INCREASING THE COMPETITIVENESS OF THE FISHING SECTOR IN MOLDOVA. RESEARCH ON NEW FISH FEEDING SCHEMES

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Abstract
This paper proposes an evaluation of the economic efficiency of fishing activities in aquaculture growth carp (*Cyprinus carpio*) by feeding it with non-cereal-based feed. This type of feed is profitable, allowing to obtain a high fish production, with a high quality, and a solution to increase the profitability of fish farming in the area. The aim of the study is to evaluate the effects of non-specialized feed for fish (grain-based) on the economic efficiency of fish farm production, and the development of methods for modelling the optimal food ration structure on carp farms. Research has shown that changing the composition of feed can significantly increase farm productivity. An increase in the proportion of barley in the diet, with the addition of vitamins, has the best effects on the quantity and quality of fish production. The results of the research are of practical importance for fish farms specializing in carp farming and for other species of Ciprinidae.

Keywords
Carp, production, feed, Republic of Moldova.

JEL Classification
Q25, O33

Introduction

Economic activity "fishing and fish farming" is important to ensure food security in the country and can be based on qualitative and quantitative production. Aquatic living creatures, and fish in particular, have the highest rate of growth and recovery of feed compared to terrestrial species. The development of significant aquaculture production involves respecting conditions linked to the fish farming season, feeding conditions, water temperature, mobility of aquatic biological resources, difficulty in predicting stocks of aquatic biological resources and determining the rational weight of their withdrawal without compromising the final outcome. The Republic of Moldova still has great potential for the development of fish

farming, although in the second half of the 20th century most of the ponds and swamps were drained and used as agricultural land. Due to the division of many ponds, the degradation of the remaining ponds and the reduction in productivity in aquaculture, the country currently imports more than 50% of the fisheries products distributed on the market. Excessive fishing, through illegal methods or in protected areas, the lack or insufficiency of systematic controls by the competent institutions have seriously affected the country's fish fauna (Munteanu Pila and Stanciu, 2017). The fisheries sector has fallen in all respects, including fish growth in pond. For example, at the end of 1980, annual fish production was over 6,500 tons and has now fallen to 1,042 tons. In the period 1970-1990, the National Fishery Directorate was concerned about improving national fisheries production by proposing a program for the development of the sector, i.e. to increase fish production by at least 30%. After 1990, state subsidies no longer covered the costs of fish farms with expensive feed, which is why the national fisheries sector experienced a sharp drop in fish production in the period 1994-2006. The most affected activity was the increase of carp, so in 2006 the sector produced only 32.2% common carp (*Cyprinus carpio).*
Common carp (*Cyprinus carpio)* and other carp fish from the Ciprinidae Family (grass carp, silver carp, bighead) represent some of the most popular fish species on the internal market of the Republic of Moldova. The correct choice of feed is of crucial importance as it has the highest production cost and has the greatest influence on profit.

Short literature review
The natural advantages, including the aquatic resources, can be successful factors for the food production of the Republic of Moldova (Munteanu Pila and Stanciu, 2018). As regards its total national area, the Republic of Moldova has a significant natural fishy potential. Rivers, lakes and other wetlands cover 95,000 ha, or 2.8% of the country. 7.5% of the natural aquaculture potential is used in the fishy area, and only 5 major fish farms operating on the national territory. Local fisheries operate extensively, based on polyculture system. Although the national territory has significant natural resources, their exploitation is ineffective, the national food market depending on the imports of fishery products. A number of fish species from the natural environment are endangered, measures to protect them being necessary.
The Government support that encourage private initiative for fishing sector, mainly in the direction of an intensive exploitation by means of aquaculture is needed. European funds may represent a solution to revive the Moldovan fishy sector.
Privezentlev, Anisimova and Taraev (1980) considers that although *Cyprinus carpio* is not a fussy fish species, an over feeding of specimens in aquaculture will lead to a rapid increase in weight, but also to a significant decrease in the organoleptic quality of the meat. Krylov, (2004) notes that the omnivorous nature of the carp allows the use of non-specialized feed such as mixes of feed, cereal feed and wheat bran, which does not reduce the organoleptic quality of fish meat. High nutritional value of feed can lead to massive agglomerations in intensive growth areas and additional aeration is required. If the rules of growth are not respected, there is a high risk of death and serious losses for farmers (Novitki, 2016). Improving methods to increase the natural productivity of aquatic ecosystems is one of the main tasks in aquavculture, as the quantitative characteristics of an established feed for carp growth can be used in the modeling of the growth process and other species of cyprinid (Tiuclenova and Klusina, 2015). Kestemont and Stalman (1992) have demonstrated that in European countries for culling non-specialized feed is used only as supplements to natural feed from pond, due to the fact that only 5 % of the feed is digested, the remaining 95 % is eliminated by feces into water, and is used only as a fertilizer for plancton development (Kestemont and Stalman, 1992).

Material and method

Information about economic efficiency, growth of commercial carp, as a species of fish of value, was obtained from specialist works, taken from official sources: Google Academic and ResearchGate. Data on the generation of major production by the introduction of two types of feed into the feed ration were obtained from their own research. Data collected has been processed statistically and interpreted. The results obtained were compared with other literature data for appropriate interpretation.

Results and discussions

The natural advantages, including the aquatic resources, can be successful factors for the food production of the Republic of Moldova (Munteanu Pila and Stanciu, 2018a).

In natural aquatic ecosystems in the Republic of Moldova, the species with vital cycle are dominant, along with a massive degradation of the population with a longlife cycle. According to study made by Munteanu Pila and Stanciu (2018b), the richest diversity of ichthyofaunistic and fishery production is found in the lower courses of the Dniester River and the Prut River due to the ecotone zone. As for the diversity of the fish population (sabre carp, ide, streber, common nase, Romanian barbel, burbot), the Prut river significantly exceeds the Dniester river, which denotes a less pronounced anthropogenic phenomenon of the Prut river compared the Dniester River. An essential factor in maintaining a multidisciplinary fishery production is the systematic water quality monitoring meant to exclude excessive mineralization or pollution, a biological improvement, and a populating with spawns that would change today's unfavourable situation.

One of the most important tasks facing the fish farms in the Republic of Moldova is the ability to grow saleable fish of the carp species (*Cyprinus carpio)* with an average weight of 2,500-3,200 g. To this end, traditional Moldovan technology recommends the use of specialized feed for the rapid weight growth of marketable fish. The largest fish farm, "Post Brat", with an area of 50 ha, in the South area of the Republic of Moldova, is engaged in the breeding of indigenous fish, especially of carp (*Cyprinus carpio).* The fish farm has been active for 8 years and uses non-specialized feed (a mixture of cereals with added vitamins) on its territory. During the years 2012-2014, the "Post Brat" fish farm used a mixture of feed (barley, wheat, sunflower sprats and other mixtures), with no addition of vitamins. This has led to a more difficult increase in carp (*Cyprinus carpio)* and low resistance to diseases, especially during the spring period.

According to figure no. 1, the private farm ‘Post Brat’ used a mixture of non-specialized grain feed for commercial growth of the species *Cyprinus carpio* in 2012-2014. Of which compound feed (61%), which accounts for the highest share in feed structure, barley (28%), wheat (7 %), sunflower meal (2 %) and others (2 % oil). Since 2015, the private farm-owned fish breeding company ‘Post Brat’ began to gradually increase the share of feed produced independently by the farm and reduce the share of compound feed in the diet of carp, thus the farm has completely switched to the non-specialized feedstuffs of its production (figure no. 1).

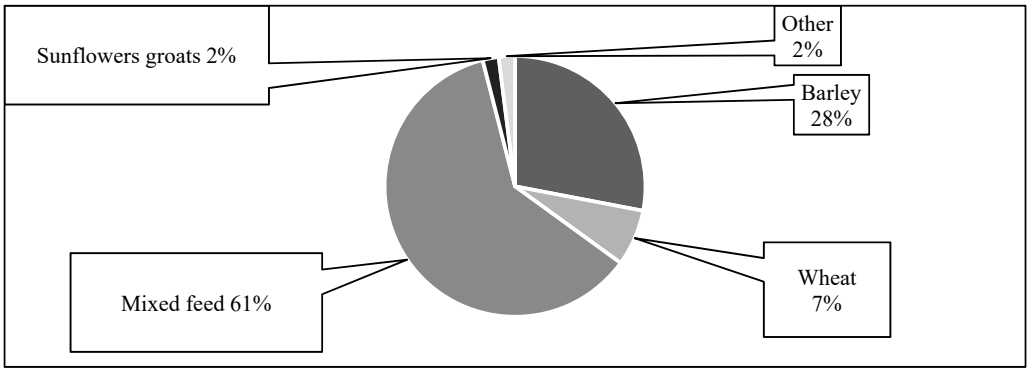

Fig. no. 1 Composition of feed for fish for 2012-2014
Source: Own research

The structure of nourishment for *Cyprinus carpio* in 'Post Brat' for the period 2015 is shown in figure no. 2.

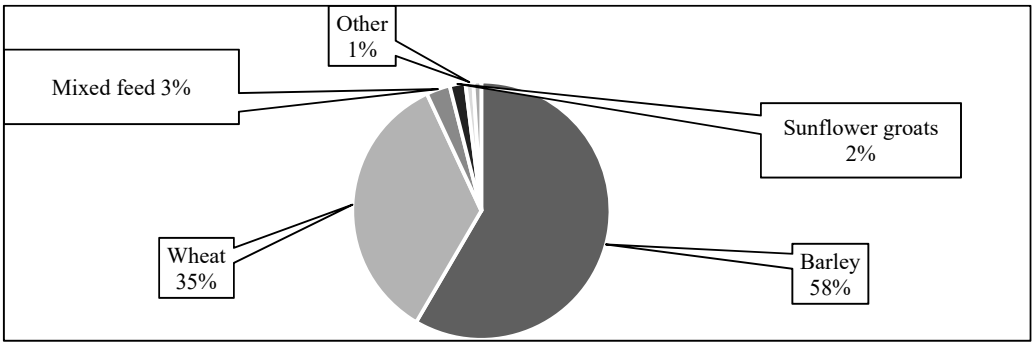

Fig. no. 2 Composition of feed for fish for 2015-2019
Source: Own research

Ingredients: Barley 58 %; wheat 35%; 2% sunflower seed; compound feed 3 %; fish oil of more than 1%;
Vitamins: Vitamin A 25000 I.U Vitamin D3 2000 I.U Vitamin E 25 mg Vitamin C 750 mg.
Composition is presented in figure no. 3

Composition:

- Extruded feed for fish on farm with high cereal quality content: barley, wheat and fish oil.
- Contains an addition of vitamins for high survival rate and for the rapid development of a healthy baby.

Fig. no. 3 Extruded feed, on farm premises
Source: Own research

The widespread use of farm-based feed will allow the economic and technical balance of the commercially available fish production to be maintained, thanks to the choice of the optimal feed ratio, in relation to resource constraints and market requirements, in order to maximize financial results. In figure no. 4a an increase in fish productivity can be increased (indigenous

fish) from 25 tons/ha of fish (2012) to 52 tons/ha of fish for 2019 can be observed, which shows a significant growth dynamic. The evolution of experimental lots of carp is represented in (figure no. 4b), as the main objective of the farm is to increase the production of this fish species.

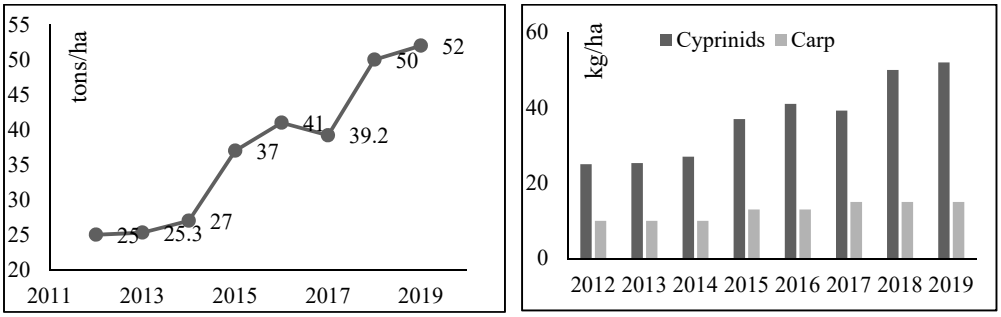

Fig. no. 4. Fish farming productivity: (a) total cyprinid, (b) carp, (2012-2019)
Source: Own research

Feeding fish to aquaculture farms appears to be one of the most difficult and important aspects of the organization of fish farming, as achieving a proper diet and rapid weight growth depends on food ration, quality and volume in terms of productivity and area. For the determination of the productivity-economic output of the ”Post Brat” farm, the following indicators were analysed, such as: average weight of a carp (on sale), average weight increase of a carp after the feed administered, productivity of the cyprinids in tons per ha and carp in kg/ha, annual profit. Due to the administration of vitamins in feed, the farm had a higher yield during the years 2015-2019 by 4.61 %. The effect of the quantity of feed on the average weight of a fish and its productivity is shown in (table no. 1)

Table no. 1 Comparison of productivity over the period (2012-2014) and (2015-2019)

Feature	2012-2014	2015-2019
Commercial fish, total (tons)	28.57	45.55
Carp (kg/ha)	10.00	15.00
Profitability (%)	2.84	4.61
Average feed administered, May-November period (kg/)	585.71	585.71
Average weight of carp, sold in fisheries (g)	1.800-2.400	2.200-5.000
Cost of carp (Euro/kg)	1.75	2.00
Annual profit (euro)	12,000	20,000

Source: Own research

According to the recommended standards, the production of carp is 8 kg/ha (minimum). By 2017, the "Post Brat" Fish Farm had achieved an average of 10 kg carp/ha. After the introduction of the two-year adaptive growth technology, with vitamin feed fortification in the period 2017-2019, the productivity of carp in pond increased up to 15 kg/ha. Improving technical and economic parameters will gradually lead to positive results in higher carp productivity of up to 25kg/ha due to the nutritional efficiency of the feed. The analysis, carried out over an eight-year period, has enabled the influence of the composition of the feed on the yield of the carp growth to be determined. This established recipe for 2 types of feed for carp growth and high economic results. The results obtained showed a high degree of reliability (more than 75 %), a major criterion for increasing the productivity of carp (more than 15 kg/ha). After comparative analysis of the administration of the two feed types, a stronger

effect of the compositional recipe 2 consisting of 59% barley, 35% wheat and vitamin addition was observed. In this case, the influence of barley and the addition of vitamins for the living weight increase of commercial carp was significant (fig.no. 2).

Conclusions

The use of non-specialized feed at the fish farm "Post Brat" offers the possibility of producing large quantities of high-quality fish at low costs, which will increase the competitiveness of the unit on the Moldovan food market.

An increase in the proportion of barley in the diet, with the addition of vitamins (feed 2), has increased the fish productivity by 1.77%. The production of non-specialized farm feed has reduced production costs, i.e. increased farm income by 8 % and increased the mass of profit (in the first feed recipe by 1,3 times, in the second to 1,5 times), what was represented in (table no. 1). This led to an increased profitability in the first case by 2.84 % and in the second case by 4.61 %. Therefore, the productivity of fish in the following years will increase to 60 tons/ha for cyprinid and 25 kg/ha for carp *Cyprinus carpio*, respectively.

The most efficient feed for fish is based on cereals: barley, wheat, maize, low-cost feed, which can lower the cost of domestic fishery products and increase the production profitability.

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