Feasibility analysis of basil and lettuce production in aquaponics system in Armenia

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Introduction

The main source of water supply for the fisheries located in Ararat Valley, Armenia are the artesian groundwater resources, that are distinguished by their high quality.

Over the last two years a significant amount of small and/or medium aquaculture enterprises located in Ararat Valley shut down, the main reason of which became the level of groundwater extraction in, that has been reduced approximately 67% in Ararat Valley, during last 20 years (ASPIRED 2016). In 2016, the actual level of groundwater abstraction in the Ararat Valley reached up to 1.6 billion cubic meters, about half of which was used by fish farms (ASPIRED 2016).

The main characteristic for the most of the fish farms in Armenia are the inefficient water use, that is typical for low-intensity aquaculture. Accordingly, the biggest problem that arises is negative environmental impact, because of huge amount of pure groundwater exploitation, that for many years exceeds the sustainability level of groundwater (artesian) water resources, as well as because of large volumes of wastewater from these production activities.

The most important steps that will support the future development of fish breeding industry in the country, are the efficient use of groundwater resources, as well as its quality protection.

Hereinafter, new activities should be set forth, in order to minimize the use of water resources by fish industry and make it more sustainable, that might be possible through the introduction of Aquaponics system. The development of an integrated aquaculture system, will lead to the reduction in volumes of discharge water and mitigation of negative environmental impact of aquaculture facilities. Operational water could be reused in several ways thus minimizing the negative environmental impact. Based on the Aquaponics system operation, the water, instead of being directly discharged into the drainage, is filtered and re-used for producing high-quality healthy crops.

Within the context of sustainable aquaculture, the aquaponics technique has its big importance, especially for small commercial applications, since this system provides collaborative production methods for fish and vegetables, even may enable to grow large amount of food in a places, where traditional or soil based farming is not possible or difficult to implement.

The main goal of this study is to reveal the financial feasibility of introducing the Aquaponics system in the Company, that will be engaged in the production of Sweet Italian Basil and Green Leaf Lettuce, through introducing the Aquaponics system into the already operating fishery. The main goal of the Company is to increase water saving levels, by de-nitrifying waste water from the fish ponds, through the Aquaponics system.

Model and Data

The stochastic financial model was constructed to analyze the financial feasibility of introducing Aquaponics system into the company. The analysis consists of probabilistic estimation of costs, required investments, future positive cash flows,that were used for net present value (NPV) calculation. For assessing the feasibility of the project, scenarios have been developed for the analysis, and assuming that the Company will operate under normal procedure, in the Base Case, the Aquaponics plant growing area (150 square meter) will be distributed as follows: 80% for Basil production and 20% for Lettuce production.

Financial feasibility analysis has been conducted through the use of Microsoft Excel add-in called Simetar. The Latin Hypercube simulation technique is used for the calculations of the probabilistic distributions of key output variables.

The following assumptions were taken into account for doing financial projection of the project:

- The Company has fish farm, which operates by breeding 4 tons of Trout yearly.
- The Company has 150 square meter land for the construction of Aquaponics system. Through the Aquaponics System Sweet Italian basil and Green leaf lettuce will be grown.
- Four different scenarios for growing basil and lettuce, are considered as follows:

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Basil growing area, %	80%	70%	60%	100%
Lettuce growing area, %	20%	30%	40%	0%

- Basil price estimation was done through uniform distribution technique, estimating with a minimum price of 1,100 AMD and maximum 1,200 AMD.

The prices were estimated for whole year, only seasonality factor was taken into account, by which the price during May, June, July and August will decrease by 50 to 100 AMD.

- Lettuce price estimation was done through uniform distribution technique, estimating with a minimum price of 250 AMD and maximum 300 AMD. The prices were estimated for whole year, only seasonality factor was taken into account, by which the price during May, June, July and August will decrease by 50 to 100 AMD.
- Fish prices are estimated based on the historical fish data, provided by the NSS RA. The Multivariate Empirical Distribution technique is used for forecasting purposes. The forecasting is done for 10 Year period.
- Fish mortality rate for one-year period is taken 25%.
- Feed ratio for fingerlings (estimated for 5 months) is 3-5% of total body weight, this is modeled through Uniform distribution. Feed ratio for fish (estimated for 7 months) is 1-1.5% of total body weight, this is modeled through Uniform distribution.
- All the costs are inflated by the inflation rate suggested by the Central Bank of Armenia, 4%.
- Aquaponics system will depreciate under straight line method by considering useful life of 20 years and 0 salvage value. Pumps and Filter will depreciate under straight line method by considering useful life of 5 years and 0 salvage value.
- 10% of positive Net Income will be paid to investors as a dividend.
- Total initial capital investment needed (beginning net worth) for construction of the Aquaponics system and installing needed pumps and filter is equal to 3.4

million AMD and 2.2 million AMD required working capital: in total 5,642,850 AMD required investment, of which, 70% will be financed by investors and 30% by long-term loan.

- The discount rate used for calculations is the WACC, which is equal to 26.34% for this company.
- The financial model was constructed for 10-year period.

Estimation Results

The analysis was done through a stochastic model. In this model, two main cases were considered, the Base Case and the Worst Case.

Base Case Scenario

The stochastic financial model was constructed for the Company. Scenarios have been developed for the analysis, and assuming that the Company will operate under normal procedure, in the Base Case, the Aquaponics growing area will be distributed for Basil production 80% and for Lettuce production 20%. All the fixed costs and variable costs are taken from the actual market, and inflated by the 4% inflation rate, suggested by the CBA.

Under the Base Case scenario, the project's NPV is equal to 554,576 AMD, using 26.34% discount rate.

According to the Probability Density Function (PDF) 95% of cases the NPV will be greater than -1.53 mln AMD and less than or equal to 2.66 mln AMD.

According to cumulative distribution function (CDF) probability of having negative NPV is equal to approximately 26.8% hence the probability of having positive NPV is equal to 73.2%.

The Company's IRR is equal to 28.41%, which shows the rate at which the Company's NPV is being equal to zero. This rate shows that the project can be

economically feasible, when the discount rate is not more than the rate of IRR. Since the Company's discount rate is equal to 26.34%, which is less than the IRR's rate (28.41%), the project is acceptable.

The analysis shows, that the Company's payback period is equal to 4.12 years. This payback period is accepted by the Company, and is considered as a good result.

The profitability index of the Company is equal to 1.10. This index helps to identify the relationship between initial investment and future benefits. Since the index for this Company is higher than 1, means that the proposed project is financially attractive one, as a fact, the project is acceptable.

The analysis conducted under the Base case scenario show that, the probability of having negative Net Income in the First year of the operation, is 23%, while the probability of having positive Net Income is 77%. Starting from the Second year the 0% probability of having negative Net Income, while from 5th year of the operation the Net Income is even higher than 1 million AMD, by 100%.

The analysis show, that the Profit Margin of the company's first year operation is 2%, because low level of sales and higher operating expenses. The Net profit margin will increase highly during 6th and 7th years of the operations, since during that period all the capacities of the system will be utilizes (150 square meter growing space). The Company will get stabile Net Profit Margin after 8th year of its operation, 11%, and will remain constant thereafter.

Worst Case Scenario

The Worst Case scenario is taken, that the 60% of growing area will be provided for basil production and 40% for lettuce production. The analysis show that this scenario is the worst one among others, which has NPV negative 4,434,163 AMD

and has profitability index of 0.21, indicating that investment under this scenario is not feasible at all. The payback period under this scenario is equal to 10.16 years. The project under this case is not acceptable.

The main goal of the project was the sustainable use of groundwater, that will become reality through intruding Aquaponics system in the Company, which will help to de-nitrify water used by the fishery and make possible it's re-use. Analysis shows that, the Aquaponics system will help to re-use 20liter water per second by fish ponds.

Conclusions

The main goal of this study was the idea to reveal the financial feasibility of introducing the Aquaponics system in the Company. The developed stochastic model for this study indicated that under the base case, the probability of having a positive net present value is 73% and in monetary terms the net present value will be equal to 554,576 AMD, and will have profitability index of 1.10, which indicates that the project is financially acceptable and profitable. The payback period is equal to 4.12 years.

Considering all developed scenarios in the study, though the Base Scenario in the study is both financially acceptable and profitable, however, the analysis show, the Alternative scenario, that underlines the possibility of not diversification of the business and considers only 100% production of basil, shows results that are financially better than in Base Scenario. This means that not diversifying the business and using the aquaponics system only for the production of basil is more profitable and financially acceptable.

Taking into considering the results of the study the Aquaponics system introduction in the Company presents good investment opportunities, along with the diversification of the business and saving the used water levels in the Company.

Ակվապոնիկ համակարգի միջոցով ռեհանի և հազարի (կաթնուկ) արտադրության իրագործելիության վերլուծություն

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Ագրոբիզնեսի հետազոտությունների և ուսուցման միջազգային կենտրոն

Սույն ուսումնասիրության նպատակն է գնահատել ակվապոնիկ համակարգի միջոցով ռեհանի և հազարի (կաթնուկ) արտադրության իրագործելիությունը: Հաշվարկները իրականացվել են հաշվի առնելով 4 սցենարներ՝ նպատակ ունենալով հասկանալ, թե ինչպես պետք է կազմակերպել ակվապոնիկ համակարգի գործունեությունը, օպտիմալ օգտագործելով առկա տարածքը ըստ մշակաբույսերի: Հաշվարկները ցույց տվեցին, որ բիզնեսի չտարբերակումը (ակվապոնիկ համակարգի տարածքի 100%-ի հատկացումը ռեհանի արտադրություն համար) ֆինասական տեսանկյունից առավել շահավետ է:

Анализ осуществимости производства базилика и салата в системе аквапоники

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Целью данного исследования является оценка осуществимости производства базилика и салата в системе аквапоники. В результате исследования были рассмотрены 4 сценария с целью идентификации наиболее оптимального распределения территории для выращивания между культурами. Расчеты показали, что использование всего участка для производства базилика (выделение 100% участка под выращивание базилика) обеспечивает наибольшую прибыль.