



Economic efficiency of cultivating virus free seed potatoes by using recirculating aquaculture system during fish farming

Eficiencia económica del cultivo de papas de siembra libres de virus mediante el uso del sistema de recirculación usado en acuicultura

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ABSTRACT:

Nowadays much attention is paid to the saturation of the Kazakh market with domestic products, improving quality, increasing competitiveness and expanding the range of products. In addition to the development of the vegetable industry, attention is also paid to the fishing industry. The problems of protecting the environment and growing high-quality products are an urgent task of the modern society, on the level of both the state and households. There are all reasons to solve the above tasks. They will be considered below. The issues on meeting the needs of farms that produce potatoes and providing them with high-quality seed materials and fish breeding are very important in Kazakhstan. Potato is susceptible to a variety of diseases that reduce its yield and quality of tubers. Moreover, in potatoes clones, as well as in the soil where they are grown, pathogens accumulate. That is why the production of disease-resistant potatoes depends on the constantly updated stock of virus-free seeds.

Keywords: Efficiency, seed potatoes, fish products,

RESUMEN:

Hoy en día se presta mucha atención a la saturación del mercado kazajo con productos nacionales, mejorando la calidad, aumentando la competitividad y ampliando la gama de productos. Además del desarrollo de la industria vegetal, también se presta atención a la industria pesquera. Los problemas de proteger el medio ambiente y el crecimiento de productos de alta calidad son una tarea urgente de la sociedad moderna, tanto a nivel estatal como de los hogares. Hay todas las razones para resolver las tareas anteriores. Serán considerados a continuación. Los problemas para satisfacer las necesidades de las granjas que producen papas y proporcionarles semillas de alta calidad y cría de peces son muy importantes en Kazajstán. La papa es susceptible a una variedad de enfermedades que reducen su rendimiento y calidad de los tubérculos. Además, en los clones de papa, así como en el suelo donde se cultivan, se acumulan patógenos. Es por eso que la producción de papas resistentes a las enfermedades depende del stock constantemente actualizado de

1. Introduction

The main idea of this work is to assess the economic activity on growing virus-free seed potatoes by using the recirculating aquaculture system (RAS) during fish farming. It means that the idea involves the obtaining of two types of products: firstly, fish, and secondly, the virus-free sort of seed potatoes which in its turn includes obtaining seeds under the laboratory conditions at the initial stage, and a sort of virus-free seed potatoes of super-elite reproduction by planting them in the soil under the greenhouse conditions and using drip irrigation (Haase, 2006).

This idea is mainly focused on the following:

- Producing high quality, competitive, export-focused products to promote the mon external and internal markets,
- Timely provision of high quality seeds of virus-free potatoes to economic entities in regions of the Central and Northern Kazakhstan, and
- Earning profit as a result of producing and selling potatoes and fish products.

Considering the economic component of this research, it must contribute to

- Developing the agricultural market environment and creating conditions for the development of the competitive environment in the crop sector,
- Developing the logistics system for the promotion and storage of agricultural products,
- Future replacement of imported agricultural products, and
- Creating conditions for attracting additional labor force and providing it with work.

Socio-economic grounds also stipulate the creation of technologies by using the RAS for the crop sector of Kazakhstan that works under the current conditions of the market development. The most considerable ones are specified below (Struik, Haverkort, 2005).

Economic:

- Potatoes are a cropper that is necessary and beneficial for cultivation in the protected soil because their production is the most profitable as compared to other croppers,
- Potatoes are always highly demanded throughout the year, and
- The applied technology helps to increase the potatoes yield and to improve its quality as compared to traditional technologies.

Reduction of costs, which is achieved due to

- Efficient and rational use of thermal energy in the course of using sub-substratal heating and reducing energy costs for steaming (Anisimov, Belov, Varitsev, 2009),
- Excluding the need for gathering soils in greenhouses and processing them,
- Considerable water savings by using drip irrigation and a reverse circuit to collect its surplus,
- Energy saving by reducing the water evaporation due to coating the surface of the substrate with a tape,
- Savings of mineral fertilizers, and
- Ability to more accurately and quickly regulate the parameters of the root environment (acidity of the nutrient solution, the content of food elements, humidity, temperature, etc.) due to its small volume and the use of control systems for all technological processes based on microprocessor technology, which provides a significant increase in yields.

Sociological:

- Seasonal nature of labor is eliminated, and the stable employment of operating personnel is guaranteed throughout the year, and
- Increase in the labor productivity, organizational and economic level of production.

2. Methods

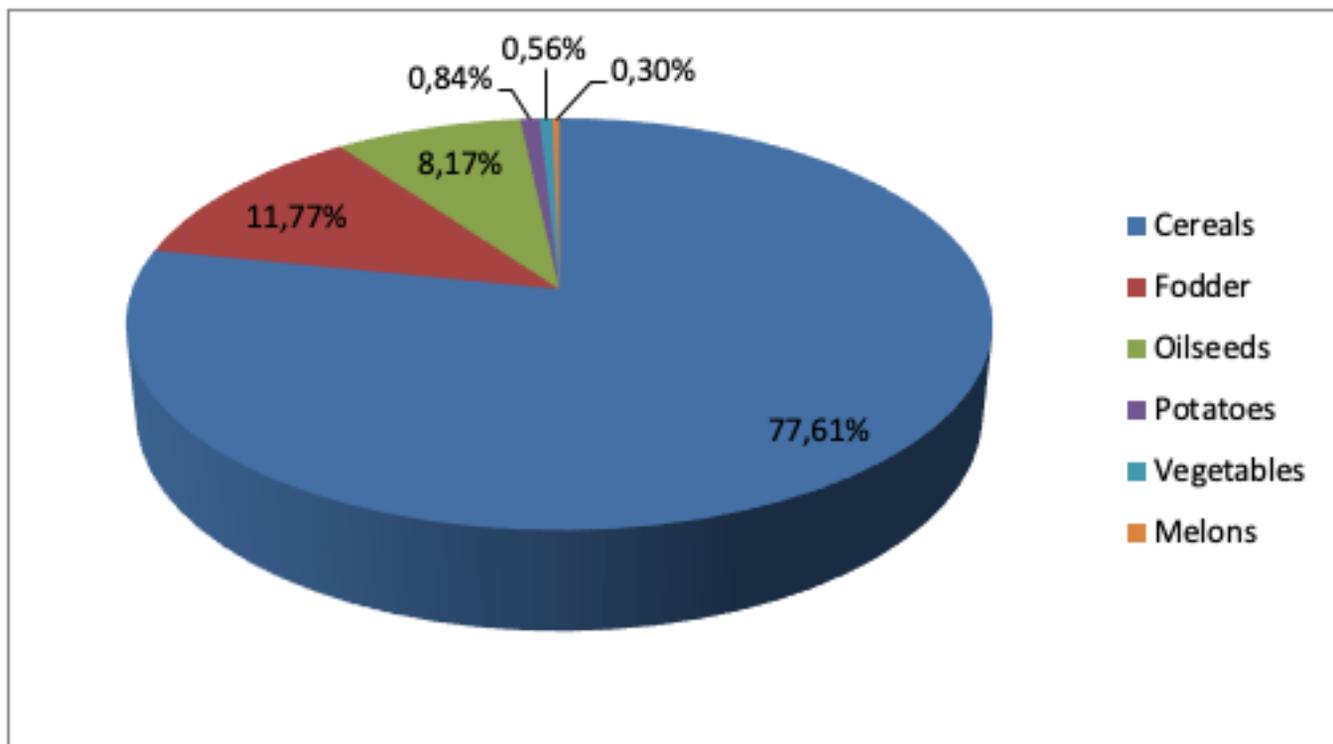
The research of this problem is based on the principles of a system-integrated approach, economic and comparative analysis, applying the historical and logical methods, and the

3. Results

Today in Kazakhstan potatoes are grown on an area of 185-195 thousand hectares. The annual demand for seed potatoes is 780-850 thousand tons, including test tubes plants – 764.0 thousand pieces, super-superelites – 382.0 tons, superelites – 2.18 thousand tons, elites– 10.91 tons thousand tons, the first reproduction – 40.9 thousand tons, the second reproduction – 153.4 thousand tons, and the third reproduction – 575.19 thousand tons [4]. The potatoes grown in Kazakhstan fully cover the population's demand for agricultural products. However, in its turn providing farms producing potatoes with elite seeds of Kazakhstan sorts used to be and remains the main problem of the industry. In most cases this is because some regions of the country do not have seed farms to grow high quality and elite potato seeds. In the Eastern regions of the country, where about 25% of potatoes are produced, farms have mainly from 1–4 to 6–12 hectares of land (Figure 1). The above does not allow organizing and conducting high quality crop rotations; rationally applying the existing machine and tractor fleet, especially purchasing modern agricultural machinery; and building modern vegetable storehouses (Derevyagina and Vasilieva, 2001).

The majority of agricultural enterprises do not have modern potato storehouses for storing the grown potatoes. It makes them sell products at a low price to intermediaries in the autumn. A lot of economic structures use morally and physically worn out agricultural equipment. All the above shows the current state and prospects for the development of the potato industry, in particular the seed production of potatoes in Kazakhstan.

Figure 1
Cultural Area in the republic of Kazakhstan in 2016



The factor of seasonality has considerable impact on the price dynamics of agricultural products throughout the year. The increase in prices for vegetables in the autumn period is interpreted by the laying of a significant part of the harvest for winter storage and the relevant decrease in the supply of agricultural products on the market. In addition, storage costs have an impact on the prices' increase in winter.

Taking into account the existing conditions of degradation of the main greenhouses built in the Soviet period and poor technical equipment of modern greenhouses, it is possible to observe the poor provision of the population with early vegetables during the off-season (23%) (Syzykov, Kurzhykaev, 2017).

The demand for rather-ripes is 88.3 thousand tons per year according to the standards. Taking into account the existing facilities of the protected ground areas (185.2 hectares), it is necessary to build 175.7 hectares of the protected ground areas more.

Now horticultural agricultural products are provided in the off-season by covering additional

protected ground areas, including public investment and increasing the gross harvest of early vegetables.

As a result, the demand for vegetables increases together with the increase in the entire consumer market. The demand for vegetables increases on average by 15% per year, which is contributed by the growth of real income of the population.

4. Discussion

There are many questions related to fish production. In general, a serious problem is related to selling products. The main consumers of this product are grocery stores, supermarkets, cafes and restaurants. Impeccable fish production is the one that has its own brand stores or sales locations. Then products are delivered directly to the end user, population. Considering the demand of the population on the agricultural products' market, it is possible to say that fish is less consumed than meat. In most cases products of the fishing industry are much more expensive than meat products. That is why a considerable part of products is consumed by the middle class. The level of the average and elite class of consumers basically prefer healthy nutrition. To attract consumers, many fish producers are constantly working on the problem of providing information about the need to buy fish products, using various marketing actions such as reducing products' price, developing a wide range of products, creating a new type of fish semi-finished products and colorful packaging materials. That is why the country plans to increase fish production. This is due to the fact that in accordance with medical requirements every person must consume more than nine kilograms of fish products per year. In our country one inhabitant gets about four kilograms. Consequently, our task is to increase the number of fish products for it to become more affordable both by price and quantity.

Favorable conditions for the comprehensive development of the fish industry have been created in our country. The total territory of all water bodies is about 4 million hectares in various regions of Kazakhstan. It will allow artificially producing various breeds of valuable fish (Table 1).

Table 1
Volume of Fish Production (tons)

Territory	2012	2013	2014	2015	2016
Republic of Kazakhstan	15,867.10	16,558.10	18,419.90	20,310.00	22,486.20
Akmolinskaya	628.3	644.2	386.1	631.5	988.7
Aktyubinskaya	724.7	419.1	799.4	818.6	647.7
Almaty	505.2	840.5	802.8	926.9	226.8
Atyrauskaya	1,908.0	2,184.6	2,567.1	2,482.6	2,155.8
West Kazakhstan	2,241.6	2,363.7	2,024.3	3,026.8	3,156.4
Zhambylskaya	468.6	837.4	963.0	914.1	776.1
Karagandinskaya	671.1	752.2	803.2	121.1	615.4
Kostanayskaya	262.8	463.9	452.1	887.8	751.2
Kyzylordinskaya	461.1	213.8	908.8	358.4	106.1

Mangistauskaya	748.0	715.7	745.7	495.2	911.4
Southern Kazakhstan	708.0	681.5	974.2	696.3	243.4
Pavlodarskaya	563.8	282.0	697.3	680.1	546.3
North Kazakhstan	969.1	688.4	452.8	328.1	712.0
Eastern Kazakhstan	1,677.8	1,278.1	1,745.9	2,072.2	2,862.8
the city of Astana	1,206.5	1,863.5	1,046.5	1,068.7	2,722.3
the city of Almaty	2,127.5	2,330.5	3,054.7	4,803.6	5,063.8
Note: Based on statistical data [4]					

The main fish products are directly intended to be used as products that are ready for sale on the domestic and foreign markets of the country.

The List of State Breeding Discoveries admitted for production in Kazakhstan contains more than 90 types of potato sorts (Agency for Statistics of the Republic of Kazakhstan).

The Kazakh potato sorts are similar to imported products in terms of quality. In general, it is necessary to say about the considerable resistance of potato to buck eye rot, high temperatures, drought, and storage stability. That is why in terms of their qualitative characteristics of adoptability for local conditions, they surpass imported varieties (Malyuga, Enina, Burmistrova, 2009).

Based on scientific achievements in biotechnology, scientists conduct primary and elite potato seed farming. Every year the country grows more than 800-1,500 tons of high quality reproduction potatoes that are sold to agricultural enterprises engaged in the seeds production. During a year Kazakhstan uses agricultural technologies to develop 150-190 thousand units of test tubes plants, including more than 400 thousand units of potato minitubers that are grown on the areas of agricultural enterprises.

In Kazakhstan along with the Saken Seifullin Kazakh Agrotechnical University (Astana), potato seeds are reproduced by the Kazakh Research Institute of Potato and Vegetables Growing, *BiopromTechnologies* LLP (Stepnogorsk, Akmolinskaya Region), the East Kazakh Agricultural Research Institute, the Aktubinskaya Agricultural Experiment Station, and the Uralskaya Agricultural Experiment Station, etc.

Within a year the East Kazakh Agricultural Research Institute uses minitubers of the potatoes selected by the Kazakh Research Institute of Potato and Vegetables Growing to grow a super-superelite material. Primary seedgrowing enterprises grow more than 200 tons of high quality and elite potato seeds.

Every year enterprises of *BiopromTechnologies* LLP of the Akmolinskaya Region grow above 400 thousand units of recovered potato seeds by using the aeroponic plant.

In the country there are above 10 certified farms that specialize in growing seed potatoes of high quality reproduction.

Farms of *Orken* LLP (Raiymbekskiy Area of the Almaty Region) grow about 2,000 tons of high quality and elite potato seeds by using virus-free minitubers produced in laboratories.

In the regions of the Eastern Kazakhstan seed potatoes are produced by the *Prirechnoye* agricultural firm and the *Ekimbayev T.K.* peasant farm. They produce about 1,000 tons of seed and market potatoes.

Farms of *Astra-Agro* LLP in the Karagandinskaya Region can meet the need of the

Akmolinskaya Region in high quality reproduced seed potatoes and provide a certain part in food potatoes. *Astra-Agro* LLP possesses modern equipment and technology for producing and storing potatoes and produces more than 6,000 tons of potatoes.

In the Tselinogradskaya Area of the Akmolinskaya Region, *Kirol-Saryarka* LLP specializes in the production of seed and market potatoes. It has a modern potato storehouse with a computer regulation of 5,000 tons, and highly efficient foreign potato growing and harvesting equipment.

In the Northern Kazakhstan the largest producer of seed and food potatoes (up to 7,000-10,000 tons) is *Biosema* JSC of the Aksuskiy Region of the Pavlodarskiy Region. It has a biotechnological laboratory for growing virus-free test tube plants and virus free minitubers and breeds domestic potato sorts.

The main competitors are the enterprises of Astana engaged in processing and storage of fish and seafood (Table 2).

Table2
List of Competing Enterprises, the city of Astana

Ser. No.	Company	Address	Services
1	<i>RADOVNIA Fishing Company</i> Limited Liability Partnership	2, Zharkol Lane, Koktal 1	Processing fish and seafood
2	<i>ZernoTseliny</i> Limited Liability Partnership	16, Beibitshilik St.	Processing fish and seafood
3	<i>Astana Fish</i> Limited Liability Partnership	28, Beiksekbaev St., Office 14	Processing fish and seafood

The main advantages of the enterprise to competitors are the following:

- Focus on the fish grown directly in the pool,
- Relatively low prices for products,
- Quality of products,
- Use of modern technology, and
- Qualified manpower resources for the project implementation.

The profitability of the potato industry development largely depends on the competitiveness and efficiency of this industry. Cultivating and selling potatoes along with vegetables in the republic is economically advantageous and profitable. The profitability of farms involved in producing potatoes is from 60 to 250% on average. The cost of producing food potatoes differs greatly depending on the territory. On average it is 25-45 tenge per 1 kg, while the selling price is 70-130 tenge per 1 kg.

Now potato producers notice high quality of such foreign sorts as *Koroleva Anna*, *Natasha*, *Zikura*, etc. *Udachais* singled out among Russian sorts. In addition to the imported sorts, Kazakh sorts are used, too. However, foreign selection is more preferred (Anisimov, Haverkort, 2007).

In 2018 it is planned to produce virus-free seeds on the level of the required production capacity. Based on it, many farms can refuse from using foreign selection and focus only on domestic seed material to achieve good results.

A positive trend in using fish raw materials is a considerable increase in the production of fish grown for processing. Today about 19% of the world's fresh fish catch is sold (Brainballe, 2010). For a stable and regular supply of raw materials to fish processing enterprises, frozen fish is used in many ways. In its turn, it reduces the seasonality in this industry.

In accordance with the classification, the market of fish products is divided into the following groups: 1) fresh, chilled and frozen fish, 2) salted, dried, smoked and dried fish, 3) fresh, frozen, salted and dried crustaceans and mollusks, 4) canned fish and preserves, 5) canned food from crustaceans and mollusks, 6) fish meal, and 7) fish oil and marine fats [9].

The product group of “fresh, chilled and frozen fish” makes up a considerable share in the fishing business. Crustaceans and mollusks account for the next significant share. The share of this group is considerably higher by cost than by volume because it mostly consists of expensive seafood – lobsters, shrimps, and crabs that are considered delicacies. The specific weight of canned fish in business is 9-11% by volume. The sale of fishmeal and fodder hydrolysates is also a significant part of the fish products’ market, with a share of 23-25%.

The fish production sector of the country is a highly developed fisheries industry. This industry has a large fishery fund and follows only to Russia in terms of importance among the CIS countries. The territories needed in the fisheries sector of Kazakhstan make up 3,340 thousand hectares, including: lakes – 2,893 thousand hectares, reservoirs – 905 thousand hectares and rivers as long as 11.5 thousand km. (“Aquaponics is an agricultural technology of the future”, 2015). Besides, on the territory of Kazakhstan there is a north-eastern part of the Caspian Sea and the preserved part of the Aral Sea – Small Aral suitable for fish farming. The fish fauna consists of 160 species of fish, including valuable fish such as sturgeon, whitefish, carp, etc. There are about 9,000 lakes in the country, a considerable number of which are small. There are relatively few large lakes in Kazakhstan, but they account for more than 60% of the fish produced in the country’s natural reservoirs.

5. Conclusion

Over the recent years the fishing industry has faced the problem of shortage of special fish food which is an obligatory condition for growing fish in cages and ponds. Previously they were supplied from Uzbekistan and Russia, and now they come from Semipalatinsk. At the same time the quality of domestic food production is lower than that supplied from abroad.

The main task of marketing is to provide terms and conditions for the vegetable and fish industry functioning.

The predominant impact of competitors against entering the market by an enterprise is mainly a considerable decrease in prices due to rather significant production capacities of these companies. It is possible to counteract it by strengthening the advertising campaign related to the products.

To promote the products on the market, it is planned to conduct a wide advertising campaign through various media. It is planned to form the demand and stimulate sales of products based on the following components:

- Rational location of greenhouses and fish farms,
- Considerable low level of prices for products as compared to similar companies,
- Introduction and use of measures to stimulate demand, and
- A sufficient base of modern equipment.

The topic under consideration provides a non-waste production technology, which is already a guarantee of environmental well-being. Plant products such as potato tops will be used after proper processing as organic fertilizers. The production does not anticipate the use of chemical or other toxic substances.

The area under research comprehensively corresponds to the needs of the country’s economic development because its implementation fully complies with the development of greenhouses functioning that will meet the modern requirements and standards and contribute to displacing the imported vegetable products. Today the idea under consideration is the most actual and demanded on the market of agricultural production.

The considered problem will contribute to

- Increasing the commodity turnover in regions,
- Developing the logistics system for the promotion and storage of agricultural products,
- Future replacement of imported agricultural products, and

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