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## Biotechnological bases of organization of industrial crayfish farm in Ukraine

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### ABSTRACT

Crayfish are valuable invertebrates that are constantly in great demand in all corners of the Earth. Breeding crayfish is not only large-scale production as it can also be arranged in small volumes using pools and installations of closed water supply. Cultivation of crayfish generates profit after a certain period of time, if all biotechnological norms of cultivation are considered. Cultivation of crayfish is a rather promising production, in which it is possible to obtain from 200 to 300% of stable profits during 3–4 years. The article gives an overview of the technology of growing crayfish, taking into account the characteristics of farming in Ukraine. The basic biotechnological stages of the establishment and operation of the economy are determined, calculations of capital expenditures for the establishment of the economy are presented and the profitability of the project for the production of freshwater crayfish is determined. Cultivation of river crayfish makes it possible to obtain environmentally friendly products that can compete on the markets of Ukraine or EU countries. Also, this way of growing crayfish allows getting stocking material for release in natural reservoirs in order to restore the populations of river crayfish.

**Keywords:** crayfish, aquaculture, biotechnology, ponds, farming

### 1. INTRODUCTION

Biotechnology and aquaculture are areas of entrepreneurial activity, which are able to feed the world. Currently, the world has about 2.5 million biotechnological companies. Breeding of crayfish is one of the areas in biotechnology and aquaculture [1-4].

Crayfish are valuable invertebrate animals that are constantly in high demand in all corners of the Earth. But, unfortunately, the natural population of crayfish decreases annually, aided by poaching, periodically there are a variety of epizootic and other reasons. Growing of crayfish has been practiced for a long time; the farms for the breeding of crayfish were built even in the USSR. Therefore a sufficient information about the biology and ecology of crayfish that may be used for the production establishment is accumulated. In recent years, much attention is paid to the breeding of crayfish in artificial reservoirs. European leader in the cultivation of crayfish is Turkey, wherein the fullness of time crawfish from Ukrainian ponds was imported. On foreign markets it supplies annually up to 7 thousand tons of commodity crawfish, somewhat less supplies Spain (3.5 tons) and China (1 tons). In the United States breeding of crayfish brings millions in profits and create jobs for many segments of the population [3]. The products of crayfish breeding industry do not require special advertising; therefore there is always demand for a commodity offer. In supermarkets, the price for kilo of fresh crayfish can range from 8.8 to 20 USD, which is almost at the level of price for live trout or sturgeon. At the same time, not everyone can boast that they have tasted sturgeon or fried trout, but almost everyone have eaten boiled crayfish.

Crayfish business includes the following stages:

- 1) The building of a crayfish farm (pools, ponds, lakes, aquariums, RAS, etc.).
- 2) Stocking crayfish.
- 3) Crayfish feeding and work on a farm.
- 4) Harvesting.

## **2. FRESHWATER CRAYFISH FARMING**

### **2. 1. The first stage: organization of the farm**

The other part of the room is the technical area where the compressor, generator, water quality analyzer, and biofilters are located.

Economic indicators of the operation of such enterprise:

- Necessary volume of investments is 125,000 USD
- The business payback period is 3.9 years
- Discounted payback period is 4.7 years
- Net present value is 220,000 USD
- Internal rate of return is 32.4%
- The profitability index is 3.288.

Since the organization of the pool enterprise has significant technological complexity and requires large financial investments, we will consider the breeding of cancers on the example of a pond farming.

### **2. 2. The second stage: the settlement of crayfish**

Breeding of crayfish can be carried out in artificial ponds and reservoirs, as well as in pools and aquariums (or in installation of closed water supply). Presence of running water is not necessary for their breeding. For the growth of crayfish throughout the year, there must be a space where winter temperatures do not drop below +15 °C but is not higher than +21 °C [5].

The optimal water temperature should reach +18 °C at a pH of 7–8. If the temperature is lower, crayfish do not eat, and hibernate, or may die at very low temperatures.

Breeding of crayfish in the ponds is a long process, because the low temperature of them contributes to the long dormancy of crayfish, inhibition of growth and reproduction [6]. Although, the more south is the region, the better is growing of crayfish in open water.

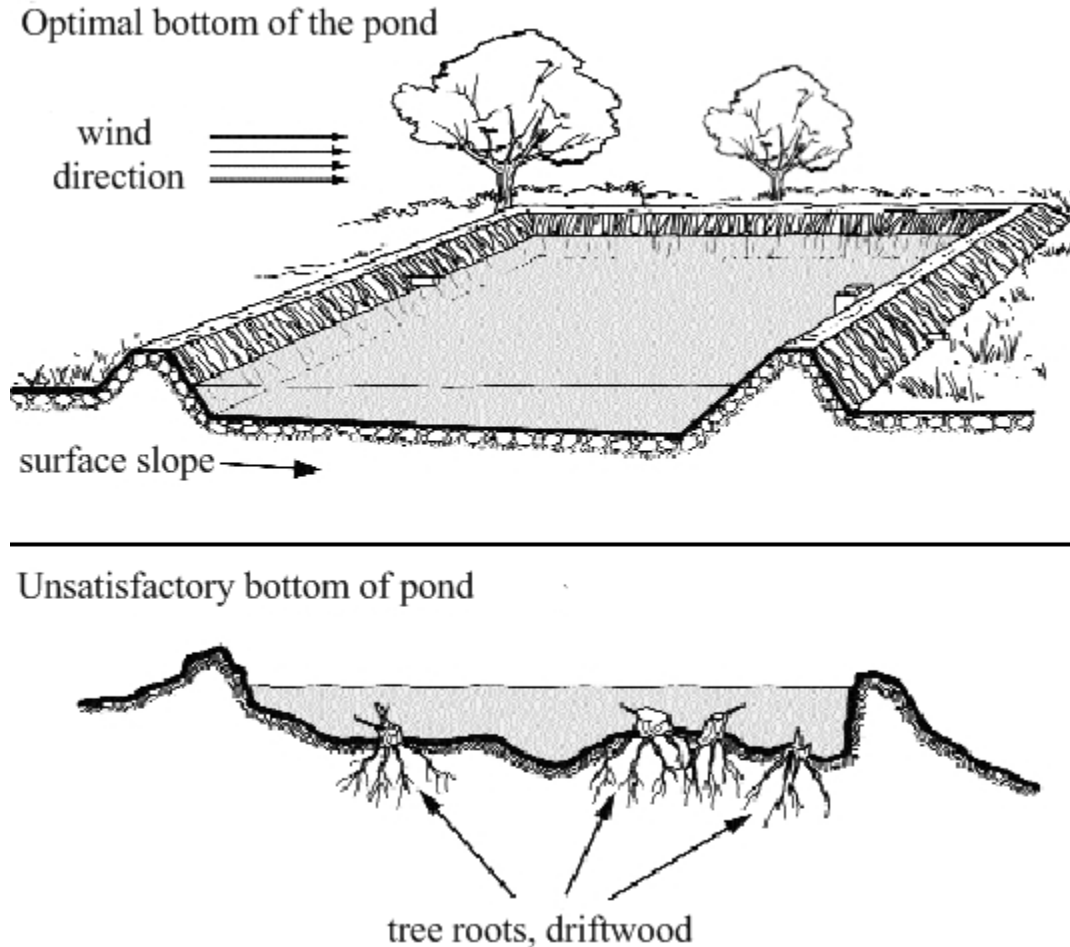
You can create the corresponding reservoir on a small area; it needs free space bulk material and construction equipment. Required reservoir depth is 1.5–2 meters; the area should be at least 30 m<sup>2</sup> (**Fig. 1**). The pond should be built with a flat and smooth bottom. Several such water bodies, about 3–4 pieces are required for the successful conduct of the proceedings. For successful fishing on the pond bottom of the pond should be smooth, without unnecessary barriers such as driftwood, large stones, etc. [3].



**Figure 1.** View of ponds for growing of crayfish

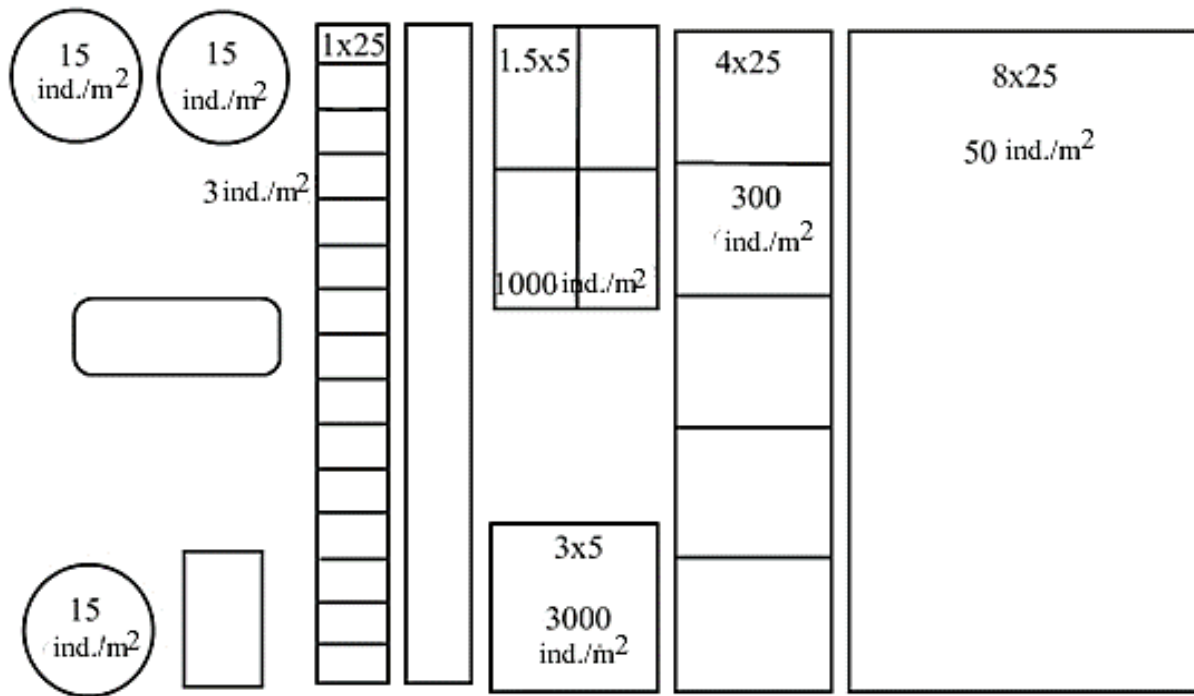
At the bottom of the reservoir stone or coarse gravel is laid out, and then sprinkled river sand. In order to provide a drain for reservoir drainage pipes in the form of a grid at the end which comes out to the pond must be installed, to make crayfish not leave it (**Fig. 2**).

The edge of the pond can be planted with garden plants, to give it a natural look. Reservoirs should be insulated in the winter, to prevent freezing of the water, and death of crayfish.



**Figure 2.** The scheme of the pond for growing of crayfish

The best variants for keeping of crayfish are covered pools, where all favorable conditions for the breeding of crayfish throughout the year can be created. They do not hibernate, but on the contrary they will constantly feed and grow. From three or four of these pools about 400 kg of commodities crayfish can be obtained [3]. The first year will not be profitable, but in the second year it can be already created own brood stock, and respectively, more crayfish would be grown. The company can also be based on the artificial cultivation of crayfish in factory conditions on the principle of building a closed water supply systems. Production of growing of crayfish can be organized in a room of 800 m<sup>2</sup>, about 360 m<sup>2</sup> of which are occupied by in basins (**Fig. 3**).



**Figure 3.** Scheme of disposition of pools in factory method of growing of crayfish

As for such an enterprise pools are built, it is necessary to make several pools for different purposes:

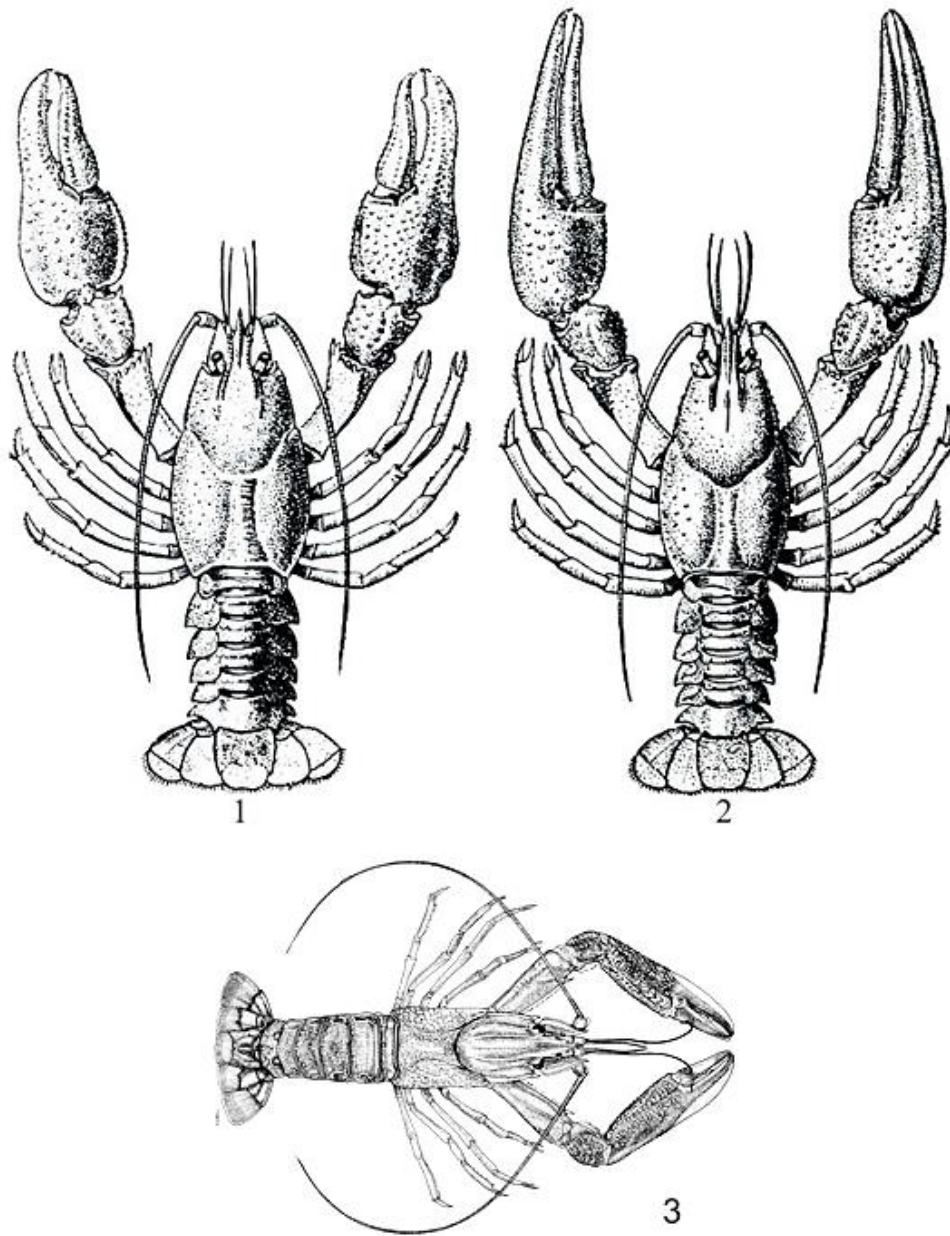
- Stock pools – oblong, with size of 1×25 m, which will contain the crayfish sires. The optimal density of adult crayfish is 3 ind./m<sup>2</sup>
- Pools for the growth and cultivation of products – 4 pools with size 1.5×5 m (density of crayfish is 1000 ind./m<sup>2</sup>.) And one 3×5 m (stocking density is 3000 specimen/m<sup>2</sup>)
- Pool for the first category of production (small and medium-sized crayfish) – pool of 4×25 meters, divided into several sections (stocking density of material is 300 ind./m<sup>2</sup>)
- Pools for growing of premium crayfish (large ones) – large pool (8×25 m) with a low density of planting (50 ind./m<sup>2</sup>).

The other part of the room is Tech Zone, where is the compressor, generator, water quality analyzer, biofilters.

For breeding of crayfish, three species are used. They are European crayfish (*Astacus astacus*), Danube crayfish (*Astacus leptodactylus*). and Redclaw crayfish (*Cherax quadricarinatus*) (**Fig. 4**) [3, 7, 8].

Firstly, it is necessary to create a broodstock of crayfish. Sires of crayfish can be purchased at a special farm for breeding or caught in pond using crayfish trap. Alive crayfish can also be bought from fishermen engaged in fishing of aquatic biological resources.

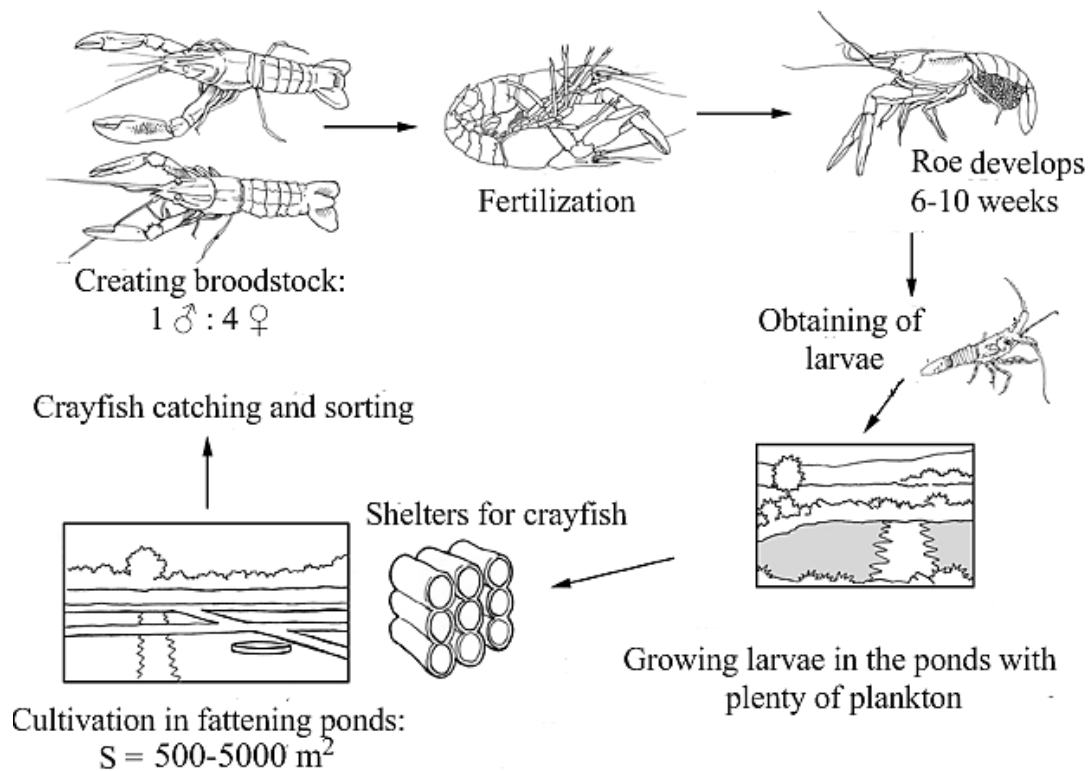




**Figure 4.** Crayfish: 1 – European crayfish (*A. astacus*);  
2 – Danube crayfish (*A. leptodactylus*); 3 – Redclaw crayfish (*C. quadricarinatus*)

To create broodstock it is sufficiently to have 30–40 individuals of large healthy crayfish without visible damage. Each female can lay about 100 eggs, from which planting material can be got [3, 9]. Considering the natural mortality and cannibalism, the fry output reaches 30 % of the eggs; that are about 30 individuals.

If 5 individuals of crayfish (4 females and one male) are run into the pond, 130–160 individuals of crayfish can be got in the following year (**Fig. 5**). On average, 1 kg consists of 12 crayfish, so if 0.4 kg of crayfish are run into the pond, they will increase by 13 kg (biomass increases more than 30 times).



**Figure 5.** Technological cycle of cultivation of crayfish

Crayfish reach marketable weight for 2–3 years, during that time they grow to a length of 10–12 cm and a weight of 40–80 g. Fingerlings (5, 10, and 15 g) are also suitable for sale and they can be implemented as planting material.

Juvenile crayfish 3–4 cm long, can be run into the pond (or pools), with an area of 30–50 m<sup>2</sup>, where their cultivation will occur. Planting norm for crayfish is 30–40 individuals per 1 m<sup>2</sup>. It is necessary to monitor the temperature and hydrochemical condition of water for growing of crayfish.

### 2. 3. The third stage: feeding crayfish and working on a crayfish farm

Feed of crayfish is carried out once in 2–3 days. It is advisable to feed the crayfish by special mixed fodder, which should contain the following components: protein – 32% fat – 5%, carbohydrates – 12%, cellulose – 4%, moisture – 12%. Given the fact that crayfish are benthic organisms, feed must be pelleted, and must sink and soak slowly. As an additional fertilizer, small fish, worms, potatoes, fresh or wheat germ can be used. Volume of feeding is set at 5% by weight of crayfish. Thus, if for the first year 15–20 kg of crayfish are populated for the growing season from May to November (210 days – about 100 feeds) the required amount of feed will be  $20 \times 0.05 \times 100 = 100$  kg. The second year of growing of crayfish will be much more expensive, because they will start to gain weight, the amount of feed may reach 15–18 kg per feeding. Thus, for 4,000 individuals (weighing about 300 kg), the amount of feed will be  $300 \times 100 \times 0.5 = 15,000$  kg = 15 t.

During the growing season it is necessary to clean regularly the water from food residues and the dead animals, to carry out a water change (about 10% every two weeks), mow the unwanted vegetation and protect the pond from excessive sunlight, apply aeration if necessary. It is necessary to carry out periodically fishing on ponds to control gains of crayfish and monitor their physiological state.

#### **2. 4. Fourth stage: harvesting crayfish**

Crayfish catch is carried out using traps or seines [10, 11]. The first collection is carried out in August and September of the second year of operation of the farm [3, 12, 13]. If crayfish reached the mass of commodities, catching of crayfish can be started. The optimal catch of crayfish is in the amount of 20 kg per week, no more than 10–12 catches a year. Thus, it is possible to defuse the population and to establish the place of sales. It is advisable to let out to the water body very small crayfish. For the first collection, 200–240 kg of crayfish can be got. Other crayfish remain for the next year. Yields can be implemented in a live, cooked and cooked-frozen state. Recent versions require additional equipment for cooking, freezing, packaging goods and certification.

At the pond growing of crayfish green tourism or agri-tourism can be arranged conditions for fishing or leisure should be created or catch of crayfish while relaxing on the shore of the pond should be offered to holidaymakers.

#### **2. 5. Advantages of a business idea**

- Crayfish breeding is business idea with minimal labor costs
- The single investment of start-up capital in the beginning of business opening; in the future, the business of growing crayfish operates practically without additional investment
- Crayfish cultivation is non-traditional idea and can become the basis for the development of green tourism or agro-tourism
- Due to the physiology and growth of crayfish, there are no problems with the sale of products (crayfish can stay alive for a long time)
- Crayfish business is perfectly suited to the concept of environmentally friendly products
- Minimal time expenditures (several hours per week) for the exploitation of crayfish business, which is generally related to the feeding and melioration works
- The prospect of business expansion
- Quite a high demand from buyers and a little competition in the market
- Benefit to the environment.

#### **2. 6. Disadvantages of a business idea**

- At the beginning of the business significant time is spent for organizing business and production process
- Extended business startup period. As for many aquaculture production businesses it is necessary for 3–4 years since the opening a cancer farm to reach full capacity and receive planned profit



- Launching the project requires significant investments (depending on the volumes of production)
- Registration of appropriate permits and documents for the cultivation and sale of water bioresources.

Taking into account the advantages and disadvantages of organizing business idea for growing crayfish, it can be concluded that in general the business is profitable and promising, and if there is necessary area and you are able to wait for several years, then you can earn a lot of money.

## **2. 7. Business plan for breeding crayfish**

The plan is given for the initial business (from scratch) at an enterprise with a capacity of 3 t/year in two ponds of 5×10 m (**Table 1**).

**Table 1.** Costs of business organization

<b>Cost items</b>	<b>Cost, USD</b>
Basic facilities	1000
Costs for water, heating, electricity per 1 year	1000
Purchase of stocking material	100
Forage, 1 <sup>st</sup> year	50
Forage, 2 <sup>nd</sup> year	700
Forage, 3 <sup>rd</sup> year	1200
<b>Total for 3 years</b>	<b>3950</b>

The cost of crayfish varies depending on the manufacturer and the size of the crayfish, for example, the source (<http://thecrayfishcompany.com/prices.html>) shows the following cost of crayfish:

- Middle: 40 g (25–30 pcs./1 kg) = 10.6 USD
- Large: 65 g (15–20 pcs./1 kg) = 15.3 USD
- Large: 100 g (10–12 pcs./1 kg) = 18.8 USD.

Potential customers for the purchase of crayfish may be supermarkets, cafes, bars, restaurants; these are the customers who guarantee a stable and regular income. The calculations were made taking into account market offers for commodity crayfish by enterprises, suppliers and taking into account wholesale sales and special offers (discounts) for regular customers (**Table 2**).

**Table 2.** Gains from the implementation of business idea

Period	Profit of items	Product volume (kg)	Total, USD
1 <sup>st</sup> year	-	-	-
2 <sup>nd</sup> year	Offtake on markets (6 USD per 1 kg)	150	900
	Offtake in restaurants and bars (large crayfish) (8 USD per 1 kg)	50	400
3 <sup>rd</sup> year	Offtake on markets (6 USD per 1 kg)	2000	12000
	Offtake in restaurants and bars (large crayfish) (8 USD per 1 kg)	700	5600
<b>Total for 3 years</b>		2900	18900
4 <sup>th</sup>	Offtake on markets (6 USD per 1 kg)	2000	12000
	Offtake in restaurants and bars (large crayfish) (8 USD per 1 kg)	700	5600
	Offtake of breeders (large selected crayfish) (15 USD per 1 kg)	100	1500
	Offtake of stocking material (youth less than 5 g) (50 USD per 1 kg)	10	500
	Offtake of stocking material (youth less than 10 g) (110 USD per 1 kg)	10	1100
	Offtake of stocking material (youth less than 15 g) (150 USD per 1 kg)	10	1500
<b>Annual income after launching the company at full capacity</b>		3300	22200

For three years, the company's net profit will be 14,000 USD. It should be noted that the third year is the peak for the growing crayfish, and in the following years, these indicators will be maintained. Starting from the fourth year, additional income can be obtained through the sale of young and crayfish breeders, the total net annual income may reach 20,000 USD.

Then production can be expanded, but the market sales of products should be noted, as increase of the volume of production is only relevant in the presence of market demand.

In addition, in fish farms where crayfish are grown, it is also possible to grow fish in the polyculture (silver carp, grass carp, carp, Prussian carp), which can become an additional lucrative object and can utilize excess feed components.

In the case of pond type of crayfish breeding, it is possible to organize green tourism or agrotourism, creating conditions for fishing or offering vacationers a chance to catch their own crayfish while resting on a beach, but this is another business idea.

### 3. CONCLUSIONS

Breeding of crayfish is not only large-scale production: it is possible to establish it in small quantities. It certainly makes a profit after a certain period of time, if all norms of cultivation of crayfish are qualitatively followed. Cultivation of crayfish is a perspective production, which from the ground for 3–4 years can bring from 200% to 300% of stable profits.

In almost all regions of Ukraine, there are many different water bodies that are suitable for growing of crayfish. Sufficient amount of natural populations of crayfish is preserved that may be used as a starting material for the stock culture.

Thus, the crayfish breeding can be attributed to profitable activities, which do not require a significant investment. Although the results of the business will appear only after 3–4 years, crayfish breeding is still considered as a profitable business.

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