Deliverable 4.2.

Guidelines for applying innovative financing mechanisms

European Regional Development Fund

EUROPEAN UNION

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Summary

Aquaculture is one of the most effective methods of producing high-quality high-protein animal food, both in terms of the ratio of feed used to the weight produced, but also in terms of the environmental impact and the use of environmental resources, including water resources. The limited resources of flowing inland waters, unusually high environmental protection standards and the specificity of the Baltic Sea mean that the most promising form of aquaculture development in the South Baltic Region is aquaculture in closed water systems (RAS) [Jóźwiak 2018].

Under the project "Cross-border development and transfer of innovative sustainable and environmentally friendly aquaculture technologies in the South Baltic area" (InnoAquaTech), in WP3 and WP4, technical and economic possibilities of breeding thermophilic water animal species characterized by high nutritional and taste values as well as fast growth rates (including African catfish and Vannamei shrimp) were examined.

The evaluation of the economics of breeding of the above-mentioned aquatic organisms was made, among others due to the availability of heat sources in the South Baltic area, such as geothermal energy, heat from cogeneration (e.g. biogas plants), excess heat from central heating systems, etc. The economic analysis included both the preparation of the forecast of the profit and loss account for selected business models in aquaculture, as well as the analysis of possible and effective sources of financing. The analyzes were based on: available literature data, a wide-range survey of already functioning SMEs farms in the South Baltic Region and analysis of results from four Pilot Projects, including two shrimp farms (one using geothermal energy).

African catfish breeding is based on proven technology, and most parameters of breeding the catfish are predictable. Studies performed as part of the InnoAquaTech project confirmed that the operating parameters in MSEs farms did not differ significantly from the literature data. Breeding of the African catfish in existing farms is relatively well optimized. With no progress in the field of e.g. genetics, it should be assumed that the farming effectiveness in both technological and economical dimension will not be higher than in existing farms, anyhow economy of scale should be considered. The breeding of African catfish can be described as relatively low-margin business, but also low-risk business. The decision to invest in African catfish should be based on the realistic assessment of market absorption, which every investor must do on his own. Strategy based on offering products with higher added value (e.g. fresh and smoked fillets) should be considered. Once you determine that there is a market for African catfish products, we recommend using this report to see that out of three analyzed production models (50 tons, 100 tons, 350 tons per year), with using EU funding (European Fisheries Fund), and

using the financing mix proposed in the report - only the scale of 350 tons a year is profitable, in terms of commonly used investments assessment methods: NPV (net present value) and IRR (internal rate of return).

Vannamei shrimp is interesting new option for RAS aquaculture, as it is a tasty product that is increasingly recognized by European consumers, also in the South Baltic region. Unfortunately RAS systems for Vannamei shrimps should be considered as business in developmental stage (early growth). Although RAS technical solutions are basically quite universal, a number of operating parameters of shrimp farming are hard to predict. Each new investor must be warned that shrimp farming, although possible from the technological point of view (which is confirmed by InnoAquaTech project two pilots), involves a number of risks from the economic side. From market point of view it must be noted that shrimp from RAS objects must be sold at a much higher price than frozen (and thawed, offered as fresh) imported Vannamei shrimps. At the same time, there is no clearly distinguished delicatessen segment of fresh shrimps on the market. This means that the future breeder will have to incur specific expenditures to promote a new product and prove to the recipient that this product is significantly different from the cheaper substitutes available. Based on current market supply statistics for fresh, unfrozen tropical shrimps, it should be noted that the market is limited: for example: several tons per year in Poland, and a maximum of several dozen tons per year in Germany. From operational point of view main risks for investors are: unpredictable mortality in the production cycle and uncertainty of sources of stocking material (as opposed to the USA, Central America and Asia - where the producer has a wide selection of sources of supply with stocking material). Once you find out that you have a market for deli shrimp with RAS and you recognize proven sources of supply with stocking material, feed and salt, we encourage you to use the calculation in this report. They show that for two production models: 3 tons and 15 tons annually, only for production at the level of 15 tons, the basic assessment parameters (NPV, IRR) give positive results - using the investment financing models proposed in the report and with the support of the EFF surcharge.

The need for advanced technologies. Planning a RAS farm, especially for species whose density in water is relatively low (as Vannamei shrimps), all possible ways should be used to make the water change low. Therefore, it is necessary to use effective biological filtration (nitrification, denitrification), degassing and oxygenation of water and effective mechanical filtration, resulting in the smallest possible water losses. This results not only from the costs of water intake and sewage disposal (these costs depend always on the local conditions, but it can be assumed that these costs will grow in the coming years). Increasing recirculation, i.e. reducing the rate of fresh water consumption, is the crucial to reduce heat costs (both for catfish and for shrimps) and water salting costs (for shrimps). Another element of cost optimization is the automation of production: automation of control of water parameters, feeding automation and fish harvest automation. Automation, especially in larger facilities, significantly reduces labor costs. This is key now in Germany and Denmark, but with time it will be increasingly important also in Poland and Lithuania. The last element that must be taken into account is the quality of building insulation - some catfish farms are still found with poor thermal insulation, especially in locations with cheap heat sources, but when planning a new investment should always design a thermally passive object. All this, combined with the use of geothermal energy (in the case Vannamei shrimps - optimally geothermal salt water), gives the chance to build economically one viable farms of thermophilic organisms such as African catfish and Vannamei shrimp in the close future.

In the following report, interested investors will find:

- introduction to production technology in RAS,

- discussion of basic concepts, parameters and functions for determining operating costs,

- an overview of possible sources of financing,

- description of different financing options,

- assessment of the possibilities of financing investment in African catfish and Vannamei shrimps farming.

Recirculated Aquaculture Systems (RAS) – introduction

Limitation in water resources, introduction of water charges, striving to reduce energy consumption during intensive farming and the specificity of the production of given fish species, such as catfish and salmonids, direct breeders towards the use of recirculated aquaculture systems (RAS). Guidelines for these systems were developed in the 20th century [Kuczyński 2014], however, their use in Polish breeding began in the 19th century. The RAS systems have been introduced mainly in fish farms of thermophilic species such as African catfish, as they made it possible to reduce the cost of heating water [Goryczko and Grudniewska 2015]. The RAS systems are used in breeding African catfish from fry to commercial fish.

In recent years, the RAS systems have been used on a large scale in the South Baltic Sea region (including Germany, Poland, Lithuania) in salmonids' farming, mainly rainbow trout, but also in several Atlantic salmon farms. This is the effect of both a very limited number of new locations where a flow flow-through system can be built [Ibidem], as well as stricter environmental standards (regarding water intake and discharge of pollutants) resulting, among others, from the implementation of the Water Framework Directive by individual countries. In the salmonids' farming, the RAS systems are used throughout the production process from fry to commercial fish or only at the selected stages of production, e.g. rearing or during the breeding of rainbow trout reaching a weight of up to 1-2 kg. The main benefits, apart from limiting the impact on the natural environment, are: the possibility of building the facility on biologically clean water - from deep water intakes (no pathogens, which is characteristic of many watercourses). In case of indoor buildings, partial or complete isolation from external factors is also obtained, including piscivorous animals (birds), salmonids' disease vectors, as well as variable ambient temperature, outside the optimal range for salmonids' breeding. The benefits of biosecurity reduce the risk of losses, while the benefits of stabilizing the temperature - allow shortening the production cycle.

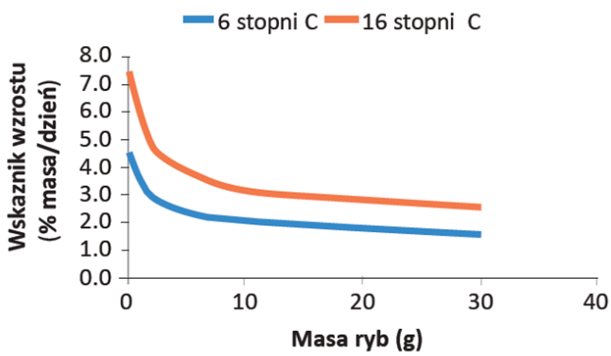

Figure 1. Growth rate (% weight/day) for rainbow trout in temperatures 6 and 16°C.
Source: Bregnballe 2015/2016PL.

Currently, more and more often fish farming in RAS is combined with plant production (aquaponics), which allows using fish metabolism products as nutrients for fertilizing plants [Bregnballe 2015/2016PL].

The main feature of the RAS systems is the multiple use of water taken from a river or a source of groundwater. In the flow system, which is used in the majority of trout farms (using a system with a volume of 4000 m^3 and annual production of 500 tons/year) the consumption of fresh water per kg of produced fish is annually approx. 30 m^3. In turn, the consumption of fresh water per day in relation to the total system volume is over 1000%. With the use of a super-intensive RAS system, the consumption of fresh water per kg of fish produced annually can be reduced to 0.3 m^3, and the consumption of fresh water per day in relation to the total volume of the system to 6%. The recirculation rate will be then 99.6% [Ibidem].

The RAS systems are especially useful for breeding species such as: Arctic char, Atlantic salmon, eel, grouper, rainbow trout, gilthead seabream, sturgeon, turbot, shrimps, and amberjack. The relatively high production costs in RAS and difficulties in farming cause that some fish species are not selected for breeding using this method, for example cobia, pike-perch or lemon sole [Ibidem]. The selection of species for breeding must therefore be supported by the biological analysis of the species survival in systems with recirculation of water and their market price, which would cover the increased production costs.

RAS facilities equipment

The basic elements of the RAS system include: tanks for fish farming, mechanical filters, biofilters, degassers (trickling filters), oxygen enrichment equipment, as well as devices for water disinfection. Other important elements of the system are: water treatment equipment, water heaters (if the temperature of the water taken is lower than the optimal farming conditions), circulation pumps, piping, automation and steering.

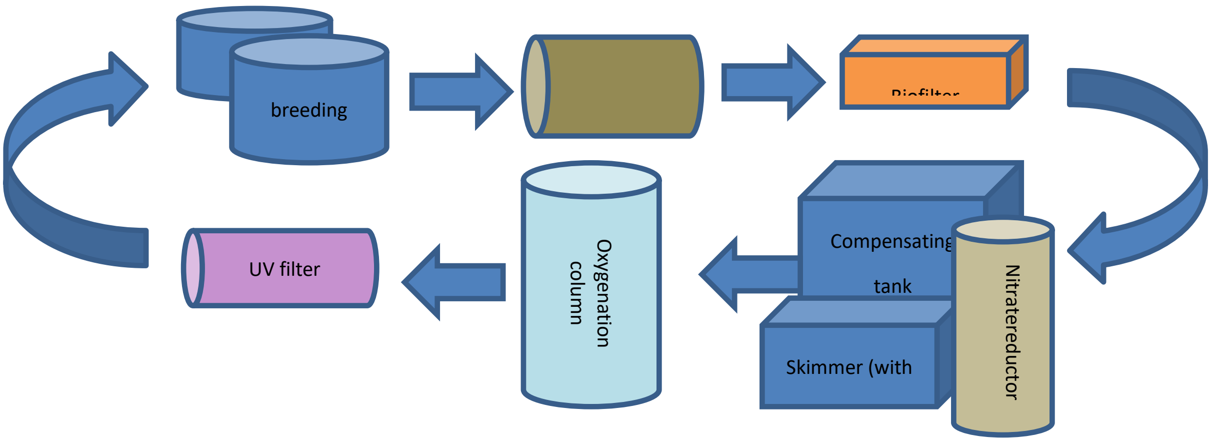

Figure 2. Basic concept of recirculation system. Such system was used in Klaipeda InnoAquaTech Pilot RAS installation for Vannamei shrimps breeding.

Fish tanks

In the RAS systems, various tank shapes are used, depending on the needs of the fish species introduced. These can be tanks in the shape of a cylinder, a cuboid or a cuboid with rounded edges (Figure 3) [Bregnballe 2015/2016PL].

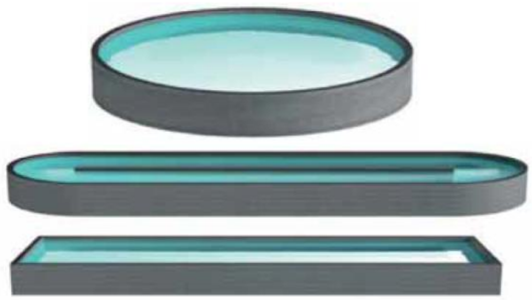

Figure 3. Different shapes of tanks used in the RAS system.
Source: Bregnballe 2015/2016PL.

Trout and catfish are usually grown in rectangular tanks which allow the best use of space, but reduce their movement possibilities. The development of large fish farms shows that cylindrical tanks are currently the most practical. The octagonal counterparts are also profitable in terms of using space and keeping the fish movement in a circle, Figure 4.

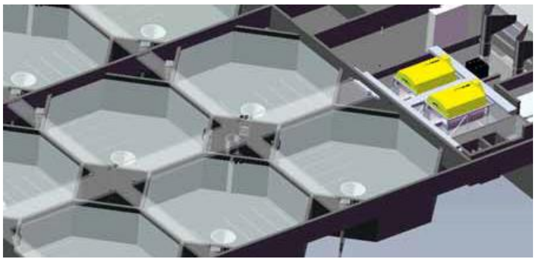

Figure 4. Example of an octagonal tank used in a recirculation system.
Source: Bregnballe 2015/2016PL.

During the implementation of the InnoAquaTech project, it was found that an innovative solution on the regional scale is used to enforce water flow (recirculation) through pneumatic pumps powered by compressed air from compressors. Such solution is especially popular in Poland, in the RAS trout farming facilities. The advantage of such solution is, among others, the integration of the enforced water flow with degassing and aeration, as well as energy benefits.

During the implementation of the InnoAquaTech project, it was found that in South Baltic Region SMEs regional scale the advanced water treatment (including MBBR and oxygenation) is also used for breeding African catfish, which significantly improves the survivability and growth rate in intensive breeding (literature sources often suggest that there is no need for such water purification in African catfish breeding).

Water purification

The first purification of river water, if such is taken into the basins, takes place already at the inflow of water, where it is purified of leaves and large impurities, most often on drains, followed by mechanical purification through a drum filter called a micro sieve, which will be discussed below.

> During the implementation of the InnoAquaTech project, it was found that an innovative solution on the regional scale is used with round tanks using the cyclone method - a properly positioned water inlet allows the sedimentation of fine solid particles and dead fish, which allows the increase in the intensification of water exchange from the zone with higher concentration of sediments and the reduction of water exchange from the upper layer characterized by lower content of solid particles.

Mechanical filtration

The first stage of recirculated water filtration is mechanical purification, usually through sedimentation of solid particles already in the basin and directing the water with sediments on a microscreen filters, usually drumfilters (Figure 5) to purify it. The solid particles are stopped by a filter and transferred to a settling tank by the rotation of a drum. With respect to microscreen, 20–100 micron (µm) filters are the most often used.

Figure 5. Drumfilter before installation AquaSyste Typ 200, such filters are commonly use in SMEs in Poland. Photo: T.Kulikowski/NMFRI

The use of a microscreen reduces the load of organic pollutants in the water directed for further purification, improves the transparency of water by removing most of the solid particles (depending on the mesh size in a microscreen), as well as improves the conditions for nitrification as the biofilter does not clog [Bregnballe 2015/2016PL].

Biological filtration

The next step in the water purification is biological filtration, i.e. water flow through a biofilter. In biofilters, moving and stationary beds can be used (Figure 6 & 7). The water inflow at a moving bed shall be from the bottom, while at a stationary bed from the top, and the water should flow down and up through subsequent parts of the bed. Filters with the moving bed can be more tightly filled with water, which results in higher efficiency per m^3 of a biofilter. Both types of beds can also be combined, which saves space and allows achieving the benefits of adhering particles in a stationary bed [Bregnballe 2015/2016PL].

Figure 6. Biological filtration - a moving bed - preparation (1) and working (2).
Photo: T.Kulikowski/NMFRI

Figure 7. Example of a moving bed LEVAPOR.
Source: Pascik I., Levapor, an innovative support for MBBR RAS systems, 9th International Sturgeon Conference, Warsaw, 21.11.2018

The ammonia forming through the biological transformation of fish has a toxic effect and must be converted into nitrates harmless for fish. The nitrification bacteria present in the biofilter are responsible for this transformation. The effectiveness of nitrification depends on the water temperature in the system and the pH value. Optimal water parameters for nitrifying bacteria are pH between 7 and 7.5 and temperature between 10°C and 30°C. The improvement of the conditions of nitrification processes is frequently studied by researchers [Zieliński et al. 2015] found that the use of microwave radiation causes a significant increase in nitrification efficiency by 5.5%.

Nitrites formed as a result of nitrification, in high concentrations, i.e. above 100 mg/l, can negatively affect the absorption of food by fish and therefore their growth. Consequently, if it is not possible to dilute water to reduce the concentration of nitrates, it is necessary to use denitrification. This process occurs under anaerobic conditions using denitrifying bacteria, most often from the genus *Pseudomonas.* As a result of this process, nitrates are reduced to atmospheric nitrogen. The use of an organic carbon source in the chamber, e.g. methanol, is indispensable in the denitrification process (denitrification of 1 kg of nitrate requires 2.5 kg of methanol). For the purpose of denitrification, the purified water should remain in a biofilter for approx. 2-4 hours [Bregnballe 2015/2016PL].

> During the implementation of the InnoAquaTech project, it was found that an innovative solution on the regional scale is used in biological filtration - unique and innovative biocarrier is used - polymeric foam matrix and a coating of fine adsorbent pigments Levapor. The active surface is 20 000 m2 per 1 m3 [Pascik 2018]

Degassing

Water after purification from solid deposits and after nitrification and optionally denitrification must be subjected to degassing in order to remove accumulated gases, mainly CO_2 generated in the process of fish breathing and also N_2 accumulated after the denitrification process. These gases have a detrimental effect on fish growth and condition; in anaerobic conditions they contribute to the formation of hydrogen sulphide – a gas toxic to fish even at low concentrations [Bregnballe 2015/2016PL].

The degassing is performed by aerating water and can be performed in the biological filter or immediately after it, by introducing air into the water that removes gases.

Oxygen enrichment

It is recommended that the next stage of the RAS system is to oxygenate water by adding oxygen to the water. Water after passing through breeding tanks has saturation at the level of 70%, and after passing through the biofilter, this parameter is even lower, hence oxygenation is necessary. This operation will increase the water saturation to 90% or even up to 100% [Bregnballe 2015/2016PL]. For this purpose, an oxygen cone or oxygenator can be used (Figure 8). The pressure applied in the cone is about 1.4 bar, while in the oxygenator it is much lower, i.e. usually 0.1 bar [Bregnballe 2015/2016PL]. Thanks to using the oxygenator, at the consumption of 1 kW, 1.5 kg of oxygen can be dissolved in water [FREA Aquaculture Solution 2019].

Figure 8. Oxygen cone in Klaipeda shrimps InnoAquaTech pilot farm.
Photo: T.Kulikowski/NMFRI

Regardless of the devices used, constant measurement of the oxygen level in water is of high importance. It should also be mentioned that breeders, especially of salmonids such as rainbow trout, notice the positive effect of water hyperoxygenation (oxygen content in water above 100%) at the inflow into the aquaculture system, both with respect to the fish growth rate and the improvement of water quality flowing out of the farm. Improving the growth rate and better fish welfare are then able to cover the higher costs of oxygen demand.

UV disinfection

An optional solution for purifying water from pathogenic bacteria is the use of UV disinfection, which shows no harmful effect on fish farming. It should, however, be performed outside fish tanks and underwater in order to avoid reflection. A UV dose of 2000-200000 µWs/cm^2 is most often used for disinfection using this method. Lower doses allow the destruction of bacterial and virus DNA, while higher of even small parasites [Bregnballe 2015/2016PL].

Removal of protein foam

In many fish farms in the RAS systems, there is a problem of removing protein substances polluting the water. They can be removed with the use of a protein skimmer (Figure 9).

Figure 9. Protein skimmer in Klaipeda shrimps InnoAquaTech pilot farm.
Photo: T.Kulikowski/NMFRI

Its operation is based on the centrifugal, mechanical removal of organic compounds using oxygen and ozone. This operation, with respect to the device used, is optimized by ozonized air which is injected into the treated water as a stream of small bubbles using a low-pressure Venturi system. As bubbles rise up in the water column, liquids with different protein viscosities and other surfactants coagulate with each other and form dense organic foam. The foam is removed from the protein skimmer through the drainage pipe and is discharged to a sewer or backwash. An important secondary effect of protein fractionation is the removal of fine particles (<40 microns) that create the foam [MAT AQUACULTURE FILTRATION 2019].

BIOFLOCK

An alternative to typical fish farming in the RAS systems is the use of Bioflock technology, i.e. organic matter rich in protein consisting of bacteria, diatoms, protozoa, microalgae, excreta and remains of dead organisms and other invertebrates [Sadowski 2018]. This technology has two important roles: it maintains the right water quality, which changes as a result of natural use and increases the availability of nutrients, as well as reduces the food factor and feed costs [Nahar et al. 2015]. It can therefore serve as the growth environment for aquatic organisms, e.g. shrimps. In Bioflock, nutrients are recycled by bacteria that remove them and transform into protein of high nutritional value, nitrogen compounds and other metabolites that maintain the water quality [Jiménes-Ojeda et al. 2018].

Shrimp farming technology on a large scale using Bioflock is successfully used in Asia, the central and Latin parts of America, and on a small scale in greenhouses in the US, South Korea, Brazil, Italy, Belgium, China and other countries.

Equipment - summary

Summing up the issues concerning the elements of RAS systems, Table 1 compares the elements of the RAS system in the production of shrimps and African catfish in terms of their necessity to breed these species.

Table 1. Elements of the RAS system necessary and optional for fish farming of shrimps and African catfish

Elements of the system	Shrimp production *Penaeus vannamei*	African catfish production *Clarias gariepinus*
Breeding tanks	Necessary	Necessary
Mechanical filtration	Necessary	Optional (for high-intensity production)
Biological filtration –nitrification	Necessary	Optional (for high-intensity production)
Biological filtration –denitrification	Optional (recommended at very low replenishment of fresh water)	Optional (rarely used)
Degassing	Necessary, occurs through a moving bed	Necessary (through a trickling filter or moving bed filter)
Protein skimmer	Optional	Rarely used
Oxygenation **or** aeration	Necessary	Optional (for high-intensity production)

Source: The results of InnoAquaTech MSEs survey

Conclusions

Breeding of fish and invertebrates in the recirculated aquaculture systems (RAS) is gaining more and more supporters. It allows for a greater impact on the quality of water introduced to the subsequent cycle (in comparison with the flow system). It is the only method of fish production with very limited water resources. In addition, it sets the lowest requirements on water quality, allowing improvement by purification or oxygenation. RAS reduces the epizootic risk and ensures full control of production processes and in the case of closed RAS systems also precludes the seasonality of production. Nonetheless, this is an expensive technology and breeders have to take into account the risk of failure of devices that are part of the system and the accompanying costs, as well as the more difficult combating of parasites and diseases due to the reuse of water [Pirtań 2016]. RAS technologies, which have been used for many years in the Northern Europe, are still relatively new in Poland and the breeders' experience is still collected allowing for better farming and increase of the net profit from the activity.

RAS business model - basic concepts for operating cost account

In order to facilitate understanding of the economics of RAS facilities for people who have not been operating in this area so far, we present below an overview of the basic concepts related to production costs. In addition, basic and simplified formulas for independent calculation of particular cost elements have been described. The formulas have been developed in a way that facilitates understanding of the interdependencies between a given cost element, as well as the production volume and the productivity from 1 m^3.

Production cycle

By the production cycle we mean the time needed to grow an aquatic organism to the size at which we can sell it. This size will be referred to as a commercial size. During the year, there may be several production cycles, but also the production cycle may be longer than one year.

In order to avoid a situation in which the supply of our product is seasonal, in RAS objects, production is usually performed in parallel cycles (before the end of the first cycle, the next starts), allowing to maintain continuous sales.

In this report, the production cycle begins with the entry into breeding tanks of small fish (shrimps), referred to as stocking material.

Productivity

In indoor facilities with closed water circulation, the system's productivity is usually determined by the volume of annual production obtained from 1 m^3 of the system volume. This size depends on two parameters: the average stocking density and the length of the production cycle. Sometimes we do not know the average stocking density, but we know empirically the volume of water needed to produce the given weight of fish, then the system's productivity can be characterized by the following formula:

$Prod = (52 / C) * Prod_C$

where:

Prod - productivity expressed in kg of annual production from 1 m^3 of a facility,

52 - the number of weeks in a year, if we anticipate technological breaks, this number should be reduced accordingly;

C - the length of the production cycle in weeks [weeks],

$Prod_C$ - production of fish in 1 m^3 of the system in the production cycle [m^3 / kg].

In the most simplified model $Prod_C$ is equated with the density of fish at the time of their catch (kg/m^3). This is the case, however, only if the fish are not transferred between the tanks in order to maintain optimal density throughout the entire production cycle. This production model means that at the beginning the tanks are stocked with very low weight organisms, which translates into low stocking density. Such a model can be used only if we do not have the possibility to transfer organisms between the tanks, e.g. as a result of their high sensitivity to manipulation.

It is worth noting that throughout this report, the volume of production and productivity refers not to the volume of water in grower tanks, but to the entire system volume, which also consists of water in pipelines, filters, and other tanks.

If we know the annual productivity (kg/m^3), then approximately, except for the first year of operation, in which we start next parallel cycles, the maximum production capacity of the facility will be:

$Pr = Prod \times V_{TOT}$

where

Pr - production volume (kg/year),

Prod - productivity expressed in kg of annual production from 1 m^3 of the facility,

V_{TOT} - total water volume in the system.

In African catfish farming, due to surveys of MSEs in South Baltic region, a 1.2 kg fish (from 10g fry) is obtained in about 6 months. Productivity in such production cycle from 1 m3 of water in the system reaches 700 kg per year.

In Vannamei shrimps farming, due to surveys of MSEs, pilots and literature, a 20 g shrimps is obtained from LP12 in minimum 4 months. Productivity from 1 m3 of water in the system, reaches just 18 kg per year. In the USA (Indiana), another breeding model is used in RAS: heavy stocking material (1.3 g) is grown to 20 g in 14 weeks with productivity of 33 kg from 1 m3 of system annually.

Purchase of stocking material

Each fish farm has basically two options:

- fish from purchased stocking material, which guarantees relatively low mortality and is already adapted to extruded feed,
- complete farming - keeping the spawning stock, spawning, hatching and rearing of larval and fry stocks, and then intensive growing (breeding).

An indirect option is running a cycle from purchased eyed-eggs to a commercial fish.

The more experienced a breeder is, the more profitable it may be to run a full breeding cycle. Running a full breeding cycle makes it independent from external sources of stocking material supply - which is important for both biosafety and production economics.

At the same time, it is a much simpler process to keep farming from stocking material to a commercial fish - and only this option is calculated in the present study.

The stocking costs for a given production cycle are described in the simplest manner by the following formula:

$$K_N = Pr * (C_N / (1-s)) / M_T$$

where:

K_N – cost of stocking

Pr - production volume of commercial fish (kg),

C_N - unit price of the fry together with transport costs (euro/individual),

M_T - unit weight of commercial fish (kg/individual)

(1 - s) - survival rate in which:

s - mortality rate (%), calculated according to the formula:

$$s = S / N,$$

where:

S - the number of individuals that died in a given time interval,

N - the size of the population at the beginning (= the number of purchased individuals of fry).

As we can see the costs of fry per 1 kg of produced fish, increase in direct proportion to the mortality rate and decrease in direct proportion to the size of a commercial fish.

During the implementation of the InnoAquaTech project, it was found that typical mortality rate in African catfish MSEs farms in South Baltic region, does not exceed 10% in the production cycle.

During the implementation of the InnoAquaTech project, it was found that mortality rate in Vannamei shrimp RAS farming is difficult to predict. Although most suppliers of stocking material "guarantee" max. 20-30% mortality, surveys conducted among MSEs and results from the pilot farms (Klaipeda, Gdańsk) indicate a mortality rate of 50-60%. Most mortality falls on the stage of transport, acclimatization and nursery.

Feed

The costs of feed used in a given facility in a given period of time (e.g. production cycle) in the simplest terms are described by the following formula:

$$K_P = Pr * FCR * C_P$$

where:

K_P- the cost of feed in a given unit of time (e.g. Euro/year)

Pr - production volume in a given unit of time (e.g. kg/year)

FCR - *feed conversion ratio*

C_P- unit price of feed (PLN/kg) including transport costs

FCR — i.e. feed conversion ratio, a factor describing how much feed should be used to get 1 kg of a commercial fish. Without going into details in our study, it is a result factor, which is directly affected first of all by: biological efficiency of a fish to process food into the body's own weight and fish mortality in a production cycle. For real businesses, FCR was calculated in the present study as the quotient of feed used annually and the annual size of fish weight growth.

It should be remembered that the feed with the highest FCR index is not always the feed with the highest rate of fish growth.

The only parameter that can be taken into account by a breeder at the business planning stage is the size of the target fish (commercial fish). In general, for the majority of fish species, the larger the organism, the worse the food factor is (for example the FCR coefficient for a 1 kg catfish is lower than for the 2 kg catfish, provided that they are farmed in similar conditions and fed with the same feed). This does not automatically mean that the profitability of breeding small fish is greater - because we have to take into account other cost factors (also usually the higher, the larger the fish are), and the price of a commercial fish (usually higher in case of larger fish).

Feed price - feed prices depend mainly on its composition (quality) and manufacturer's brand. The feed price is also affected by (like the purchase of most other goods):

- transport costs of feed,
- the buyer's ability to pay for delivery in advance,
- the buyer's ability to make one-off larger purchase of feed,
- negotiating skills.

In African catfish farming, due to surveys of MSEs in South Baltic region, for production of 1.2 kg fish (from 10g fry) FCR amounts to 0.95-1.0.

In Vannamei shrimps farming, due to surveys of MSEs, pilots and literature, FCR (in production from LP12 to 20 g shrimps] amounts at average to 1.6. Such result was obtained in e.g. Klaipeda InnoAquaTech pilot farm.

Electricity

The costs of electricity consumption in a RAS system can be calculated approximately, as the product of the sum of the consumption of individual devices and the electricity unit price, according to the formula:

$$K_{EL} = \Sigma (W * T)_1 .... (W * T)_n * C_{EL}$$

where:

K_{EL} - the cost of electricity in a given unit of time

C_{EL}- price (cost) of 1 kWh of electricity

W - power rating of a given electrical device

T - operating time of a given device in a given unit of time

The basic devices responsible for electricity consumption in farming facilities are:

– pumps:

- for deepwater / surface water intake;

- constant flow pumps;

– mechanical filters;

– water aerators.

To a lesser extent, the consumption of electricity is influenced by lighting, UV filter, monitoring and control system.

For the purpose of the InnoAquaTech project, an estimation of energy consumption costs per 1 m^3 of the system was also used, through analysis of real SMEs electricity consumption (surveys).

The use of energy sources in RAS systems

An important factor in reducing the costs of running a business related to intensive breeding of fish and other aquatic organisms, especially in closed circuits, is the acquisition of low-cost energy. This has been included in the "Strategy for the Development of Sustainable Intensive Aquaculture 2020" and transferred to the "Strategic development plan for fish farming and breeding in Poland in 2014-2020" constituting an annex to the Operational Program "Fisheries and Sea" 2014-2020 (OP FISH). In addition to the economic dimension, an important factor supporting the acquisition of relatively low-cost energy is the reduction of the negative impact of fish farming on the environment. Such activities are supported in Poland through the Operational Program "Infrastructure and Environment 2014-2020" (OPI & E).

The issue of obtaining electricity from renewable sources is supported by successive international agreements limiting the emission of harmful compounds and programs supporting the installation of such sources. Renewable energy can be obtained from solar energy (photovoltaic), wind (wind turbines), biomass combustion or fermentation, geothermal waters, as well as potential and kinetic energy of water. The organization and allocation of support from the OPI & E is performed by the National Fund for Environmental Protection and Water Management, and the support may amount up to 85% of eligible costs of the project for investments not exceeding 15 million EUR [www.nfosigw.gov.pl].

A heavy financial burden is also ensuring the right temperature of water. In Poland, it is possible to use geothermal sources (example of salmon farm in the vicinity of Trzęsacz), however, the potential of water of combined heat and power plant (CHP) plants and biogas plants producing electricity and heat for the needs of a municipality or commune in waste treatment plants and sewage treatment plants remains unfulfilled. The construction of a biogas plant is a relatively economical and effective form of waste management, but it requires finding heat recipients.

The construction of local commune biogas plants is the most developmental direction of obtaining renewable energy. The theoretical raw material potential in Poland is estimated to be sufficient to produce 5 billion m^3 of biogas [www.pigeor.pl]. Available materials describing the operation of a standard commune biogas plant with an electric power unit of about 1 MW and thermal power of about 1.1 MW indicate that it is possible to produce about 8,600 MWh of electricity and 30000 GJ of heat annually [bip.susz.pl]. Heat recovery from the water returning to the circulation after drying the biocomponents would completely cover the needs of a farm, while generating only the maintenance costs of the transmission system [www.zielona-energia.cire.pl].

Thermal energy

Heating costs are generated by the need to ensure constant, optimal temperature, which for tropical animals (Vannamei shrimp, African catfish), for the vast majority of the year, is higher than the ambient temperature. They can be divided, according to the place of formation, into two components:

- heating costs of the building, equal to its energy losses (through partitions - ceiling, walls, floors, windows and ventilation of the building), which depend on the structural features of the building (insulation quality, ventilation technology, or the use of heat recuperation);
- costs of heating up the water exchanged, depending on the volume of substitution (supplementation) of water, temperature of water in the production cycle, water temperature at the entrance to the facility and heat exchange between removed wastewater and cold water introduced (in the heat exchanger).

The energy balance of the building is positively influenced by:

- metabolic heat of fish;
- metabolic heat of a biological filter microorganisms (ignored in the calculations).

The metabolic heat of fish was determined at 700J/hr/MW (where MW is the metabolic weight: $kg^{0.85}$). This means that the metabolic heat of 10,000 kg of fish is able to heat 15 m^3 of water throughout the day (24 h) by about 0.8 degrees.

The costs of heating the water exchanged can be described by the following analytical formula:

$$K_{WTH} = Pr / Prod * W_{EX} * 365 * \Delta T_W * 0{,}998 \text{ kg/m3} * 4{,}186 \text{ kJ/kgK} * EF_{TH} * C_{TH}$$

where:

K_{WTH} - cost of thermal energy consumption for heating water [Euro/year]

Pr - production volume in the facility per unit of time [kg]

Prod - productivity expressed in kg of annual production from 1 m^3 of the facility.

W_{EX} - the ratio of the daily volume of water consumed (V_{IN}) compared to the total volume of the system (V_{TOT}): $W_{EX}= V_{IN} / V_{TOT}$ [%];

ΔT_W - temperature difference between the temperature of circulating water, and the temperature of water entering from outside, after heating in the heat exchanger (with waste water) [K],

0.998 kg/m^3 - weight of 1 m^3 of water [kg];

4.186 kJ/kgK - specific heat of water;

EF_{TH} - efficiency of the heating device;

C_{TH} - price of energy carrier calculated based on its calorific value (Euro/kJ).

The second component of thermal energy costs, i.e. the cost of heating the facility, can be calculated according to the following formula:

$$K_{BTH} = (Pr / Prod) * SVR * ThL * EF_{TH} * C_{TH}$$

where:

K_{BTH} - cost of thermal energy consumption for heating the building [Euro/year]

Pr - production volume in the facility per unit of time [kg/year],

Prod - productivity expressed in kg of annual production from 1 m^3 of the facility [kg/m^3]

SVR - the ratio of the building area to the volume of water in the system [m^2/m^3], ThL - thermal losses of the building [kWh/m^2/annually] — the size characteristic for the building construction and ventilation in a specific technology;

EF_{TH} - efficiency of the heating device;

C_{TH} - price of energy carrier calculated based on its calorific value (Euro/kJ).

Cost of water salting

With respect to breeding organisms that need higher water mineralization (e.g. shrimps), the costs of salting water should be predicted, as they can be an important cost factor. Salting costs, as well as water heating costs, are directly related to the substitution of water in a facility, according to an approximate formula:

$$K_{SAL} = Pr / Prod * W_{EX} * 365 * C_S * S$$

where:

K_{SAL} - the cost of salt consumption for salting the water [Euro/year]

Pr - production volume in the facility per unit of time [kg]

Prod - productivity expressed in kg of annual production from 1 m^3 of the facility.

W_{EX} - the ratio of the daily volume of water consumed (V_{IN}) compared to the total volume of the system (V_{TOT}): $W_{EX} = V_{IN} / V_{TOT}$ [%];

S - salt concentration [‰ corresponding to approximately kg of salt / m^3 of water];

C_{SAL} - price of salt [Euro/kg].

Water and sewage costs

In the majority of examined facilities, in the course of the InnoAquaTech project, no direct variable costs of water intake and sewage disposal were incurred. Usually, the facilities did not bear these costs, or they incurred water, legal and environmental costs on a flat-rate basis. Nevertheless, in the light of the Water Framework Directive, it cannot be excluded that fees for water intake and discharging post-production water into the environment will be introduced. Fees are also incurred when using communal water and discharge of sewage to communal sewerage, which is possible at RAS facilities. In this case, the formula describing this cost element will take the following simplified form:

$$K_{WS} = Pr / Prod * W_{EX} * 365 * (C_W + C_S) + W_{EV} * 365 * C_W$$

where:

K_{WS} - costs of water intake and post-production water discharge (sewage) [Euro/year]

Pr - production volume in the facility per unit of time [kg]

Prod - productivity expressed in kg of annual production from 1 m^3 of the facility.

W_{EX} - the ratio of the daily volume of water consumed (V_{IN}) compared to the total volume of the system (V_{TOT}): $W_{EX} = V_{IN} / V_{TOT}$ [%];

W_{EV} = volume of water lost daily due to evaporation;

C_W - price of water consumed [Euro/m^3];

C_S - price of discharged sewage [Euro/m^3].

During the implementation of the InnoAquaTech project, it was found that typical water daily exchange rate in highly intensive RAS aquaculture amounts to minimum 3% (usually 5%), even in systems that are declared as "completely closed". This is due to among others the specifics of the work of mechanical filters.

Personnel costs

Production workers

Labor costs are a result of work efficiency (which can be expressed in the form of employee productivity, e.g. in the form of a number of tons of fish produced per 1 worker employed in a production position in a farm), and labor price.

The workload per 1 kg of produced fish (employee's productivity) depends on many factors, among which the following should be mentioned:

- management skills of the owner / manager of the facility,

- automation of production (e.g. the use of automatic feeders, monitoring system of water parameters) and ergonomics of the facility's design (e.g. easy access for employees to fish tanks, easy fish harvest, methods of fish sorting),

- individual skills and employee involvement, which, with just several employees, can also have a significant impact.

The labor costs of production workers are described by a simple pattern:

$$K_L = Pr * Ef * C_L$$

where:

Pr - production volume (kg/time) in a given unit of time (e.g. year) [kg/year]

C_L- price (cost) of labor with mark-up per 1 employee per given time unit (e.g. year) [PLN/person/year]

Ef - labor intensity (number of employees per production volume) [person/kg]

It should be remembered that the function describing the size of Ef is a step function.

During the implementation of the InnoAquaTech project, it was found that in small African catfish farms (<= 80 tons), minimum employment is one production worker per 40 tons of annual production. In large farms (over 300 tons), one production worker can account for ca. 70 tons of annual production. The highest recorded productivity during InnoAquaTech surveys and study visits, in automated and ergonomic RAS rainbow trout farms, reached over 300 tons of fish per 1 production worker per year!

In small shrimp farms, labor costs are a significant burden on production costs. Regardless of the production scale in the range from several to 15 tons per year, the employment is no less than 2 production employees. The cost of labor per 1 kg of shrimp produced falls linearly with increasing production scale. Above 3 tons of annual production, automatic feeding and harvesting equipment must be used.

Office and administration personnel

In the majority of cases that we had during the implementation of the InnoAquaTech project, regardless of the scale of production in the facility, the size of employment of administrative and office staff ranged from 1 to 2 people, including the manager of the facility. It is worth noting, however, that certain types of activities (e.g. introducing a new product, such as fresh shrimp from the RAS system, to the market) will require intensive marketing activities that will increase the employment of office workers or incur costs of external services.

Other costs

There are a number of other costs in closed-cycle fish farming, which are quite difficult to assess in detail when starting a business. These costs include: supervision and veterinary consultation, purchase of chemicals (eg NaOH to neutralize the pH of the water), purchase of small equipment, costs of dead fish disposal, certification costs. However, the most important is the awareness that it is a breeding of living organisms, which is associated with the risk of death of an excessive number of individuals, which causes specific losses.

Sources of financing RAS investments - general overview

Financing is an action designed to provide the enterprise with capital resources necessary for its operation and development. The concept of financing is closely related to the concept of investing. Thus, it can be said that financing is collecting or acquiring money (capital), and investing is spending it [Michalak 2007]. Cash necessary to carry out a given investment called "financial capital" comes from various sources [Walica 1995]. Financing therefore depends on proper selection of sources of capital, and designing a capital structure adequate to a given undertaking.

Enterprises, depending on the level of development, legal and organizational form, and finally on the financial situation, can use two types of financing. The basic breakdown due to the origin of the cash is the division into external and internal financing [Panfil 2008].

The generated equity (internal sources of financing) include [Ickiewicz 2004]:

- funds from current receipts:
    - sale of goods and services
    - depreciation write-offs
    - sale of unnecessary assets
- funds from accumulated capital:
    - retained earnings (profits)
    - long-term reserves.

The contributed equity (external financing), the donor of which receives the right to participate in the profit earned by the enterprise, includes:

- funds from the issue of shares
- shareholder / shareholder payments
- contributions
- entry fee
- grants.

The sources of capital from external financing, which is of a forward-looking and interest-bearing nature, include:

- financial market instruments
- short-term loans
- long-term loans and debits
- debentures
- investment loans
- commodity market operations (trade credit).

The market economy opens wide opportunities for businesses to use various additional forms of financing current and development activities, i.e. leasing, private equity (i.e. venture capital, mezzanine),crowdfunding. Enterprises, including agriculture and aquaculture, may also co-finance the implementation of the project with funds from the European Union. The structure of financing sources is presented in the Figure 10.

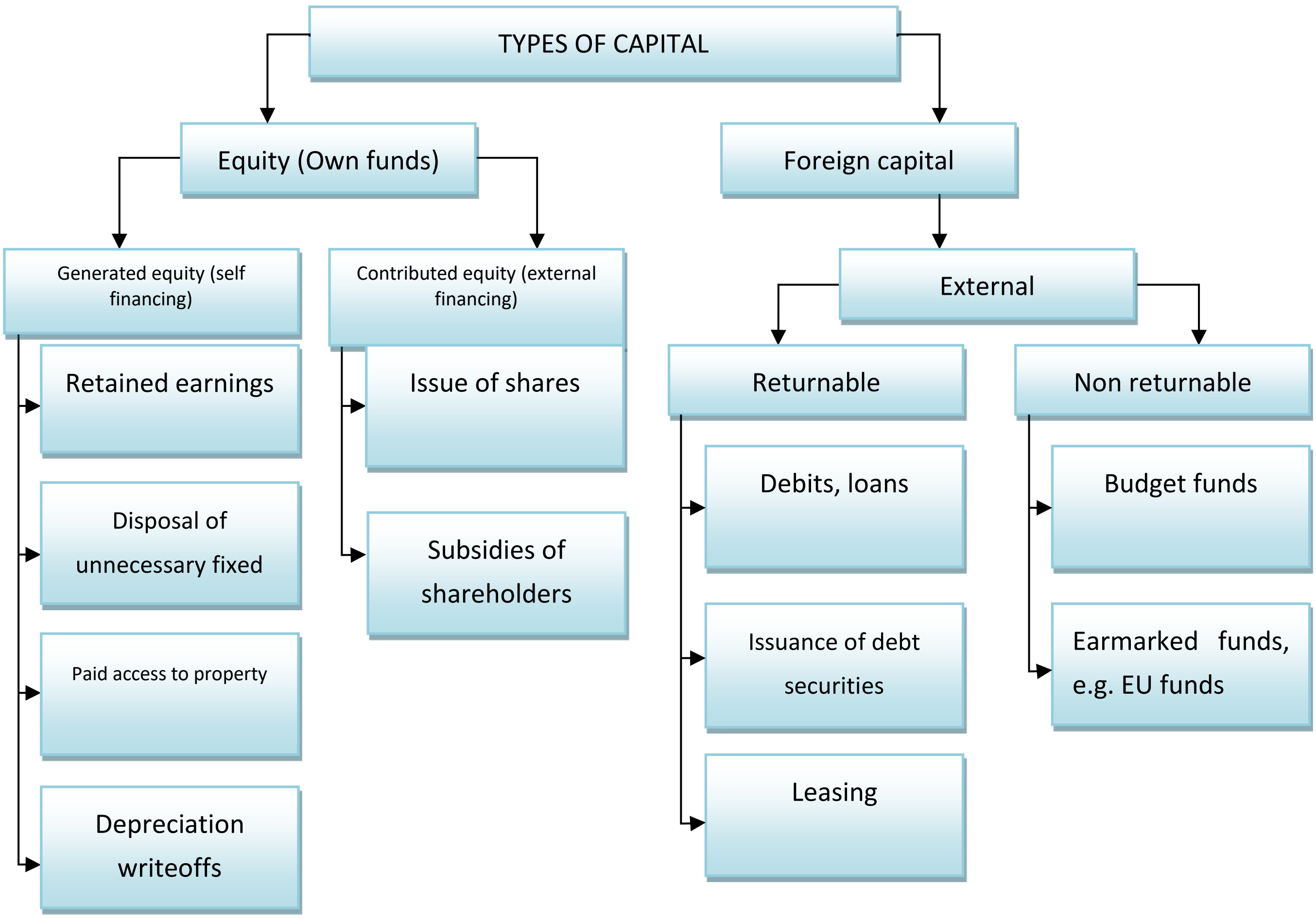

Figure 10. Selected sources of enterprise financing.

The success of the undertaking depends to a large extent on the proper selection of sources of financing of the conducted activity.

Having appropriate - in terms of size and structure - resources for the company not only enables operational and investment activities, but also ensures financial security, i.e. maintaining liquidity in the short and long term.

Access to financing instruments that meet the company's needs in this area can also be a source of competitive advantage for the company.

When choosing a specific source of financing, many factors should be taken into account [Różański 2016]. The most important should include:

- type of assets and their purpose;
- availability;
- costs;
- flexibility;
- leverage;
- service risk.

An important criterion for the selection of the company's financing strategy is the cost of obtaining capital financing the enterprise's assets (including interest on the loan). These costs have a significant impact on the final results of its operations. The repayment schedule should also be considered. Availability means the appropriate amount of property that will be used as collateral for possible loans. The enterprise must also take into account the structure of external capitals and their impact on the effectiveness of using own capital. Each source of financing is characterized by a specific level of risk related to expectations, future profits and opportunities to achieve them [Rutkowski 2016].

Equity

Running a business is connected with the necessity for an enterprise to have a certain property that is covered by the sources of financing. Each enterprise has assets (current assets and fixed assets) necessary to conduct operations. In order to finance the necessary assets, the enterprise needs to obtain adequate capital. Equity is the basic form of financing the company's operations in the sense that according to legal regulations each company must assume a certain minimum declared equity amount already when being established.

Capital means funds (financial resources) entrusted to the enterprise by its owners. Irrespective of the stage of development, size and nature of the activity, equity plays a special role among the sources of financing business entities. It gives the donor of this capital the ownership of the enterprise. They participate in the division of earned profits or covering losses in accordance with the contributed shares.

Donors of funds that constitute the equity of an enterprise have, among others, the ability to decide how to use the capital invested by them as part of their business activity, as well as the right to liquidation value in the event of liquidation of the enterprise and a number of other attributes, depending on the legal form of the enterprise.

Its characteristic feature is long-term commitment, static and permanent connection with the company's operation. Equity depends on the legal form of the business conducted under various names, e.g. for partnership it is equity, for a limited company it is share, supplementary or reserve capital.

he special significance of equity is due to the fact that it is involved in enterprise financing indefinitely and when the entity is liquidated, it is returned to donors only after the claims of other creditors are closed. Thus, this type of financing is the most stable source of financing in an enterprise, conditioning its economic strength. In addition, equity is a kind of guarantee for the enterprise creditors, being a solid basis for financing and a source of creditworthiness.

It should be noted that an entity contributing equity to an enterprise usually has no right to return it during enterprise operations or receive interest. Their remuneration for the involvement of resources is expressed through participation in earned profits.

The higher the level of equity in the structure of enterprise financing sources is, the lower the risk of losing accounting liquidity and its bankruptcy.

Equity can have various origins, i.e. its sources can be both external and internal. Thus, it is possible to distinguish: contributed equity - identified with external financing (e.g.: issue of shares, subsidies of shareholders, increase of shares), and generated equity - defined as self-financing (e.g. retained earnings, depreciation, disposal of unnecessary fixed assets), acceleration of capital trading).

The double origin of equity is due to the fact that the funds generated by the enterprise itself may turn out to be insufficient. In this case, it is possible to raise capital by collecting funds from investors, for example in the form of share issues. The equity, increased in this way, improves the financial credibility of the enterprise, facilitates overcoming possible payment difficulties and increases the chances of acquiring borrowed capital in the future.

According to the theory of finance, equity is the most expensive form of financing enterprises, because shareholders have the right to pay in the form of a dividend the entire net financial profit earned in a given year. Therefore, few companies use only financing from their own resources, most of them support various forms of liabilities, such as bank credits, liabilities to suppliers, etc. Despite the high cost of obtaining this capital, it guarantees the security of assets financed from this source, because it is the most long-term and stable capital among all sources of financing.

Private equity funds (PE)

Private equity is a type of capital investment based on the involvement of companies non-listed in stock exchanges. The activities of private equity funds involve the use of money obtained from investors to purchase all or part of existing enterprises and their subsequent resale. The purpose of this type of investment is to achieve a profit from capital growth in the medium and long term. Private equity funds invest in new and developing entities (enterprises) but also in so-called mature companies planning to enter the stock exchange in the foreseeable future, requiring restructuring, or changing owners or ownership structure. Typical restructuring activities of the private equity fund towards purchased companies include increasing debt, minimizing tax burdens, reducing costs due to getting rid of unnecessary facilities and reducing employment. The last stage of the portfolio investment is a solution, which can usually consist in selling the company to another investor or listing it on the stock exchange. In the life cycle of private equity / venture capital funds, four basic stages can be distinguished:

1. Acquisition of capital from investors, conducted in parallel with the process of finding attractive investment targets;
2. Launching of funds (selection of business plans, analysis of potential investments, negotiations and structuring of investments, possibly additional capital calls from investors, investing accumulated capital);
3. "Driving" investments - building the value of portfolio companies;
4. Exit from investment.

Private equity funds raise funds from external financial institutions - the so-called Limited Partners (LP). This group includes wealthy institutions such as pension funds, state property funds, foundations, insurance companies as well as private persons with sufficient assets, i.e. High Net Worth Individuals (HNWI). The founders of the fund (General Partners) also provide a certain part of own funds (most often it is about 1-5% of the fund's value). The company's partners (GP) can raise capital in person through the so-called roadshows with potential investors, or to use for this purpose external entities, the so-called placements agents, i.e. companies experienced in raising capital, whose task is to present fund managers to investors, as well as to provide additional services in the form of preparing advertising materials, formulating marketing strategies, and organizing roadshows. The capital bar that allows access to private equity fund is usually set very high (at the level of tens or even hundreds of millions of US dollars) in order to exclude the participation of small investors.

Funds that are physically deposited in the fund are called "contributed capital", as opposed to declared "committed capital". The ability to join an existing fund depends on the level of achieving the target fund size. Many funds announce the so-called first close, meaning the achievement of a certain minimum level of capital to start the investment. New shareholders may declare the payment of financial resources to the fund during this period, as opposed to final close, when the maximum capital has been reached and there is no possibility of joining the fund. It is worth emphasizing that there are many restrictions with regard to investment opportunities of private equity funds to prevent the temptation of abuse.

The structure of private equity funds includes groups of alternative investment methods; which include leveraged buyout funds, growth capital funds, venture capital, as well as some real estate investment funds, special debt financing funds (mezzanine, threatened companies), and other types of special funds (Table 1). The first three groups of funds are the most important. The basic scheme of leveraged buyout funds includes the acquisition of controlling packages of mature, stable and large enterprises with good prospects for future cash flows. The fund may enter into this transaction alone or in cooperation with other private equity companies, using a combination of debt financing in the form of bank loans or bonds with different maturity and seniority dates (e.g. senior or subordinated bonds), equity (contributed by partners and shareholders), and hybrid instruments (mezzanine). In line with their name, this type of funds purchase companies using primarily borrowed funds supplemented with a small own capital contribution. Relations between debt and equity involved are usually around the level of 80/20. The security of borrowed funds are assets and future cash flows of the acquired companies as well as special clauses guaranteeing seniority of lenders' claims, in the event of liquidation bankruptcy.

Table 2. Investment strategies of private equity funds

Strategy	Subject of investment	Mode of financing	Market conditions favorable for operation
Leveraged Buy Out (LBO)	Large, mature and stable enterprise	Debt with the addition of equity. High leverage	Low interest rates and good condition of enterprises
Venture capital	Small and medium enterprises. Start-ups	Financing with equity at various stages of company development	Active and liquid capital markets, an intense process of merging and acquisition in the market
Financing capital growth	Mature companies with proven business models seeking capital for development or restructuring of operations, expansion into new markets or acquisitions	Financing with equity, most often acquisition of minority shares	Active and liquid capital markets, an intense process of merging and acquisition in the market, good condition of enterprises
Mezzanine funds	Leveraged Buy Out, venture capital funds, direct investments	Debt financing with the possibility of converting into equity	Active and liquid capital markets, an intense process of merging and acquisition in the market
Special funds	Enterprise in bad financial condition, requiring restructuring, special projects, one-off investments	Debt financing and equity - depending on the needs	The increased insolvency of enterprises, sectoral innovations as well as regulatory and legal changes on the markets
Funds of funds	Private equity funds	Equity	Various

Source: J. Gray, D. Rodgers Introduction to Private Equity and Infrastructure Investing, SOA Investment Symposium 2015

The financial contribution of the fund to the development of the company allows overcoming the cost barrier, the so-called pre-commercialisation phase "proof-of-concept" consisting in demonstrating the correctness of the solution idea (material and non-material). Its authors should prove the possibility of implementing the concept and the ability to achieve the assumed results and gain the interest of potential clients. VC funds investing in projects that successfully passed the pre-commercialisation phase provide the means to expand the business and maximize the growth potential. Support techniques for investment portfolio companies include searching for new potential clients and partners, assistance in recruiting highly qualified technical and managerial staff as well as training indicating the possibilities of expanding and professionalizing various corporate functions (e.g. finance, marketing, sales, HR, legal department).

Growth equity funds (GE) can be described as an intermediate link or bridge between LBO and VC entities. Similarly to Leveraged Buy Out, the main objective of the investment is stable and relatively large companies with proven business models, seeking capital for expansion or restructuring, planning to enter new markets or significant acquisitions. Revenues and profits generated by these companies may not be sufficient to finance large-scale business expansion. Similarly to VC entities, funds for financing growth are involved on a minority basis, however the selection of investment goals is not limited to industries with high growth potential, and the objects of investments are not start-ups, but usually mature companies - often market leaders in a given industry.

In many cases, the amounts needed to maximize the company's potential exceed many times its ability to generate free cash flow, so access to the capital of private equity funds can be crucial for the necessary development of production facilities, increase in sales, development of marketing activities, purchase of equipment and introduction of new products. The funds raised from the investor can also be used to restructure the company's balance sheet, in particular, to reduce the leverage. The equity funds involved in this case most often have the form of privileged shares, although some investors also prefer different hybrid instruments of a debt nature, where the promised payments (i.e. interest) also include the option of converting into shares of the company.

Funds are not interested in participating in company management bodies and offering assistance in operational activities, but rather focus on providing financing, often using financial engineering instruments, and the scale of their involvement is counted in hundreds of millions of US dollars, which results in their dominant position in the context of the potential entry of the company to the stock exchange. Exits from the investment are made after 5-7 years by introducing the financed enterprise to the public market, its sale to the next owner or merger with another enterprise, or decapitalization.

Private equity investments are often carried out through closed-end non-public investment funds. In this type of funds, the proposal to acquire certificates can be addressed to a maximum of 149 investors. According to the position of the Polish Financial Supervision Authority, detailed information on them cannot be publicly available. They are characterized by high entry (minimum first payment) and exit barriers.

Long-term external financing

The majority of enterprises seeking sources of financing for the development, introduction of modern technologies and methods of production and distribution use various forms of external long-term financing. Engaging such capital is necessary to finance investments, mainly property and sometimes financial in nature.

The development of enterprises with the use of borrowed capital is gaining more and more supporters. Financing with the borrowed capital gives the opportunity to use the leverage effect. An enterprise that incurs a credit or a loan to finance its development - with more capital resources - can gain new clients quicker and serve them more efficiently. As a consequence, the company achieves better financial results than a company which develops only with its own financial resources. In the first stage, the use of borrowed capital gives temporary deterioration of the ratios, after which - if the money is used correctly - the situation clearly improves.

Long-term borrowed capital is obtained in various forms. The most important ones include bank credits, loans and leasing which is increasingly used in Poland. The various forms of long-term financing are available to enterprises to varying degrees and usually have a different price. Taking into account these factors, as well as many others, it is necessary to choose the forms of financing and their scope, so that by optimizing the structure of capital, to affect the increase in profitability of own capital.

Debit

The term bank credit is defined in art. 69.1 of the Banking Law. Pursuant to it "by the credit agreement, the bank obliges to make available to the borrower for the period specified in the contract the amount of cash for the specified purpose, and the borrower obliges to use it under the terms of the contract, repay the amount of the credit used, including interest at specified repayment dates, and payment of commission on the credit granted ". Incurring a credit consists in the bank disposal of cash to the borrower under certain conditions (including specified time, declared aim), and the borrower undertakes to use it on the terms specified in the contract, to return the amount of credit used, including interest, in accepted repayment dates, payment of commissions on the credit granted, and to provide to the bank the necessary information used to assess its creditworthiness. The most important features of the credit include: purposefulness, payment and repayability.

Obtaining a credit is connected with incurring some additional costs resulting from the procedure of granting the credit (e.g. availability fee, management fee, fee for preparing a creditworthiness certificate). In addition, when assessing profitability, the interest rate of the credit must be taken into account. By minimizing the risk, banks may also require own contribution .

Cash loan

Cash loan is defined as “a contract under which a lender obliges to transfer a certain amount of money to a borrower, and the borrower obliges to return the same amount of money and pay interest to the bank". The main difference between a cash loan agreement and a bank credit agreement is that under the loan agreement the ownership of the subject of the loan is transferred to the borrower, and as a result of the credit agreement, the credit amount is available to the borrower. Thus, the bank has the right to interfere in the manner of using funds left at the disposal, which cannot be made by the creditor on the basis of the loan agreement .

Leasing

Enterprises show an increasing interest in the leasing form of financing. It results from a more flexible approach of leasing companies to the client than in case of banks, and the procedures for obtaining it are shorter and less complicated. The increased competition in this market among leasing companies is also significant.

Leasing is a civil law contract in which the financing party transfers the right to use a fixed asset in a specified period in return for leasing installments paid by a user. The formalities related to leasing are simpler compared to the credit. Leasing does not require any security other than the fixed asset itself. Using the product in this way is possible in two options: operational or financial leasing .

Financial leasing is granted for a period longer than one year (close to the standard period of use) and involves the introduction of the leased asset to the fixed assets register and amortizing it by a user. At the same time, after payment of the last installment, the subject of the lease may become the property of the user . Operational leasing (in tax terms) is a type of lease where the lease payments fully constitute the cost of obtaining revenue of the user, and the leased item (the subject of the lease) remains the property of the financing party during the contract period, who makes depreciation deductions from it ; after the contract expires, the ownership of the leased item may be transferred to the user (lessee).

In addition, a combination of these two forms of leasing, i.e. mixed leasing, can be distinguished. For accounting purposes, this is a financial lease, and for tax purposes - an operational one. Mixed-lease transactions are divided into two phases. The first one is an operational lease agreement which does not end with the transfer of ownership to the lessee. In the second phase, the same item is subject to financial leasing, but at a lower level of its value, taking into account current payments. The mixed leasing ends with the automatic transfer of the item ownership to the lessee.

Among the forms of leasing, direct and indirect leasing should also be distinguished. With respect to the direct leasing, the producer of the leased asset is also the lessor. In case of indirect leasing, a minimum of three entities participate in the transaction, i.e. a supplier, a user and a leasing company. The leasing company purchases from the producer the given asset, indicated by the future user, and then transfers the purchased item to the user .

Crowdfunding

Crowdfunding is one of the innovative forms of financing investment projects. The very concept of crowdfunding is defined as follows "type of collection and allocation of capital transferred for the development of a specific venture in return for a specific returnable service, which involves a wide group of capital providers, is characterized by the use of Information and Communication Technologies (ICT) and a lower barrier to entry and better transaction conditions than generally available on the market ”.

Crowdfunding involves raising funds from the Internet users who transfer micro-payments for a designated purpose. The project is financed by a large number of small, single payments made by people who consider a given project as creative, credible, and transparent. The project must be completed before the deadline, otherwise the auction will be closed and all contributions will be returned.

Crowdfunding as a new mechanism of obtaining funds is characterized by certain features that distinguish it from public collections, donations or other traditional forms of financing.

The characteristics of crowdfunding are :

- Handing over cash, almost always in a dematerialized form. It is not possible to provide support in a different form, for example, material or other means.

- The whole process of raising capital takes place using ICT solutions.
- The aim of a project funded under crowdfunding is clearly defined, the appropriation of funds and the effects of their spending are also clearly defined.
- Crowdfunding does not require the consent of any state body and may be run for personal, business or public purposes.
- A wide community of message recipients - information about the project is available to a very large group of people.
- No restrictions on access to project support.
- The possibility of project support is presented in an open manner, addressed to an unmarked addressee.

The terms of raising capital under crowdfunding are better, more advantageous than generally available market conditions.

Crowdfunding can take many forms :

1) Donations model, also called a charity model - the most popular model, it consists in financial support of a given project with a specific, philanthropic aim. In a traditional donations model, participants are not rewarded;
   a) Non-rewards model - participants are not rewarded;
   b) Reward-based model - also called a sponsorship model, in which participants receive support in the form of material prizes, i.e. for example records, books, concert tickets etc.;
2) Lending model – offers the option of borrowing funds directly from the online community, without banks, shadow banking system or other intermediary organizations in obtaining money; two variations can be distinguished here:
   a) microfinance – the essence of the model consists in financial aid for the poorest, small sums are distributed;
   b) social lending – large financial amounts are considered; funds are collected and then lent to interested parties under certain conditions; loans may be granted for consumption or business purposes.
3) Investments model – Internet users using investment platforms invest their own funds in specific projects and ventures in anticipation of specific financial profits; this is a common method of financing start-ups; three variations can be distinguished in this model:
   a) collective investment – it involves various groups of people, including business angels, investing relatively small sums in the development of a company or a specific project;
   b) investment fund – the essence is the collective placement of funds and joint investment, there may be a situation, in which the electronic platform is organized as an investment fund (e.g. venture capital funds); in this model, in return for investing in a given project, funders expect a share in profits, e.g. shares, securities;
   c) securities model – involves the sale of shares and transfer of ownership to online investors, the funds invested are usually high.
4) Mixed solutions – it consists in combining the above models.

The total scale of support in Polish crowdfunding platforms is only counted in millions of zlotys; only slightly over 40 percent ends with success fundraising project must be atypical, preferably unconventional.

Long-term rental, lease, lending

Long-term rental, lease and lending are not a way to finance a fixed asset, but are a way to own and use it. The long-term rental consists in paying by a tenant a specific rent for a specified period of use of a fixed asset. The tenant bears the operating costs, for example of a machine, while the costs of repairs are the responsibility of a landlord. The lease differs from the rental in that the renovation costs rest on the lessee, who additionally pays a specific rent to the lessor. The lending is a free use of a given fixed asset. A person who is a user of a given machine or device bears the costs associated with its operation .

European funds and government grants

The aquaculture support forms, in the form of EU funds and preferential credits, have been discussed on the example of Poland. This is due to the access to detailed data and knowledge of legal regulations in this area.

EU funds

Example - Poland:

Entrepreneurs can support the company's development by acquiring external sources of financing. Since 2004, the importance of non-returnable assistance programs for companies co-financed from the European Union funds has been growing. Subsidies are directed to various industries and sectors of the economy, including investments in fixed assets, implementation of innovations, internationalization of economic activity and development of human resources. Polish enterprises from the fisheries, aquaculture and fish processing sectors can now use Operational Program "Fisheries and Sea" for 2014-2020 assumes the implementation of six priorities:

I. Promoting sustainable, innovative and competitive fisheries;
II. Supporting sustainable, innovative and competitive aquaculture;
III. Supporting the implementation of the Common Fisheries Policy;
IV. Employment and territorial cohesion in fisheries areas;
V. Supporting marketing and processing;
VI. Integrated Maritime Policy.

The source of financing for the program is the European Maritime and Fisheries Fund (EMFF) for 2014-2020, which replaced the European Fisheries Fund, implemented in 2007-2013. Poland has been awarded over 531 million euros, which together with the contribution from the national budget (about 179 million euros) gives approx. 710 million euros .

The priority aimed at supporting the aquaculture area is Priority II. Supporting environmentally sustainable, innovative, resource-efficient, competitive aquaculture, based on knowledge

The general objective of Priority 2 is to achieve and maintain Poland's leading position in the European Union in the production of fish from inland aquaculture. As part of this priority, the following areas were selected (specific objectives), for which financial support was targeted:

- supporting the strengthening of technological development, innovation and knowledge transfer;
- increasing the competitiveness and profitability of aquaculture enterprises, including improving safety and working conditions, in particular in SMEs;
- protecting and restoring water biodiversity and supporting ecosystems related to aquaculture and promoting resource efficient aquaculture;
- promoting aquaculture with a high level of environmental protection and high level of animal health and welfare;
- development of training and new professional skills.

Description of activities implemented under Priority 2

Operation: Innovation.

Co-financing under this operation is directed to scientific institutes and entities conducting farming or breeding activities operating within the consortium. Such a definition of the beneficiary enables a comprehensive approach to research on the effectiveness of applying specific innovation in aquaculture farms, enabling monitoring at every stage of the work - from the creation of a given solution to technology transfer and practical implementation.Operation: Management, substitution and advisory services for aquaculture farms.

As part of this operation, advisory projects for aquaculture enterprises are implemented, aimed at improving their profitability and competitiveness.

Operation: Production investments in aquaculture, including:

- increasing energy efficiency, renewable energy sources;
- effective resource management, reduction of water and chemicals consumption, recirculation systems minimizing water consumption.

One of the factors causing the increase in production is the increase of investment expenditures, therefore operations carried out under this measure are of key importance for the development of aquaculture - their main objective is a significant increase in production. The beneficiaries of the activity may be both current and future fish farmers.

Due to the wide spectrum of assumed results of financial intervention, investment operations were divided into three groups (sub-measures) under the above-mentioned measure. As part of the first one, operations contributing to increasing the competitiveness and profitability of enterprises, including improving safety and working conditions, are conducted.

Under the second group (sub-measure), operations related to increasing energy efficiency and renewable energy sources are performed. This sub-measure is crucial for achieving the assumed "technological leap" of Polish aquaculture enterprises. The majority of new technologies - allowing for more efficient water management as well as reducing pressure on the environment - require the use of electricity, raising both costs and indirectly the impact of the business on the environment (by increasing energy intensity). Combining the use of modern technologies of breeding and rearing fish with renewable energy sources will help with improving the energy balance of aquaculture enterprises - both in terms of cost balance and environmental impact.

However, operations carried out under the sub-measure - effective resource management, reduction of water and chemicals consumption, recirculation systems minimizing water consumption - were divided into two groups. As part of the first one aimed at increasing production - co-financing included projects involving the construction of facilities for fish farming in RAS systems, while in the second group, aimed at improving the efficiency of water management and reducing the impact on the environment - projects that have a positive impact on the environment or reduce the negative impact of aquaculture on the environment were subsidized.

Operation: Encouraging new breeders to start their activities in the sustainable aquaculture sector.

Assistance under this measure is an important supplement to the project designed in the current financial perspective - broad support for investment activities that increase the production of aquaculture. The purpose of its launch is to provide the possibility of obtaining financial support also for entities that are just starting their activity, and thus do not meet the criterion of promoting experience, included in the methodology of selecting operations in relation to other investment activities covered by co-financing under Priority 2.

Operation: Aquaculture providing environmental services.

Assistance under this measure is financial compensation paid to the beneficiaries for the use of production methods that help to protect and improve the state of the environment, preserve biodiversity and promote ecological production practices in the fish farming or breeding sector. Support is granted to owners of farms with a registration area of at least 1 ha, in which the basic principles of good fishing practices are applied.

Operation: Promotion of human capital and networking.

Operations carried out in the scope of this activity - are aimed at financial support for aquaculture fishing organizations in propagating knowledge on sustainable fish farming and breeding. At the same time, in order to increase the efficiency of resources allocated to this action, the criteria used in the call for proposals - primarily promote organizations associating the largest group of aquaculture entrepreneurs and trainings gathering a large number of potential recipients of training.

Operation: Insurance of aquaculture resources.

A novelty within the framework of the financial perspective 2014-2020 is assistance addressed to fish producers, granted in the form of co-financing the insurance premium for aquaculture resources. The insurance may cover economic losses arising, among others, in connection with natural disasters, adverse climatic phenomena or diseases in aquaculture.

Preferencial credits

Polish aquaculture enterprises may also profit from sources of funding preferencial credits. A preferential credit is a type of credit granted by a bank on more favorable terms than market conditions. It is dedicated to specific bank clients, in this case to farmers / fish farmers. Granting credit on preferential terms is usually associated with the need to meet additional formal requirements, not occurring when applying for credit under market conditions.

Benefits for a fish farmer: better conditions that can be obtained may concern: interest rate, general terms of the contract, credit repayment schedule, required collateral, the possibility of using the so-called grace period or prolongation.

Preferential credits are mostly used for: purchase of land, construction and modernization of buildings, as well as purchase of machinery and equipment.

Example

The Polish Agency for Restructuring and Modernization of Agriculture (ARMA) uses national funds to support investments in agriculture, special agricultural production and inland fishing as well as processing of agricultural products, fish, crustaceans and molluscs. Preferential credits in parallel with the co-financing of investments from EU programs are an important source of financing for projects in agriculture, special departments of agricultural production, inland fishing and processing of agricultural products, fish, crustaceans and molluscs.

The Agency's assistance in paying back preferential credits consist in ARMA paying back

*part of **interest** (subsidies to interest rate of credit). Preferential credit lines with interest rate subsidies:*

***RR -** for investments in agriculture and inland fisheries*

***Z** - for the purchase of agricultural land*

***PR**- for investments in the processing of agricultural products, fish, crustaceans and mollusks, as well as for the purchase of shares*

Interest

1. The credit interest rate is variable and cannot be more than the WIBOR 3M reference rate increased by no more than by 2.5 percentage points. When setting the interest rate, the reference rate WIBOR 3M is applied, published on the last working day of the second month of the quarter, which is subject to changes in the loan period according to the WIBOR 3M reference rate announced on the last working day of the second month preceding each subsequent quarter.

2. The interest rate due to the bank is paid by:

1) borrower in the amount of 0.67 of the interest rate, referred to in paragraph 1, however not less than 3%, and in case when the interest calculated in accordance with the method set out in paragraph 1 is below 3% - in the amount of this interest rate,

2) Agency – in the remaining part.

The crediting and grace period

1. The credit may be granted for a maximum of 15 years.

2. Credit grace period, which counts from the date of the credit agreement to the date of the first installment of the capital specified in the credit agreement, cannot exceed 2 years.

The amount of credit

1. The amount of credit cannot exceed:

2) in case of investments carried out in the special section of agricultural production or in inland fisheries - 70% of the value of investment expenditures and amount to more than 8 million PLN, subject to paragraph 7,

2. If the entity uses preferential credits, the sum of the amounts of credits granted with subsidies or partial repayment of capital and the newly granted credit, may not exceed 8 million PLN for the entity, which uses credits for investments in inland fisheries,

Financial forecast for selected RAS business models

The financial forecasts for breeding in RAS facilities are presented below. These forecasts were prepared for 10 years of full activity. It should be remembered that they are based on assumptions described in the chapter "RAS business model - basic concepts for operating cost account". Although the profit and loss account was prepared on the basis of the best knowledge regarding particular parameters influencing operating costs, including detailed analysis of literature data and surveys conducted in Germany, Poland, Denmark and Lithuania among MSEs, it should be remembered that in real conditions the results may differ from the presented ones values. It should also be remembered that the most sensitive cost for local conditions, i.e. the cost of labor, has been taken into account for Poland. The value of fish sales was also adopted for the Polish market.

Financial costs options were assumed for various financing models - the option number corresponds to the description in the chapter “Analysis of the adequacy of financing sources for RAS activity”.

Table 3. Financing option I for African catfish – 50 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	73 256	105 698	106 755	107 822	108 900	109 989	111 089	112 200	113 322	114 455
Operation costs	0	0	105 206	108 712	110 085	111 480	112 895	114 332	115 790	117 270	118 772	120 297
Profit /lossfrom sales	0	0	-31 950	-3 014	-3 331	-3 658	-3 995	-4 342	-4 701	-5 070	-5 450	-5 841
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-31 950	-3 014	-3 331	-3 658	-3 995	-4 342	-4 701	-5 070	-5 450	-5 841
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	40 384	5 936	5 936	5 937	5 937	7 860	3 105	3 105	3 105	3 105	3 105
Gross result	0	**-40 384**	**-37 886**	**-8 950**	**-9 268**	**-9 595**	**-11 855**	**-7 447**	**-7 805**	**-8 174**	**-8 555**	**-8 946**

- currency – euro
- term:
    - 1-2 – investment preparation (investment phase)
    - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing
    - Leasing (machinery, equipment) entry fee 20%, 192187,26 Euro;
    - credit 54276,76 Euro,
    - own funds 59173,13 Euro

Table 4. Financing option II for African catfish – 50 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	73 256	105 698	106 755	107 822	108 900	109 989	111 089	112 200	113 322	114 455
Operation costs	0	0	105 206	108 712	110 085	111 480	112 895	114 332	115 790	117 270	118 772	120 297
Profit /lossfrom sales	0	0	-31 950	-3 014	-3 331	-3 658	-3 995	-4 342	-4 701	-5 070	-5 450	-5 841
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-31 950	-3 014	-3 331	-3 658	-3 995	-4 342	-4 701	-5 070	-5 450	-5 841
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	3 812	5 718	5 718	5 718	5 718	5 718	5 718	5 718	5 718	5 718	5 718
Gross result	0	**-3 812**	**-37 668**	**-8 732**	**-9 049**	**-9 376**	**-9 713**	**-10 061**	**-10 419**	**-10 788**	**-11 168**	**-11 560**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing
  - Own funds 131439,52 Euro;
  - preferential credit 190612,65 Euro

Table 5. Financing option III for African catfish – 50 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	73 256	105 698	106 755	107 822	108 900	109 989	111 089	112 200	113 322	114 455
Operation costs	0	0	96 644	100 150	101 524	102 919	104 334	105 770	107 229	108 709	110 211	111 736
Profit /lossfrom sales	0	0	-23 389	5 547	5 231	4 904	4 567	4 219	3 861	3 492	3 111	2 720
Other operating income	0	136 152	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	136 152	-23 389	5 547	5 231	4 904	4 567	4 219	3 861	3 492	3 111	2 720
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	4 812	7 788	7 788	7 788	7 788	7 788	7 788	7 788	7 788	7 788	7 788
Gross result	0	**131 340**	**-31 177**	**-2 240**	**-2 557**	**-2 884**	**-3 221**	**-3 569**	**-3 927**	**-4 296**	**-4 677**	**-5 068**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - Own funds 33333,33 Euro
  - Investment credit 136151,90 Euro
  - EU funds 136151,90 Euro

Table 6. Financing option I for African catfish – 100 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	146 512	211 395	213 509	215 644	217 801	219 979	222 179	224 400	226 644	228 911
Operation costs	0	0	189 520	207 023	209 797	212 612	215 469	218 370	221 313	224 301	227 334	230 412
Profit /lossfrom sales	0	0	-43 008	4 372	3 713	3 032	2 331	1 609	865	99	-690	-1 502
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-43 008	4 372	3 713	3 032	2 331	1 609	865	99	-690	-1 502
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	50 874	8 656	8 656	8 656	8 656	11 040	5 140	5 140	5 140	5 140	5 140
Gross result	0	**-50 874**	**-51 664**	**-4 284**	**-4 943**	**-5 624**	**-8 709**	**-3 531**	**-4 275**	**-5 041**	**-5 830**	**-6 641**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing: Leasing (machinery, equipment) entry fee 20%, 238409,86; credit 89858,14 Euro; own funds 71008 Euro

Table 7. Financing option II for African catfish – 100 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	146 512	211 395	213 509	215 644	217 801	219 979	222 179	224 400	226 644	228 911
Operation costs	0	0	189 520	207 023	209 797	212 612	215 469	218 370	221 313	224 301	227 334	230 412
Profit /lossfrom sales	0	0	-43 008	4 372	3 713	3 032	2 331	1 609	865	99	-690	-1 502
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-43 008	4 372	3 713	3 032	2 331	1 609	865	99	-690	-1 502
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	5 030	7 545	7 545	7 545	7 545	7 545	7 545	7 545	7 545	7 545	7 545
Gross result	0	**-5 030**	**-50 553**	**-3 173**	**-3 832**	**-4 512**	**-5 213**	**-5 936**	**-6 680**	**-7 446**	**-8 235**	**-9 046**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing: Own funds 147782,73 Euro, preferential credit 251493 Euro

Table 8. Financing option III for African catfish – 100 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	146 512	211 395	213 509	215 644	217 801	219 979	222 179	224 400	226 644	228 911
Operation costs			178 462	195 965	198 739	201 554	204 411	207 312	210 255	213 243	216 276	219 354
Profit /lossfrom sales	0	0	-31 950	15 430	14 771	14 091	13 390	12 667	11 923	11 157	10 368	9 556
Other operating income	0	179 638	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	179 638	-31 950	15 430	14 771	14 091	13 390	12 667	11 923	11 157	10 368	9 556
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	6 334	10 275	10 275	10 275	10 275	10 275	10 275	10 275	10 275	10 275	10 275
Gross result	0	**173 304**	**-42 225**	**5 155**	**4 495**	**3 815**	**3 114**	**2 392**	**1 648**	**882**	**93**	**-719**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing: Own funds 40.000,00 Euro, investment credit 179637,88 Euro, EU funds 179637,88 Euro

Table 9. Financing option I for African catfish – 350 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	512 791	739 884	747 283	754 755	762 303	769 926	777 625	785 401	793 255	801 188
Operation costs	0	0	548 998	626 923	635 739	644 687	653 769	662 988	672 344	681 842	691 481	701 265
Profit /lossfrom sales	0	0	-36 207	112 961	111 544	110 068	108 534	106 938	105 281	103 560	101 774	99 923
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-36 207	112 961	111 544	110 068	108 534	106 938	105 281	103 560	101 774	99 923
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	95 995	14 374	14 374	14 374	14 374	18 936	7 694	7 694	7 694	7 694	7 694
Gross result	0	**-95 995**	**-50 582**	**98 586**	**97 169**	**95 694**	**89 598**	**99 244**	**97 587**	**95 866**	**94 080**	**92 229**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing: Leasing (machinery, equipment): entry fee 20%, value 456199,7 Euro; credit – value 134509,3 Euro; own funds 88759 Euro

Table 10. Financing option II for African catfish – 350 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	512 791	739 884	747 283	754 755	762 303	769 926	777 625	785 401	793 255	801 188
Operation costs	0	0	548 998	626 923	635 739	644 687	653 769	662 988	672 344	681 842	691 481	701 265
Profit /lossfrom sales	0	0	-36 207	112 961	111 544	110 068	108 534	106 938	105 281	103 560	101 774	99 923
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-36 207	112 961	111 544	110 068	108 534	106 938	105 281	103 560	101 774	99 923
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	8 813	13 219	13 219	13 219	13 219	13 219	13 219	13 219	13 219	13 219	13 219
Gross result	**0**	**-8 813**	**-49 426**	**99 742**	**98 325**	**96 850**	**95 315**	**93 719**	**92 062**	**90 341**	**88 556**	**86 704**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing: Own funds 238840,60 Euro; preferential credit value 440628,08 Euro

Table 11. Financing option III for African catfish – 350 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	512 791	739 884	747 283	754 755	762 303	769 926	777 625	785 401	793 255	801 188
Operation costs	0	0	520 852	598 777	607 593	616 541	625 623	634 842	644 198	653 695	663 335	673 119
Profit /lossfrom sales	0	0	-8 061	141 107	139 690	138 215	136 680	135 084	133 427	131 706	129 921	128 069
Other operating income	0	314 734	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	314 734	-8 061	141 107	139 690	138 215	136 680	135 084	133 427	131 706	129 921	128 069
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	11 063	18 003	18 003	18 003	18 003	22 565	18 003	18 003	18 003	18 003	18 003
Gross result	**0**	**303 672**	**-26 064**	**123 104**	**121 687**	**120 212**	**114 115**	**117 082**	**115 424**	**113 703**	**111 918**	**110 066**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing: Own funds 50000 Euro; investment credit 314734,35, EU funds 314734,35 Euro

Table 12. Financing option I for Vannamei shrimp – 3 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	63 000	90 900	91 809	92 727	93 654	94 591	95 537	96 492	97 457	98 432
Operation costs	0		96 060	96 492	97 558	98 640	99 739	100 854	101 986	103 135	104 301	105 484
Profit /lossfrom sales	0	0	-33 060	-5 592	-5 749	-5 913	-6 085	-6 263	-6 449	-6 643	-6 844	-7 053
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-33 060	-5 592	-5 749	-5 913	-6 085	-6 263	-6 449	-6 643	-6 844	-7 053
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	5 430	8 145	8 145	8 145	8 145	8 145	8 145	8 145	8 145	8 145	8 145
Gross result	**0**	**-5 430**	**-41 205**	**-13 737**	**-13 894**	**-14 058**	**-14 230**	**-14 408**	**-14 594**	**-14 788**	**-14 989**	**-15 198**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - Leasing (machinery, equipment) entry fee 20%, Euro 53255,81;
  - credit 89858,14 Euro,
  - own funds 53255,81 Euro

Table 13. Financing option II for Vannamei shrimp – 3 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	63 000	90 900	91 809	92 727	93 654	94 591	95 537	96 492	97 457	98 432
Operation costs	0	0	83 361	83 792	84 859	85 941	87 040	88 155	89 287	90 435	91 601	92 785
Profit /lossfrom sales	0	0	-20 361	7 108	6 950	6 786	6 615	6 436	6 250	6 057	5 856	5 647
Other operating income	0	205 557	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	205 557	-20 361	7 108	6 950	6 786	6 615	6 436	6 250	6 057	5 856	5 647
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	11 805	11 758	11 758	11 758	11 758	11 758	11 758	11 758	11 758	11 758	11 758
Gross result	0	**193 752**	**-32 119**	**-4 650**	**-4 808**	**-4 972**	**-5 143**	**-5 322**	**-5 508**	**-5 701**	**-5 902**	**-6 111**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - Own funds 134706,02 Euro;
  - preferential credit 271500,69 Euro

Table 14. Financing option III for Vannamei shrimp – 3 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	63 000	90 900	91 809	92 727	93 654	94 591	95 537	96 492	97 457	98 432
Operation costs	0	0	83 361	83 792	84 859	85 941	87 040	88 155	89 287	90 435	91 601	92 785
Profit /lossfrom sales	0	0	-20 361	7 108	6 950	6 786	6 615	6 436	6 250	6 057	5 856	5 647
Other operating income	0	205 557	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	205 557	-20 361	7 108	6 950	6 786	6 615	6 436	6 250	6 057	5 856	5 647
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	11 805	11 758	11 758	11 758	11 758	11 758	11 758	11 758	11 758	11 758	11 758
Gross result	0	**193 752**	**-32 119**	**-4 650**	**-4 808**	**-4 972**	**-5 143**	**-5 322**	**-5 508**	**-5 701**	**-5 902**	**-6 111**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - Own funds 3000,00 Euro;
  - investment credit 205557 Euro;
  - EU funds 205557,00 Euro

Table 15. Financing option I for Vannamei shrimp – 15 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	283 500	409 050	413 141	417 272	421 445	425 659	429 916	434 215	438 557	442 943
Operation costs	0	0	434 011	463 712	467 705	471 758	475 873	480 048	484 287	488 589	492 955	497 387
Profit /lossfrom sales	0	0	-150 511	-54 662	-54 565	-54 487	-54 428	-54 389	-54 371	-54 374	-54 398	-54 445
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-150 511	-54 662	-54 565	-54 487	-54 428	-54 389	-54 371	-54 374	-54 398	-54 445
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	246 990	42 315	42 315	42 315	42 315	53 881	25 443	25 443	25 443	25 443	25 443
Gross result	0	**-246 990**	**-192 825**	**-96 976**	**-96 879**	**-96 801**	**-108 309**	**-79 832**	**-79 814**	**-79 816**	**-79 841**	**-79 887**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - Leasing (machinery, equipment) entry fee 20%, Euro 686000,00
  - credit 444800,00 Euro,
  - own funds 59173,13 Euro

Table 16. Financing option II for Vannamei shrimp – 15 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	283 500	409 050	413 141	417 272	421 445	425 659	429 916	434 215	438 557	442 943
Operation costs	0	0	302 353	332 054	336 047	340 101	344 215	348 390	352 629	356 931	361 297	365 729
Profit /lossfrom sales	0	0	-18 853	76 996	77 093	77 171	77 230	77 269	77 287	77 284	77 260	77 213
Other operating income	0	0	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	0	-18 853	76 996	77 093	77 171	77 230	77 269	77 287	77 284	77 260	77 213
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	15 831	23 747	23 747	23 747	23 747	23 747	23 747	23 747	23 747	23 747	23 747
Gross result	0	**-15 831**	**-42 600**	**53 249**	**53 346**	**53 425**	**53 483**	**53 522**	**53 540**	**53 537**	**53 513**	**53 466**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - Own funds 398413,13 Euro;
  - preferential credit 791560,00 Euro

Table 17. Financing option III for Vannamei shrimp – 15 tones/year

Economic values / Year	1	2	3	4	5	6	7	8	9	10	11	12
Sales revenues	0	0	283 500	409 050	413 141	417 272	421 445	425 659	429 916	434 215	438 557	442 943
Operation costs	0	0	269 438	299 139	303 133	307 186	311 300	315 476	319 714	324 016	328 383	332 815
Profit /lossfrom sales	0		14 062	109 911	110 008	110 086	110 144	110 183	110 201	110 198	110 174	110 128
Other operating income	0	578 320	0	0	0	0	0	0	0	0	0	0
Other operating cost	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	0	578 320	14 062	109 911	110 008	110 086	110 144	110 183	110 201	110 198	110 174	110 128
Financial revenue	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs	0	20 335	33 080	33 080	33 080	33 080	33 080	33 080	33 080	33 080	33 080	33 080
Gross result	0	**557 985**	**-19 018**	**76 831**	**76 928**	**77 006**	**77 065**	**77 103**	**77 121**	**77 119**	**77 094**	**77 048**

- currency – Euro
- term:
  - 1-2 – investment preparation (investment phase)
  - 3-12 – lifetime (10 years)
- Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)
- Financing:
  - 3. Own funds 33333,33 Euro;
  - investment credit 578319,9 Euro;
  - EU funds 578319,90 Euro

Analysis of the adequacy of financing sources for RAS activity

The notion of the cost of capital is a key concept for financial decisions taken in the area of capital structure design. It can be said that the lower the cost of capital, the higher the effectiveness of ventures implemented by an enterprise. The cost of capital is calculated as the average cost determined on the basis of the capital structure and the cost of capital originating from different sources. The weighted average cost of capital is calculated on the basis of the following formula [Jajuga, Jajuga 2012]:

$$WACC = \sum_{t=1}^{n} w_i \, k_i$$

k_i- capital cost from i source,

w_i- share of capital from i source in the capital structure

In practice, the following formula is more often used:

$$WACC = w_d k_d (1 - T) + w_p k_p + w_e k_e$$

w_d- share of borrowed capital

w_p- share of capital from preference shares

w_e- share of own capital

k_d- cost of borrowed capital

k_p- cost of capital from preference shares

k_e- cost of own capital

T- income tax rate paid by a company.

WACC answers the question of what the minimum required rate of return which makes it profitable for a company to carry out projects is. The assets of the business entity are financed by debt or equity. WACC is the average cost of the company's capital, weighted respectively by the share of debt and equity in the capital structure of the company. The weighted average cost of capital is the minimum required rate of return at which it is profitable for the company to participate in new projects.

The concept of economic efficiency refers to the relationship between the value of expenditures incurred and the value of the effects obtained while incurring these expenditures. The economic and financial efficiency of innovative investments is measured by means of efficiency indicators. They characterize the size and time of obtaining economic effects as a result of incurred investment expenditures for the implementation of innovations [Szutro 2013].

Both in theory and practice, there are different methods for assessing the economic effectiveness of innovation. The basic division of assessment tools for investment projects is the division into static (non-discount) methods and dynamic (discount) [Jajuga, Jajuga 2008] methods. The main difference between these methods is to take into account the change in the value of money over time, which occurs as a result of positive inflation, i.e. a decline in the purchasing power of money, occurring in most countries of the world. This means that a given monetary unit is worth more today than it will be worth in future [Ibidem].

Due to the fact that static methods do not take into account the phenomenon of changes in the value of money over time, they are usually used for initial assessment of investment projects and for projects with a short time horizon. The following methods apply to innovative projects [Szutro 2013]:

- Return period,
- Accounting rate of return,
- Current and accumulated rate of return,
- Cost comparison account,
- Profit comparison account.

Dynamic methods in practice more often take into account the change in the value of money over time. They are of great importance in the modern economy and are used to assess the majority of investment projects. With regard to innovative projects, the most commonly used methods are [Ibidem]:

- Net present value (NPV),
- Internal rate of return (IRR),
- Profitability index,
- Modified internal rate of return.

The investment under study is profitable if: NPV>0. A positive NPV value means that the rate of return of this venture is greater than the limit rate determined by the discount rate accepted for the account. Therefore, any investment characterized by NPV greater than zero can be implemented, as it will bring specific financial benefits to the enterprise, thus increasing its value.

We can use NPV to determine the most economically efficient investment option. We can do this only if the compared development projects have the same (or very similar) value and time distribution of capital expenditures and calculation periods. The most profitable venture is characterized by the largest net present value:

$$\max \Rightarrow NPVmax$$

With NPV <0, the investment from the company's point of view is unprofitable and should be rejected. Therefore, if the profitability of several equivalent projects for which NPV ≥ 0 is compared, then the one with the largest NPV project will be the most effective one.

The internal rate of return (IRR) is such a discount rate for which the sum of present net flows is equal to 0 (i.e., NPV=0), or otherwise, the sum of present revenues equals the sum of present expenses. IRR shows directly the profitability rate of the projects under investigation (investment projects). The investment is profitable when the internal rate of return is higher than the border rate, which is the lowest possible rate of profitability accepted by the investor, which can be written as follows:

$$IRR>r$$

In order to determine the sources of financing the project and their percentage share in the entire undertaking, financial assembly was used. It is a process of integrating different sources and methods of financing in the implementation of a specific project in order to indicate the most favorable structure of financing sources.

Therefore, the aim of the financial assembly is to help in identifying and selecting financial institutions involved in financing the investment project and determining the proportion of funds from various sources of financing.

African catfish

Three variants of production of African catfish were analyzed:

1. 50 tons
2. 100 tons
3. 350 tons

The financial assembly includes the possibility of using the following sources of financing:

- equity,
- investment credit,
- preferential credit,
- leasing,
- EU funding.

In order to carry out the analysis, the following capital cost values were adopted:

- equity - the cost of lost profits is the highest on the market - 5% average dividend for 2018 given by the WSE on the basis of 6 largest enterprises (Pekao, PZU, GHM, PGE, PKO, Orange),
- investment credit - interest rate on WIBOR3M credit increased by a margin (in the annex the conditions for granting a credit)
- preferential credit - interest rate on the credit – 3% (in the annex the conditions for granting a preferential credit)

- leasing - percentage resulting from the concluded contract (the calculation includes the offer received for the leasing of machinery and equipment),
- EU funding - the cost of capital does not occur; funding 50%

The financial assembly included 3 financing options:

1. leasing, credit, own funds
2. own funds, preferential credit
3. own funds, investment credit, EU funding

Additional assumptions:

1. currency – EURO
2. term:
    a. 1-2 – investment preparation (investment phase)
    b. 3-12 – lifetime (10 years)
3. Polish conditions (no obligation to pay income tax, the opportunity to receive co-financing, the cost of credit, the cost of leasing)

As a result of the analysis, the following results were obtained regarding the investment in breeding African catfish.

Option I- annual production scale of 50 tons

Option I of the analysis assumed the production of African catfish in an amount of 50 tons annually. As a result of the analysis performed, it turned out that this option is unprofitable from an economic point of view (Table 3).

Table 18. African catfish financial option I

Option I- annual production scale of 50 tons			
financial assembly option	*1*	*2*	*3*
WACC	0.030	0.038	0.031
NPV	-150 320.79	-128 518.40	-81 643.39

1. Leasing (machinery, equipment) entry fee 20%, 192187,26 Euro; credit 54276,76 Euro, own funds (59173,13 Euro)

2. Own funds 131439,52 Euro; preferential credit 190612,65 Euro

3. Own funds 33333,33 Euro; investment credit 136151,9 Euro; EU funds 136151,9 Euro

The negative NPV value in each of the financial assembly options is indicative of a lower than the profitability margin of the venture. Implementation of an investment in an object with production capacity of 50 tons per year for breeding African catfish in this case is unprofitable from the point of view of the company's interests.

Option II – annual production scale of 100 tons

The second option presents an analysis of the effectiveness for the breeding of African catfish in the amount of 100 tons per year (Table 4).

Table 19. African catfish financial option II

Option II - annual production scale of 100 tons			
financial assembly option	*1*	*2*	*3*
WACC	0.0270	0.0374	0.0262
NPV	-151 717.89	-123 931.95	-54 060.20

1. Leasing (machinery, equipment) entry fee 20%, 238409,86; credit 89858,14 Euro; own funds 71008 Euro

2. Own funds 147782,73 Euro, preferential credit 251493 Euro

3. Own funds 40.000,00 Euro, investment credit 179637,88 Euro, EU funds 179637,88 Euro

The results presented prove a lack of financial rationality of the investment in question. With NPV <0, the investment from the company's point of view is unprofitable and should be rejected**.**

Option III – annual production scale of 350 tons

The third option adopts the large scale production of African catfish, at the level of 350 tons per year.

Table 20. African catfish financial option III

Option III - annual production scale of 350 tons			
financial assembly option	*1*	*2*	*3*
WACC	0.0289	0.0370	0.0302
NPV	542 527.45	548 776.50	647 466.14
IRR	11%	12%	21%

1. Leasing (machinery, equipment): entry fee 20%, value 456199,7 Euro;

credit – value 134509,3 Euro; own funds 88759 Euro

2. Own funds 238840,6 Euro; preferential credit value 440628,08 Euro

3. Own funds 50000 Euro; investment credit 314734,35, EU funds 314734,35 Euro

As the internal rate of return for all three options of financial assembly exceeds the discount rate, which is the weighted average cost of capital, projects are cost-effective.

As the venture characterized by the largest net present value is the most profitable:

max ⇒ NPVmax

For implementation it was necessary to adopt the third option, assuming the use of EU funds as one of the sources of financing. This option is also characterized by the highest IRR (21%). Therefore, the *production of 350 tons, with the help of EU funds, will be the most advantageous form of investment in breeding African catfish.*

Vannamei shrimps

The same assumptions were adopted to analyzing the breeding shrimps.

Two variants of production of shrimp were analyzed:

- 3 tons
- 15 tons

Option I – annual production scale of 3 tons

As a result of the analysis, the following results were obtained regarding the investment in breeding shrimp (table 6).

Table 21. Vannamei shrimps financial option I

Option I - annual production scale of 3 tons			
financial assembly option	*1*	*2*	*3*
WACC	0.029	0.038	0.030
NPV	-233 296.77	-162 314.98	-97 059.49

1. Leasing (machinery, equipment) entry fee 20%, Euro 53255,81; credit 89858,14 Euro, own funds 53255,81 Euro

2. Own funds 134706,02 Euro; preferential credit 271500,69 Euro

3. Own funds 3000,00 Euro; investment credit 205557 Euro; EU funds 205557,00 Euro

The negative NPV value in each of the financial assembly options is indicative of a lower than the profitability margin of the venture. Implementation of an investment in an object with production capacity of small scale, ie. 3 tons per year for breeding shrimp in this case is unprofitable from the point of view of the company's interests.

Option II – annual production scale of 15 tons

The second option presents an analysis of the effectiveness for the breeding of shrimp in the amount of 15 tons per year (Table 7).

Table 22. Vannamei shrimps financial option II

Option II- annual production scale of 15 tons			
financial assembly option	*1*	*2*	*3*
WACC	0.033	0,037	0,029
NPV	-74032.59	210 928,20	469 503,50
IRR	-	7%	15%

1. Leasing (machinery, equipment) entry fee 20%, Euro 686000,00 ; credit 444800,00 Euro, own funds 59173,13 Euro

2. Own funds 398413,13 Euro; preferential credit 791560,00 Euro

3. Own funds 33333,33 Euro; investment credit 578319,9 Euro; EU funds 578319,90 Euro

The negative value of NPV orders to refuse first option of financing, included leasing, credit and own founds. As the internal rate of return for options second and third of financial assembly exceeds the discount rate, which is the weighted average cost of capital, projects are cost-effective.

For implementation it was necessary to adopt the third option, assuming the use of EU funds as one of the sources of financing. This option is characterized by the highest IRR (15%) and highest NPV.

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Authors: Joanna Krupska, Tomasz Kulikowski (ed.), Olga Szulecka, Małgorzata Kieliszewska

Collaboration: Anna Ochman, Marcin Rakowski, Adam Mytlewski, Sylwia Stasiak

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ERDF

1 400 068,44 EUR

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Lead partner

Name: BioCon Valley GmbH

www.innoaquatech.eu

Address: Walther-Rathenau-Str. 49a, 17489 Greifswald

Region/Subregion: Landkreis Vorpommern-Greifswald

Country: Germany

Project partners

Name: University of Rostock, Faculty of Agricultural and Environmental Sciences, Aquaculture and Sea-Ranching

Address: Justus-von-Liebig-Weg 6, 18059 Rostock

Region/Subregion: Kreisfreie Stadt Rostock

Country: Germany

Name: Danish Technological Institute

Address: Maribovej 9, 4960 Holeby

Region/Subregion: Vest-og Sydsjalland

Country: Danmark

Name: Maritime Institute in Gdańsk

Address: Dlugi Targ 41/42, 80-830 Gdańsk

Region/Subregion: Gdański

Country: Poland

Name: University of Gdańsk

Address: Bażyńskiego 1a, 80-952 Gdańsk

Region/Subregion: Gdański

Country: Poland

Name: National Marine Fisheries Research Institute

Address: Kollataja 1, 81-332 Gdynia

Region/Subregion: Trójmiejski

Country: Poland

Name: Klaipeda Science and Technology Park / KSTP

Address: Vilhelmo Berbomo str. 10, 92221 Klaipeda

Region/Subregion: Klaipedos apskritis

Country: Lithuania