submit their application to Provincial Forest Ranger.	1
Post larvae nursing	Strongly yes	Strongly yes	Strongly yes	Strongly yes	To support via training	2
OAA (e.g. crab, fish)	Yes	Yes	Yes	Yes	Adult OAA are marketed, not used for selling as seeds (young OAA collection)	3
Diversifying livelihood activities via cash crop cultivation (root onion)	Yes	Yes	Yes	No (threats to ground water resource)	Training for farmers on farming techniques Store and use rain water	4
Non-economic Mangrove timbering	Strongly yes	Strongly yes	Strongly yes	Strongly yes	Under local authorities' control and regulations as recommended by timber forest experts	5
Derris cultivation	Yes	Yes	Yes	Yes	Demonstration, pilot study	6

Notes: Tech, Eco, So, Env is Technical, Economic, Social and Environmental aspects respectively

4 CONCLUSION

The baseline assessment revealed obstacles related to technical, financial, natural and policy aspects, and identified opportunities for productivity improvement of integrated mangrove-shrimp system. Field trials on four selected farms in study site indicated that applying techniques such as ponds cleaning, low seeds density releasing, post larvae nursing and additional seeds supply increased production and effectiveness compared to control farms (traditional practices). Particularly, pilot farms increased in shrimp and OAA yields resulting in improved gross and net income. Beside shrimp, farmers had diversified and improved their livelihood activities such as vegetables production and increase productivity of the integrated mangrove shrimp system.

The system is sustainable in terms of land and water protection, clean product supply, mangrove conservation, livelihood diversification, low productions costs and investments that suit to farmers and community resources. The tested techniques are feasible and have potential for other places in Soc Trang province with different priorities. Nevertheless, the required conditions include an adjustment and flexible application of policies on mangrove forest management need to be reconsidered. Farmers should be allowed to clean their

shrimp ponds, and to timber hindering mangroves trees. Then, mangrove-shrimp may remain an integrated agroforestry system generating livelihood opportunities to the poor landless farmers, inhabitants of remote coastal areas of the Mekong Delta.

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