For farmers

- Production stability
- Reduced water conflicts
- Reduced dependence on agrochemicals
- Increased values of food
- Protected mangrove forest
- Increased market preference
- Reduced biodiversity loss rate

For environment

- Reduced water conflicts
- Reduced waste/containers from agriculture
- Increased market preference
- Protected mangrove forest
- Reduced biodiversity loss rate

Fig. 1: Benefits of agricultural development and environmental protection in XTNP

2. Materials and Methods

2.1 Data collection:
The initial in-depth interviews were conducted with 12 staffs from local authorities (managers of communal people’s committee (CPC), heads of communal agricultural board (CAB) and communal agricultural cooperative (CAC), members of XTNP board management and officials of department of agriculture & rural development (DARD)). Then 234 farmers living in buffer areas of XTNP were chosen for this study.

2.2 Data analysis:

- Production stability index (PSI) is estimated by an index of farmers’ responses to production trends in recent five years.

\[ PSI = \frac{\sum De*1 + Sa*2 + In*3}{n*3} \]

(0 ≤ PSI ≤ 1); De = number of farmers’ response decrease yield; Sa = number of farmers’ response remained yield; In = number of farmers’ response increase yield; n = total number of respondents.

- Biodiversity loss (BLS) can be evaluated by multiplying the responses with scoring value and divided by total number of respondents and divides total number of respondents. The scores of wild-catch habitats are classified as > 50% = 0.25; 20 – 49% = 0.5; < 20% = 0.75; and no natural fry use = 1.

- Farmers’ opinion on the effective level of AAS was evaluated by weighted average index (WAI): WAI = \[ \frac{\sum (VT*7.02) + (VP*0.6) + (PH*0.8) + (VTP*0.03)*1}{(0 ≤ WAI ≤ 1); VL = number of farmers’ response very low effectiveness; LT = number of farmers’ response very low effectiveness; M = number of farmers’ response very medium effectiveness; H = number of farmers’ response very high effectiveness; VH = number of farmers’ response very high effectiveness; n = total number of respondents.

The above index were adapted to indicator-based sustainability assessment from works of Chowdhury, Khanir, and Shvikait (2015).

3. Results

3.1 Farm management and inputs

<table>
<thead>
<tr>
<th>Mode</th>
<th>Rice-based (RB)</th>
<th>Shrimp farming (ISH)</th>
<th>Integrated aquaculture - mangrove (IAM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Economic</td>
<td>Production of target product (kg/ha)</td>
<td>69.89</td>
<td>3,745</td>
</tr>
<tr>
<td>2. Farming changes (no. of respondents)</td>
<td>Increase</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Production stability index</td>
<td>Increase</td>
<td>78</td>
<td>2</td>
</tr>
<tr>
<td>4. Biodiversity loss index (BLS)</td>
<td>&gt;50%</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>5. Pesticide &amp; fertilizers application</td>
<td>Feeding and water mgt.</td>
<td>Harvesting</td>
<td>Feeding and water mgt.</td>
</tr>
</tbody>
</table>

Fig. 2: Farming activities of three main farming systems

- **RB**: Rice is cultivated by two mono-crops/year. Farmers no longer use rotational cropping or integrated pest management (IPM). Diverse kinds of synthetic fertilizers and pesticide are broadly used by 100% respondents. There are overuse of urea and imbalance rate of chemical fertilizers in this proportion.

- **ISH**: Cultivates shrimp (Penaeus monodon) was reared with crabs in mangrove farms. Besides crabs and shrimp, co-products such as wild-catch shrimp (metapenaeus ensis) & fishes, seaweed are harvested. This system relies mainly on ephemeris going from the coast. No fertilizers and lime are utilized. Eight-month production cycle lasts from April to November annually.

- **IAM**: The yield of IAM, ISH were lower than other areas of Vietnam (Seafood Trade Intelligence Portal, 2018; Thakur, K., 2018), whilst yield of RB were higher than Vietnam national average (FAO, 2019).

3.2 Constraints of agricultural development toward environmental protection

- **Farmers’ rank conservation at least important while cultivating**:

\[ \text{Following government advice} \]
\[ \text{Bird protection} \]
\[ \text{Home consumption} \]
\[ \text{Maintaining mangroves} \]
\[ \text{Creating jobs} \]
\[ \text{Land ownership} \]
\[ \text{Profit} \]

3.3 Farm outputs and impacts

- **RB**: Farmers have options to sell or to use them for household consumption. Only 10% of respondents sold shrimp. The yield of shrimp is relatively low due to high quality and low quantity. The yield of shrimp was higher than rice (69.89 kg/ha) with 1.35 times.

- **ISH**: The yield of ISH is lower than that of RB and IAM. There are difficulties in managing shrimp larvae. The yield of ISH was lower than that of RB (24.78 kg/ha) with 0.82 times.

- **IAM**: The yield of IAM is lower than that of RB and ISH. There are a lot of problems in shrimp farming. The yield of IAM was lower than that of RB (24.78 kg/ha) with 0.82 times.

3.4 Constraints of agri. development toward env. protection

- **Policy/regulation of agriculture**: Farming activities are under regulated by DARD of district but are not enforced.

- **Constraints of agricultural practices**: There are no environmentally friendly programs in the protected area in recent three years (2015-2019).

- **Constraints of farmers’ capacities**: There is no awareness of organic products in this area.

- **Constraints of agri. development toward env. protection**:

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy/regulation of agriculture</td>
<td>Environmentally friendly practices</td>
</tr>
<tr>
<td>Improving stability of production through application of sustainable practices</td>
<td>Promoting specific policies/programs and the enforcement in agricultural management for buffer zones of protected areas</td>
</tr>
<tr>
<td>Strengthening capacity of local authorities in translating advanced technologies of conservation agriculture and problem solving</td>
<td>Developing certification for farm products applying environmentally friendly practices</td>
</tr>
</tbody>
</table>

4. Implication

- Heightening awareness of farmers on the conservation through the public education.

- Improving stability of production through application of sustainable practices (1) reducing of wild-captured in IAM; (2) lower antibiotics, improving recycling and lower water exchange system in ISH; (3) restraint of urea abuse and synthetic fertilizer imbalance and pesticide in RB.

- Developing certification for farm products applying environmentally friendly practices.

- Promoting specific policies/programs and the enforcement in agricultural management for buffer zones of protected areas.

- Strengthening capacity of local authorities in translating advanced technologies of conservation agriculture and problem solving.

- Developing certification for farm products applying environmentally friendly practices.