INTEGRATED MANAGEMENT OF LAGOON ACTIVITIES
IMOLA PROJECT II

A REPORT ON

EVALUATION OF ECONOMIC EFFICIENCY AND ENVIRONMENTAL IMPACTS OF FROG RAISING USING WORMS AS SUPPLEMENTARY FEED

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PEOPLE'S COMMITTEE OF THUA THIEN HUE PROVINCE

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I. BACKGROUND

The worm farming derives from the United States, and it is widely developed there. Later, it has been introduced to culturists in many countries such as France, Canada, Italy, Australia, China, the Philippines, Vietnam, and others.

At the beginning, worms were raised to provide baits for line fishing in tourism sites but when worm raising was expanded to immense scale, the idea for using worms in other fields instigated. The farming and processing of earthworms have turned into an industry for the benefit of horticulture, waste discharge treatment, environmental protection and feed provision for cattle, poultry and aquatic species. Earthworms are also utilized in cosmetics, Eastern and Western medicine manufacture. In the past years, earthworm raising has become one of the ever enlarged businesses in many countries such as the United States, Canada, the Philippines, India, and so on.

Huong Phong is a lagoon commune under Huong Tra district, Thua Thien Hue province. Due to the geographical distribution, horticulture and husbandry are two major economic activities in this commune. Furthermore, the shallow topography makes rice to be the monoculture plant in the locality. Cattle raising is to provide pulling force and manure with species including cattle, pig, and poultry. Aquaculture attracts the attention with diverse species.

However, economic activities mainly take place in small scale due to the economic restraint; the performance and income are not stable. Lately, lots of advanced technologies have been applied to the production. Meanwhile, the price of products sold in the market is unsteady; cost for purchasing feed tends to boost. Households adopting industrial feed gain products of good quality; however, their benefit is trimmed down due to the high investment cost in feed procurement. In particular, for more difficult households, less capital they own, more difficulties they encounter in their venture in husbandry and less access they have to appropriate scale. Therefore, the search for a kind of supplementary feed that is protein rich, highly nutritious and easily produced on spot and enables farmers to take advantage of byproducts and waste from animals raising is a necessity and partly responds to the need of supplementary feed use in the household farming.

Upon the commune needs and thanks to the assistance from IMOLA project, the pilot model namely “evaluation of the economic impact of earthworms (*Perionyx excavatus*) as supplementary food in the commercial frog raising” has been conducted.

Objectives of the pilot culture include 1) to diversify culture species, and 2) to create the source of supplementary feed for the husbandry, contributing to increasing farmer’s income and improving the environment.

II. TARGET – VENUE – CONTENT AND RESEARCH METHODOLOGY

2.1 Research target

Earthworm (*Perionyx excavatus*) with the following classification system:

Classification system:

Phylum: Annelida

Class: *Olygochaeta*

Family: *Megascolecidae*

Species: *Perionyx excavatus*

2.2 Research venue

Thuan Hoa village – Huong Phong – Thua Thien Hue

2.3 Research content

- Raising the biomass of earthworm (*Perionyx excavatus*) in the brick container.
- Evaluating the performance of earthworm use in frog commercial culture.

2.4 Research methodology

2.4.1 Methodology of data collecting

- Primary data are collected from the direct interview with the farmer
- Secondary data are collected via magazines, newspapers and related researches

2.4.2 Methodology of doing experiments

Frogs are divided into 2 experimental lots, as follows:

- Control lot: 100 % of industrial feed is used
- Treatment lot: 50 % industrial feed + 50 % earthworms is used (experiment duplicated 3 times)

Frogs are stocked in 2 lots with the same rate: 100 units/m^2.

2.4.3 Monitoring the growth rate of frogs

Sampling is taken every 10 days to check the growth rate of the cultured species. 30-40 samples/ cage each sample. The sample is weighed by g/ unit.

2.4.4 Accounting method

Assessment of the revenue of the model: *Total revenue = total earnings – total expenditure*

Assessment of the revenue gained from the pilot model: Revenue is the amount achieved after the subtracting the total expenditure from the total earnings (including both fixed and mobile costs).

Total revenue = (total earnings + remaining value)-(total expenditure + beginning value+ depreciation)

III. RESULTS AND DISCUSSION

3.1 Biology of earthworms

3.1.1 Morphological features

The earthworm is backboneless; the outer surface is a thin "*kitin*" pigment layer. The body is a long tube, slightly pointed at the two ends. One outstanding feature of the earthworm is that the worm body is formed of many segments. In general, the number of segments of earthworm ranges from 110 to 180 units. Seta is the organ that helps earthworms to move forwards; these setae are normally short and enable earthworms to dig their shelters and move under the ground.

3.1.2 Internal organs of earthworm

The digestive system includes: mouth hole – mouth sinus – fauces – gullet – belly (mề) - stomach – gut – typhlon – rectum and anus. Apart from this, the earthworm also has the circulatory, respiratory, nerve and sexual systems.

3.1.3 Feeding habit

The earthworm mainly feeds on harmless organic substances with apt pH, and high mineral salt: feces of cattle and poultry, waste of processing factories, agricultural byproducts and cabbage. Herbs (such as rau hung, rau quế, etc.) and others (lemon leaf, orange leaf, and pomelo leaf) may kill worms or they will run away. In particular, earthworm is highly sensitive with sugary and fishy food. Therefore, during the earthworm raising, broken fruits and fishy water can be added to the feed with the purpose of reducing their eating desire.

3.1.4 Growth and reproduction features:

Earthworm grows up by increasing the number of body segments and surface of the segments. The cocoons (*kén*) are of oval or circular shape. Under the normal condition, the spawning time for the larva of earthworm is 2 – 3 times. Each cocoon consists of 1 – 20 units of earthworms. Once the reproduction belt appears, earthworms have been sexually mature. Reproduction of the earthworms is sexual reproduction *(sinh sản hữu tính)*. Under the culture condition, earthworms can copulate all the year round in favorable conditions.

3.2 Biomass of earthworm (Perionyx excavatus) in the brick container

3.2.1 Preparation of the worm container

The volume of the brick container is constructed with the size of 1 x 1 x 0.4 m. The brick container is built in the farm with covered roof. The bottom of the tank is concreted with a temperate gradient (5-10%). At the container bottom, there is a hole with the diameter of 1 – 1.2 cm for drainage.

Add to the bin an amount of buffalo feces to make the bedding. Water the bedding until it reaches the moisture of 60-70 %. Earthworms will be stocked into the bedding with the density of 3 kg of worms/ m^2.

The optimal temperature for the earthworm growth and reproduction is 20 – 30 ^oC. Water is the important part making up 75 – 90 % of the earthworm weight. For *P.excavatus* species, the suitable moisture is 60 – 70 %. There is a mutual relationship between the moisture and the temperature, impacting the growth and reproduction of the earthworm, of which the moisture is the one of the major reasons leading to the increase or reduction of earthworms.

Shining level:

The ultraviolet ray is extremely harmful, shriveling up the worms and can kill them. The worms normally avoid the sunlight; the strong light from the torch is also the cause for earthworms to live in the wet area with many feed.

pH:

The earthworm is suitable with the living environment with the pH of 7.

3.2.2 Bedding method

Bedding is the temporary or stable shelter for your worms to avoid the sunlight, heat and cold and other unfavorable conditions. The bedding should be fertile, highly moist, unacid, and nontoxic. The bedding must meet four characteristics: fertile, non-adhesive, nutrient rich and clean. The bedding is processed from the mixture of cattle feces (buffalo and oxen and cows) and carefully composted.

Substrate composting:

The piling method is applied: a layer of vegetations (straws, leaves, etc.) 20 cm thick, a layer of cattle feces 10 cm thick. The piling is combined with the watering. Watering is less for the lower layers to make bedding with the moisture of 50 – 60 %. When the compost is made into piles, they should not be pressed too much so that aerobic bacterial will not develop quickly. On the top, a nylon net is used to fully cover or a layer of mud is made to keep the appropriate temperature and moisture. A bamboo pointed stick is utilized with the surface of 5 – 10 cm to make a hole from hill top to be able to add water to the compost.

After 2 – 3 days of composting, the temperature will gradually increase. After 4-7 days, it can reach 70 – 80 ^oC. Once the temperature drops to 60^oC, we can stir the compost. The stirring is conducted every 15 days. Stir and add more water to the compost. Once the temperature goes down, use hands to touch the compost, if we feel no heat, the compost has been completed.
The appropriate time for the compost is 30-45 or over 90 days (for newly fresh composting materials). The time is only 12-15 days for old feces and straws. A rake or spit is used to break the compost. A thin layer of compost will be stretched in a shady area; harmful gas, ants and insects will escape and we will have ideal bedding for worm raising.

3.2.3 Feed of the earthworm

Under the natural condition, the worms feed on rotten organic substances in the feces and soil. After the domestication, it can feed on other food types. In reality, major food of the earthworm includes waste from all types of animals. Besides, it is possible to make use of straws, bean family branches and vegetables, and so on. These can be the valuable feed for the earthworms.
The earthworm is omnivorous, like feeding on organic substances. It prefers eating on rotten organic matters or compost.

3.2.4 Selection of breeding earthworms

Healthy and good earthworms are selected (once the cover of the furrow is removed, the earthworms will immediately burrow down). Selected worms for culture should have the color as the ripe plum-tree fruits, no viscosity and good smell. Young earthworms or worms that already have sexual belts can be used.

3.2.5 Stocking of the seed earthworms

The soil is well prepared before being put into the bin and farming furrow. The soil should be added to a thickness of 5 – 20 cm at the bottom. After that, the bottom soil is sprayed with water till the moisture reaches 60 – 70 %. This can be checked by two ways: take one handful of soil and squeeze it, if there are some water drops, the soil is quite moist. The density of the earthworms in bins ranges from 1 – 3 earthworms/ $m^{2.}$ Earthworm fingerlings are spread into parts or lines in the middle of the bedding. Around 10 – 15 minutes later, earthworms will burrow into to the bottom bed. Weak earthworms that can not burrow deep down should be left out to avoid the attack of ants.

3.2.6 Care taking of the earthworms

Covering the bin:

Earthworms like darkness and are afraid of the sunlight. Therefore, in order that earthworms are healthy, grow and spawn well, the farming cells must be covered with sheets such as old carpet, waste papers, and so on. Plastic or rubber covers should not be used because they are too air-tight. The good covers will help to keep moist for the bins.

Keeping moisture:

Moisture has an important role to play in earthworm growth and development. The optimal moisture for the earthworms is 60-70 %. To maintain the moisture, water should be added during the farming process. The added water must be unpolluted with neutral pH, has no combination of matters harmful to the earthworms (such as soap and other chemicals, and so on). Normally, water should be added once every day; in summer, 2-3 times of watering per day is necessary.

Feeding the earthworms:

One day after the stocking day, earthworms start to be fed. Food is spread on the centre of the farming cell and separated into the patches. The amount of feed consumed by the earthworms is equivalent to the biomass of the earthworms.

Adding more bins:

If the released amount of waste from the earthworms increase, the quality of the earthworms reduces; there should be a periodical plan to change the content of the soil 2 – 3 times/ month.
After one month of culture, the productivity of the earthworms increases from 1.5 – 2 times; it is time to harvest and create more furrows.

Method:

The new furrows should have the same area as the old bin and furrow; a half of the old soil should be added to the new furrow. After that, feed the worms and water them so that they can quickly adapt to the new environment. Adding further bins and furrows is to adjust the farming density and create the conditions for worms' growth and reproduction.

Harvest:

One month after the culture, the productivity of the earthworms increases from 1.5 – 2 times, harvest should be done. There are many ways of harvest:

i. Exposing earthworms to sunlight
This is based on the behavior of earthworms to avoid the exposure to sunlight: put the worm container in the sun, we will find worms concentrated. As the cover sheet is removed, the worms can be easily harvested.

ii. Flooding the earthworms burrows
If the burrows are flooded, worms will move to the top soil and can be easily caught. Water should be quickly drained after harvesting necessary worms.

iii. Providing food
Put favorite food of earthworms into the bamboo basket with holes; locate it on the worm container. Worms are sensitive to the smell of the food and will concentrate to where there is food.

iv. Using electric lights
This method is similar to the harvest by exposing worms to sunlight; however, electric light is used.

3.2.7 Some common diseases and treatments for the farmed earthworms

Poisonous air:

Cause:
The bedding substance has not been replaced by the farmers after long culture time so it is contaminated with a big proportion of CO_2 and worms have to move to the surface.

***Treatment*:**
bedding is completely replaced and new food is added.

Protein poisoning:

Cause:
This is caused by over-feeding the earthworms with protein-rich food, which leads to the decomposition of this food.

Treatment:
Remove all the feed, old bedding and heavily infected worms; add more fabric food with temperate amount.

Besides, during the farming process, there are some other common diseases such as bacteria, fungus and bacteria.

3.3 Efficiency of the earthworm raising

3.3.1 Evaluate the economic efficiency of the model

Table 1 Summary of economic efficiency of two pilot models

Criteria	Culture using earthworms as supplementary feed	Culture by industrial feed
Total expenditure (I)	**5,330,000**	**3,370,000**
Cage depreciation	330,000	330,000
Worm tank depreciation	400,000	0
Frog breeding	1,000,000	1,000,000
Worm breeding	1,000,000	0
Feed cost	800,000	1,440,000
Labor cost	1,800,000	600,000
Total revenue (II)	**10,750,000**	**6,000,000**
Frog	6,750,000	6,000,000
Remained value (breeding earthworms)	4,000,000	0
Profit = II – I	**3,620,000**	**2,630,000**

3.3.2 Growth and survival rates of the frogs

The growth rate of frog is shown through Fugure 1. The growth rate of frogs over the time in the treatment lots shows the difference. Specifically, the frog eating worms as a supplementary feed have higher growth speed compared with frog consuming 100 % of industrial feed. After 85 days, frog reached the weight of 157g/ unit and 132 g/ unit in the treatment lot and control lot, respectively. However, the statistical data reveals no variation on the frog growth rate between the two lots ($p>0.05$). The reason may be that the used frogs in the lots are weak and grow poorly because their parents have been used so many times (this is the tenth times) so the quality of the seed frogs are not good and have negative impacts on the frog growth rate.

Feed used for the two lots were unlike and the monitoring time was quite short so a clear impact of feed parts on frog growth rate can not be identified. Probably the mixture of feed (50 % earthworms + 50 % of industrial feed) are not really apposite for the biological growth of the cultured frogs.

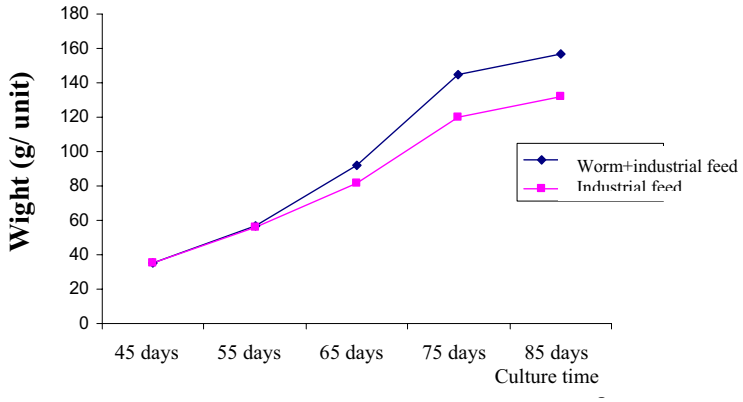

Figure 1 Frog growth rate over the time

The survival rate of frog is illustrated in Figure 2. There is no difference about the survival rate of frog in two experimental lots. The survival rate of frog is relative high after 85 days of farming: 95 % and 93 % in the lot where earthworms are used as supplementary feed and the lot where 100 % of industrial feed is applied, respectively.

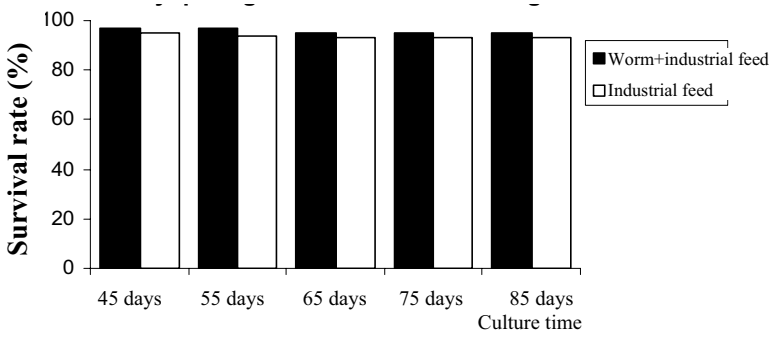

Figure 2 Survival rate of frog over the time

3.3.3 Environmental impact

Huong Phong is a commune that has a low terrain. Around the commune is a system of rivers and the Lagoon; therefore, water resource is abundant. Bo and Huong rivers are two sources providing use water for the commune. The topographic features have some certain impacts on the structure of culture and farming of the area. Culture is the key economic sector of Huong Phong commune. Furthermore, the shallow topography makes rice to be the monoculture plant in the locality with two major crops including summer autumn and winter spring. The rice area of the whole commune is 919 ha, with the productivity reaches 50.5 quintals/ ha. As rice is the major cereal, after the harvest season, a large amount of straw is discharged. Cattle raising has been developed in the commune for the past years with major animals such as cattle, pig and poultry. Solutions to agricultural activities (including culture and husbandry) are an issue of concern to the commune authority. When life was still difficult, local people mainly used straws as fire materials to cook meals. However, the use of straws as burning materials is now no more as common as before. In Huong Phong commune, straw after the harvest is normally burnt to supply the manure for the crop; some is used as family burning materials and as bedding for straw mushrooms (7 households). The remaining straws are directly thrown into the rivers so water source has become contaminated.

Undue attention is paid to waste from husbandry (cattle, pigs, etc). Most farmers do not build the storage trench or no treatment but direct discharge is applied. Serious environmental pollution occurs and has negative impacts on the life of the people.

The development of economic models to take full advantage of waste discharge from agricultural activities such as straw mushrooms and earthworm raising together with the education and awareness raising for the people on the environmental protection has been creating new production models and improving the livelihood for the people.

The earthworm culture using the byproducts from husbandry and culture has contributed to improving household livelihood and providing protein source in aquaculture, husbandry and improving environmental conditions.

IV. CONCLUSION

- People are learning the techniques for earthworm raising and trying some pilot models at home.
- Earthworms develop well under the natural condition of the community.
- The use of earthworms as supplementary feed in frog commercial raising had brought about better economic efficiency for households as compared to frog raising only with industrial feed. The model of raising earthworms as supplementary feed produced more benefit than the current traditional model and improved the livelihoods of the people.
- Growth rate of frogs in the lot where earthworms are used as supplementary feed is faster than in the control lot (where 100 % of industrial feed is applied) although this was statistically not significant.
- There is no difference about the survival rate between the two experimental lots.
- Frogs raised in the experimental lots have good resistant capacity against the disease pathogens.
- The production of earthworms by taking advantage of the byproducts and animal waste from agriculture has contributed to creating the on-spot supplementary feed, nutrient rich with low cost, leading the reduction in operation cost and increasing income.

V. REFERENCES

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