Deliverables 7.1

Aquaculture farms site

Introduction

A major global trend nowadays is urbanization and its degree reached 70% in various European countries (dos Santos, 2016). The main challenges brought by this trend include population rise, food insecurity, climate change, water and fossil fuel scarcity and soil degradation (dos Santos 2016; Suhl et al., 2016). The current annual population increased to more than 80 million and there is an expected increase from the current 7.5 billion people to approximately 9.5 billion people by 2050, therefore the world population will require 50% more food by 2050 (Pinstrup-Andersen, 2017). According to FAO (2014) aquaculture is one of the fastest-growing food production sector, which provides approximately 50% of fish and fish products for human consumption. Also as part of the European Union's Blue Growth Strategy to create sustainable growth and employment in the marine economy, aquaculture has been identified as a sector with high growth potential (Grealis et al., 2017). Nowadays, aquaculture is considered more important than fisheries due to the depletion of wild fish populations and the importance of maintaining the supply of protein for human diets (Nadarajah & Flateen, 2017; Ismail et al., 2017). However, traditional aquaculture production in natural ponds causes significant negative environmental impacts through the use of high amounts of freshwater and the hazard brought by the high nutrient load in the waste water (Suhl et al., 2016). Shrimp farms destroy coastal mangrove habitats, salmon farms can release genetic anomalies into local fish populations, farms of high-value fish species use wild-caught forage fish stocks for feed inputs and farms of fed species can pollute local waters (Froehlich et al., 2017). Excessive and unrestricted use of antibiotics, pesticides and fertilizers is a general problem in the aquaculture sector, particularly in developing countries (Ottinger et al., 2016). Potential increased pressure on water resources (shortages in freshwater availability) and water quality (eutrophication) could lead to the decline of aquaculture production and affect food security (Ottinger et al., 2016). Nevertheless, advances in the technology, practices, and siting of aquaculture have allowed significant mitigation of these environmental risks and harms (Froehlich et al., 2017). Aquaculture integrated systems, such as aquaponics, can address and relieve environmental pressure caused by traditional food production techniques. Aquaponics is the merger of two profitable and well-established food production technologies – aquaculture and hydroponics (Ginkel et al., 2017). Aquaponics is the fusion of recirculating aquaculture and soilless vegetable production, within a complex closed-loop system (Cerozi & Fitzsimmons, 2017). It integrates and combines synergistically aquaculture and hydroponic techniques in a one merged system (Wongkiew et al., 2017). According to dos Santos (2016) aquaponics could represent a new integrated agricultural system from producers to consumers, in an integrated manner, due to the short supply chains and organic fresh food. Also, due to its double purpose, aquaponics might be a sustainable solution to the low provision of fish and vegetables in some countries (Bosma et al., 2017). This technological method has the potential for higher yields of produce and protein with less labor, less land, fewer chemicals and a fraction of the water usage (FAO, 2016). Aquaponics offers a complete food diet that covers both vegetable and meat products (Addy et al., 2017). The aim of this paper is to make a general overview about aquaponic systems, by following four main key aspects that characterize the efficiency of this concept, as follows: technical and technological aspects, waste management, water management and land management aspects. As a result, this study must identify the utility of integrating aquaponics and also, proposal must be made in order to assure a future development of this concept.

Management of technical and technological aspects

FAO guidelines confirmed that the most common aquaponic production techniques are: the deep-water culture (DWC), the nutrient film technique (NFT) and the media bed method (FAO, 2014). The media bed technique is the most popular design for small-scale aquaponics due to its relatively low initial cost and its beginner friendliness. For the construction of the media bed, different substrates are used, such as gravel, sand, mineral wool, clay balls (hydroton), coconut shells (Lacheta, 2010; Wahome et al., 2011). From the hydraulic criteria point of view, the media bed technique is divided into two subcategories: permanent submersion regime (PSR) and intermittent submersion regime (ISR). Petrea (2014) pointed out that indicators such as the hydraulic loading rate (HLR) and hydraulic retention time (HRT) are frequently used to control the physical filtration process more efficient in the aquaponic units, in case of the media bed technique. The NFT technique consists of using horizontal pipes for the vegetable biomass, each with a continuous shallow stream of nutrient-rich aquaponic water (Timmons et al., 2002). Plants are placed within holes in the top of the pipes, and are able to use the thin film of nutrient-rich water (FAO, 2014). The DWC method involves suspending plants in polystyrene sheets, with their roots hanging down into the water. Both the NFT and DWC are popular methods for commercial operations as both are financially more viable than media bed units when scaled up (FAO, 2014). Many fish and vegetable species are potentially suitable for the aquaponic system (Forchino et al., 2017). The most common fish species reared are Oreochromis niloticus (nile tilapia), Onchorynchus mykiss (rainbow trout), Cyprinus carpio (common carp) and Clarias gariepinus (african catfish), however more valuable species are reported suitable for the aquaponic system, such as Acipenseridae species (sturgeons) (Petrea et al., 2016; Forchino et al., 2017). Other aquatic organisms such as shrimps, prawns and crayfish can be reared in the system (Love et al., 2015). In terms of plant selection, leafy vegetables such as Lactuca sativa (lettuce), Ocimum basilicum (basil), Spinacia oleracea (spinach), Ipomoea aquatic (water spinach), Mentha piperita (mint), Artemisa dracunculus (tarragon), Brassica oleracea (kale), Brassica rapa var. chinensis (pok choy), Brassica rapa var. parachinensis (choy sum) have been reported suitable but also fruity plants such as Cucumis sativus (cucumber), Capsicum annuum (bell pepper), Solanum lycopersicum (tomatoe), Solanum melongena (eggplant) and root crops such as Daucus carota (carrot) (Trang et al., 2010; Endut et al., 2009; Love et al., 2015; Petrea et al., 2016; Shete et al., 2016; Forchino et al., 2017; Bosma et al., 2017). Regarding the growth performance of the vegetable biomass under aquaponic conditions, data from a series of scientific articles are centralized in Table 1., aiming to create an overall picture of the influence of different technical and technological conditions on the productivity of aquaponic systems.

Table 1 Vegetable biomass growth performance under different aquaponic techniques and conditions.

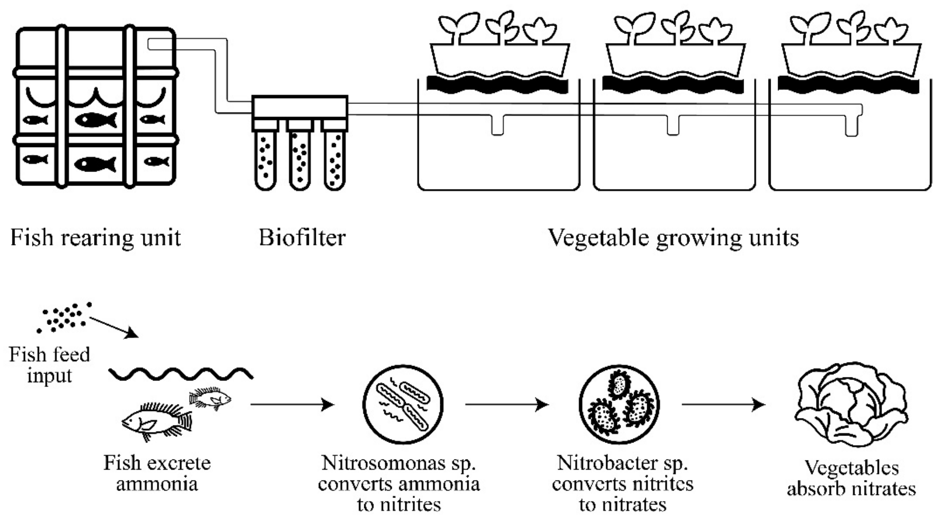
References	Researched plant-fish species	Details related to experimental conditions	Plants growth performance
Licamele, (2009)	**Lettuce** (*Lactuca sativa*) –**Nile tilapia** (*Oreochromis niloticus*).	**Different stocking densities of fish biomass:** A: 2 kg/m^3; B: 5 kg/m^3; C: 8 kg/m^3.	**Lettuce growth rate:** A – 4.32 kg; B – 4.65 kg; C – 3.09 kg.
Endut *et al.*, (2009)	**Water spinach** (*Ipomoea aquatica*) - **African catfish** (*Clarias gariepinus).*	**Testing of different hydraulic regimes:** HRT_1=0.64 m/day; HRT_2=1.28 m/day; HRT_3=1.92 m/day; HRT_4=2.56 m/day.	**Daily plants growth rate (height):** 1.70 cm/day (HRT_1); 2.11 cm/day (HRT_2); 1.75 cm/day (HRT_3); 1.59 cm/day (HRT_4).
Endut *et al.*, (2010)	**Water spinach** (*Ipomoea aquatica*) –**African catfish** (*Clarias gariepinus).*	**Application of different hydraulic regimes:** HRT_1=0.64m/day; HRT_2=1.28m/day; HRT_3=1.92m/day; HRT_4=2.56m/day; HRT_5=3.20m/day.	**Daily plants growth rate (height):** 1.75 cm/day (HRT_1); 2.50 cm/day (HRT_2); 2.06 cm/day (HRT_3); 1.90 cm/day (HRT_4); 1.90 cm/day (HRT_5).
Trang *et al.*, (2010)	**Lettuce** (*Lactuca sativa)*; **Water spinach** (*Ipomoea aquatica*); **Pok choy** (*Brassica rapa var.chinensis*); **Choy sum** (*Brassica rapa var. parachinensis).*	Application of different biomass culture technologies: • Fully immersed plant root (FI); • Half immersed plant root (HI);	Leaves surface: **Lettuce**: FI: 251 cm^2; HI: 830 cm^2; **Water spinach**: FI: 251 cm^2; HI: 830 cm^2; **Pok choy**: FI: 251 cm^2; HI: 830 cm^2; **Choy sum:** FI: 251 cm^2; HI: 830 cm^2.
Lennard & Leonard, (2004)	**Lettuce** (*Lactuca sativa)* –**Murray Cod** (*Maccullochella peelii peelii*).	Application of different submersion regimes: • permanent submersion regime (PSR);	**Lettuce growth rate:** PSR: 129 g/plant – 4.97 kg/m^2; ISR: 113.45 g/plant – 4.34 kg/m^2.

		• intermittent submersion regime (ISR).	
AL–Hafedh *et al.*, (2008)	**Lettuce** (*Lactuca sativa)* –**Nile tilapia** (*Oreochromis niloticus*).	Application of different reports between feed input: culture surface of vegetable biomass: A: 169; B: 113; C: 56.	**Lettuce final individual biomass:** A: 289 g/plant; B: 212 g/plant; C: 157 g/plant.
Sikawa & Yakupitiyage , (2010)	**Lettuce** (*Lactuca sativa)* –**Catfish hibrid** (*Clarias macrocephalus x Clarias gariepinus*).	Application of aquaponic technique on sand/gravel substrate to perform a comparative analysis of treated unfiltered technological water (UTW) and filtered water (FW).	Lettuce growth rate for UTW: **Substrate gravel:** 14 g/plant; 165.87 g/m^2; **Substrate sand:**23.13 g/plant; 277.53 g/m^2; Lettuce growth rate for FW: **Substrate gravel:** 22.59 g/plant; 271.13 g/m^2: **Substrate sand:** 35.28 g/plant; 423.4 g/m^2.
Dediu *et al.*, (2012)	**Lettuce** (*Lactuca sativa)* - **Sturgeon hybrid** *(Huso huso x Acipenser ruthenus).*	Application of different hydraulic regimes: A: HRT_1 = 5.4 min; Water $flow_1$ = 8 L/min; B: HRT_2 = 2.7 min; Water $flow_2$ = 12 L/min.	**Lettuce growth rate:** A: 75 g/plant; 3.77kg/m^2; B: 66.02 g/plant; 3.37kg/m^2.
Rafiee & Saad, (2006)	**Lettuce** (*Lactuca sativa var. longifolia)* -**Nile tilapia** (*Oreochromis niloticus*).	Evaluation of the influence of zeolite utilization as growth substrate under aquaponic conditions.	**Lettuce growth rate:** With zeolite: 6.54 g/plant; Without zeolite: 35.88 g/unite.
Graber & Junge, (2009)	A. **Tomatoes** (*Solanum lycopersicum*) and cucumbers (*Cucumis sativus*) – **Perch** (*Perca fluviatilis*) B. **Eggplant** (*Solanum melongena*) –**Nile tilapia** (*Oreochromis niloticus*).	Application of different combinations of fish-plant species.	**Plants growth rate:** A. tomatoes: 355 g/m^2/day; cucumbers: 80 g/m^2/day; B. eggplants: 90 g/m^2/day.

Waste management

The production of nitrogen and phosphorous compounds by humans increased dramatically, especially during the second half of the twentieth century, through the use of fertilizers or as a by-product of the combustion of fossil fuels (Simionov et al., 2017). Aquaculture effluents are rich in nitrogen and phosphorus, thus being a worldwide concern for potential environmental pollution (Cerozi & Fitzsimmons, 2017). Aquaculture effluents are known to be rich in dissolved and suspended solids that contain mainly phosphorus and nitrogen, generated from fish excretion, feces and uneaten feed (Cerozi & Fitzsimmons, 2017). Effective water filtration to remove waste material is critical to developing land-based aquaculture systems (Little & Bunting, 2016). Elevated concentrations of these substances, which also constitute plant nutrients, led to the development of aquaponics systems (Little & Bunting, 2016). Aquaponic systems function by symbiotic relationships as follows: the waste produced by fish in the water tanks (which are toxic to fish development and growth if not removed from the technological water) is used directly or converted by bacteria into useful nutrients for plants (Bosma et al., 2017). In the aquaponic systems, the ammonia nitrogen-rich aquaculture effluent is converted to nitrate (NO3−) via nitrification, and the NO3− is recycled as a fertilizer for plant growth in the hydroponic grow bed (Wongkiew et al., 2017). All four forms of nitrogen (NH3, NH4+, NO2−-, NO3−) can be used by plants and stimulate growth, however the form quickly absorbed by plants is nitrate. In the fish waste, ammonia nitrogen is the main form of nitrogen pollutant (90%) in the exit water (Addy et al., 2017). Thus, the exit water from the fish tanks should be directed into the biological filters first, so that the "Nitrosomonas" bacteria genus can oxidize the ammonia into nitrite (NO2−) and then nitrite-oxidizing bacteria, represented by the "Nitrobacter" genus, converts nitrite further to nitrates (NO3−) (Fig. 1).

Fig. 1: General principle of aquaponics function.



Further on, the water is directed to the plant growing units, where plants assimilate these nutrients, the water becomes clean and is recycled back to the fish tank (Bosma et al., 2017). The nutrient balance focuses on nitrogen because this is the most needed nutrient for both plants and fish (Bosma et al., 2017). If the biological filters are somehow inefficient in converting ammonia nitrogen into the less toxic nitrate, as an alternative aquaponics vegetable crop is algae, which can utilize both nitrate and ammonia nitrogen (Addy et al., 2017). As well, another study pointed out that aquaponics can maximize phosphorus utilization to 71.7% of total phosphorus input, hence there is potential for aquaponics systems to become an alternative way of recycling P and enhancing overall P utilization (Cerozi & Fitzsimmons, 2017). In aquaponic systems emissions are mainly constituted by nitrogen and phosphorous released in the environment, due to suspended solids and dead plants removal and disposal (Forchino et al., 2017). However, these wastes can be easily recycled within the farm dead vegetables could be used for the production of humus through their mineralization by earthworms. Therefore, aquaponics, the integration of aquaculture and agriculture, can have the ability to enhance nutrient efficiency and environmental sustainability (Cerozi & Fitzsimmons, 2017).

Water management

Water is the basic natural resource for the development of human society and for the survival of ecosystems (Zeng et al., 2013). Freshwater is a fundamental resource for human well-being and the natural environment (Liu et al., 2016). Due to rapid socio-economic development, conflicts between water demand and supply have become more intense (Zeng et al., 2013). Many of the new cities that will be built by 2050 will be in areas with little or no freshwater supply (Kiss et al., 2015). Freshwater is remotely the main source for the cultivation of aquatic organisms (FAO, 2015). Only 3% of the Earth's water is freshwater and 0.3% of that is found in surface waters such as lakes, rivers or swamps (Ottinger et al., 2016). Water scarcity is a widespread problem in many parts of the world (Liu et al., 2016). A critical challenge for the 21st century is the increasing scarcity and quality of water, with less water available for agriculture, including aquaculture (Edwards, 2015). The aquaculture sector affects water quality and water quantity, thus having negative impact on aquatic biodiversity and the planet's natural resources (Ottinger et al., 2016). High amounts of water are used in aquaculture systems in order to replenish oxygen, balance water loss from evaporation and to remove wastes (Ottinger et al., 2016). Worldwide, the total surface of aquaculture ponds accounts of more than 110.000 km2, with most ponds (87,500 km2) used for freshwater production (Ottinger et al., 2016). Fish in an integrated recirculating aquaponic system can be reared with 8 times higher density than the recommended fish stocking density (Diem et al., 2017). Irrigated agriculture is globally the largest user of water and 40% of global agricultural production is from irrigated croplands (Winter et al., 2017). Aquaponics has many advantages such as water use efficiency and environmental sustainability (Cerozi & Fitzsimmons, 2017). Growing the same quantity of vegetables in an aquaponic system will require only 5% of water use compared with the open field agriculture (Pinstrup-Andersen, 2017). Also, irrigated agricultural areas are typically located in arid and semi-arid regions, with abundant sunlight but low precipitations (Winter et al., 2017). These areas are the most susceptible to water stress and aquaponics can resolve issues such as water scarcity by minimizing water exchange and sustain an adequate water quality (Winter et al., 2017; Wongkiew et al., 2017; Shete et al., 2016; Cerozi & Fitzsimmons, 2017). Another study reported that aquaponics consumes only 1/7 of conventional agriculture water usage (Addy et al., 2017). Cutting water use by 95% is extremely important at a time with increased water scarcity (Pinstrup-Andersen, 2017). After assessing the environmental impact of a micro-scale aquaponic system, by using the life cycle assessment method, Maucieri et al. (2017) concluded that the water consumption scored the lowest values, which represented less than 1% of the total contributions from all the impact researched categories.

Land management

For the first time in history, in 2008, the human society became primarily urban (Kiss et al., 2015). For the foreseeable future the world's population will continue to move to cities, so that by 2050 almost 70% of the human population will be city dwellers (Kiss et al., 2015). The expansion of aquaculture activities leads to increased demand for natural resources such as land (Ottinger et al., 2016). Aquaculture is in increasing competition with primarily existing agricultural areas and in many coastal regions land is already a scarce resource (Ottinger et al., 2016). As the urbanization rate is rapidly increasing, aquaponic systems could offer solutions such as produce marketable vegetable crops and fish meat close to urban centers (Forchino et al., 2017). Aquaponics can be set up almost everywhere and has the potential to urbanize food production (dos Santos, 2016). This food production technique could be implemented in old industrial neglected buildings, with the advantage of re-establishing a sustainable activity without increasing urbanization pressure on land (dos Santos, 2016). Since there is no soil involved in the system, the problems associated with soil contamination and soil degradation are eliminated (Addy et al., 2017). In their study Ginkel et al. (2017) found that aquaponically grown vegetables have a real productivities 10 times higher than the field grown vegetables. The production of vegetables in open fields is associated with large risks and uncertainties from different biotic and abiotic stresses (Pinstrup-Andersen, 2017). Pest attacks, droughts, floods and strong winds are some of the possible threats that may occur in the traditional agriculture system. Also, traditional agriculture and aquaculture are both seasoned conditioned, while aquaponic production is continuous through the year, due to the indoors practices. The agriculture food system footprint is more than 67 times larger than the area of the city it serves. Therefore, shifting crop and animal food production to aquaponic greenhouses, combined with other efficiency improvements, reduces the food system footprint to approximately 3.5 times the city area (Kiss et al., 2015). There is growing interest in locally produced food that is commercialized directly to consumers, and aquaponics is a growing form of aqua-agriculture that can ensure a local and regional food system model practiced in or near large population centers (Love et al., 2015).

Entrepreneurial Management in Aquaponics

Aquaponic systems are widely researched in the scientific communities, endorsed by many commercial producers and supported through specific guidelines by FAO. However, the lack of a certain legislation regarding the integration of those systems in the already existing fish farms is required. Also, the integration of aquaponics concept must be sustained by a know-how sharing platform. Future research must be made regarding the implementation of aquaponics vertical systems, in order to determine their productivity and cost-effectiveness. The specialists from both fisheries and aquaculture, and agriculture domains must work together in order to share their knowledge, sustain and develop this eco-friendly production systems. The aquaponics systems both production and water treatment efficiency were widely demonstrated. Aquaponics are able to assure the water treatment process by both bio and phytoremediation. The aquaponics concept has a high degree of technical aspects that gives its engineering absolute character. It is recommended that future socio-economic studies to be made in order to rise the popularity of this concept world-wide.

Policy-makers and development agents are increasingly viewing aquaponics as an integral component of the search for global food security and economic development.

Fisheries and aquaponics can provide a key contribution to food security and poverty alleviation. However, productivity gains in fisheries do not always imply long-term increases in supply. In fact, in wild capture fisheries such gains can ultimately lead to the demise of stocks and reduced production.

Agricultural and livestock activities are considered the biggest consumers of fresh water. Estimations reveal that 85% of the global fresh water consumption is for agriculture and nearly one-third of the total water footprint of agriculture in the world is used for livestock products in Hoekstra (2007) and Mekonnen & Hoekstra (2012). Aquaponics has ancient roots. Aztec cultivated agricultural islands known as chinampas in a system considered by some to be the first form of aquaponics for agricultural use (Diver, 2006), where plants were raised on stationary islands in lake shallows and waste materials dredged from the chinampa canals and surrounding cities were used to manually irrigate the plants in Boutwelluc (2007) and Rogosa (2013). Also, South China, Thailand, and Indonesia who cultivated and farmed rice in paddy fields in combination with fish are cited as examples of early aquaponics systems. Aquaculture development as a whole in the country in combination with production technology, favorable socioeconomic condition and culture environment has already proven successful in terms of increasing productivity, improving profitability and maintaining sustainability by Toufique (2014).

Aquaponics Data Model

This informational system has been specifically designed for recirculation aquaponics technology. The bio-economic model used can be classified as a non-optimizing budget simulation which uses the growth and FCR (feed conversion rate) and mortality characteristics of a particular species and cash and accrual accounting principles to arrive at performance and profitability measures. Various scenarios (including farm size, species characteristics, harvesting and sales strategies) using different bio-economic inputs (including risk) can be compared and contrasted.

Informational system provides the currently operating aquaponics and the potential of the critical information that will allow the user to model expected cash flows and associated profitability ratios and indices for a particular sized operation farming a particular species of fish.

The informational system has built into its program the ability to enter risk aversion details in order to more adequately depict the learning curve situation that new entrants experience at the beginning, and also build into the ten year production cycle the one in ten year production short fall that normally occurs in farm production due to unforeseen circumstances. As a result the ten year cash flow stream will more adequately depict reality by accounting for risk.

The aquaponics informational system will be able to answer the following critical questions in relation to investment decisions or ongoing financial management of an aquaponics operation:

- How much do I have to invest to attain a certain cash flow stream?
- What will be the return on that investment?
- How much will I have to borrow?
- What is the minimum sale price that can be accepted for the product?
- What is the profit margin?
- How much do I have to increase production by to maintain profit levels if sale prices fluctuate?
- Which harvesting and sales strategy maximizes cash-flow?
- How does fluctuating FCR affect profit?
- How is profit affected by a learning curve?
- What is the current equity position?

Informational model is a financial planning, harvesting and sales management tool, which enables you to plan your investment and determine the size of your commitment before you begin, taking the risk out of your investment. It allows developing and evaluating sustainable aquaponics systems and management practices at both an operational and strategic level.

The system can determine potential profitability of the farm as investment levels and other key performance indicators vary. You can see how critical movements in the key elements of aquaponics can affect the performance of your farm, enabling you to determine the amount of production required in relation to cost. Relevant data such as fish growth and mortality statistics are used to calculate key performance and profitability indicators. Other key data information includes:

- Sale price of fish and vegetables;
- Type of product (live or processed);
- Number of tanks or ponds;
- Stock density;
- Cost of feed;
- Cost of fingerlings;
- Loan size and costs;
- Risk aversion (production assumptions incorporating learning curves);
- Harvesting planning charts;
- Water cost and use.

The software provides easy-to-read accounts, giving you a concise summary of your farm's potential. You can see how critical movements in this key data can affect the performance and profitability of your farm, and demonstrate the feasibility of investing in this exciting new industry.

The software package is delineated into eight major modules, each capable of producing custom-built reports for business plan development and on-going farm financial management and monitoring. The modules include the following areas of Accounts:

- *General Report,* brings major variables together to allow scenario mapping;
- *Species Variables,* includes industry best practice growth rates, FCR's and mortality;
- *Bio-economic Variables*, includes all the variables necessary to develop a aquaponics;
- Aquaponics *Model Accounts,* over a ten year period;
- *Internal Rate of Return Analysis;*
- *Cash Flow Statement,* describes opening and closing cash balance;
- *Key Financial Ratios, p*roduces accounts to calculate critical financial and profitability ratios;
- *Volume Cost Analysis, p*roduces fixed and variable cost accounts for volume planning;
- *Harvesting and Sales Strategy, p*roduces annual harvesting by product type;
- *Charts,* produces a series of charts and diagrams.

Green leafy vegetables with low to medium nutrient requirements are well adapted to aquaponics systems, including lettuce, basil, spinach, chinese cabbage, chives, herbs, and watercress (www.backyardaquaponics.com).

The selection of plant species in aquaponics system is important. Lettuce, herbs, okra and especially leafy greens have low to medium nutritional requirements and are well suitable to aquaponics system. Plants yielding fruits like tomato, bell pepper and cucumber have higher nutritional requirement and perform better in a heavily stocked and well established aquaponics system (Adler, 2000).

A few fish species are adapted to recirculating aquaculture which includes tilapia, trout, perch, arctic char and bass. Most commercial aquaponics system in North America is based on tilapia. Furthermore, tilapia is tolerant of fluctuating water conditions such as pH, temperature, oxygen and dissolved solids by Rakocy (1999). Tilapia is the fish species which is very hardy, can tolerate wide range of environmental parameters, can live with versatile of feed and are fast grow thing fish species by Salam (2012).

The farm model is a ten year account of the farm enterprise calculated from the various bio-economic inputs and the species characteristics. The software assumes that capital is purchased in Year 0 and that the revenue streams begin in year 1, depending on the time taken for final grow-out.

The aquaponics account assumes that once costs (except those costs associated with biomass such as feed, electricity, and product insurance) have been set in year 1, they remain the same throughout the ten year cycle. The aquaponics account therefore presents what is *expected* from the parameters.

The farm is set up using a particular set of data relating to a particular species. This data includes:

- Cohort growth to final grow-out;
- Mortality;
- FCR;
- Recovery rates from fish.

This module shows the critical variables which affect production and financial performance of your farm. The informational system feasibility results include the following performance measurements:

- Internal Rate of Return;
- Benefit Cost Ratio;
- Profit Margin;
- Assets Turnover;
- Return on Total Assets;
- Debt to Equity;
- Leverage Return;
- Return on Equity;
- Contribution to Overheads;
- Cost per Kilo (variable and total);
- Harvesting Strategy and Cashflow[1].

Critical Bio-economic Data

Pond water quality is largely defined by temperature, transparency, turbidity, water color, carbon dioxide, pH, alkalinity, hardness, unionized ammonia, nitrite, nitrate, primary productivity, biological oxygen demand and plankton population (Bhatnagar, 2013).

The accepted level of ammonia should be under the range of 0.05 to 0.10 mg/l by Shoko (2014) and above range it is toxic to the cultured fish in Francis-Floyd (2009).

According to Mizanur et al., intensive aquaculture ponds sediments has various fertilizing components such as nitrogen, phosphorous, sulphur etc. which are very useful for growth and production of aquaponic plants by Mizanur (2004). Moreover, water spinach is an efficient plant having clustered roots that can absorb nutrients from the water very efficiently by Kibria (2012).

Aquaponics is an integrated and intensive fish-crop farming system under constant recirculation of water through interconnected devices. It is considered a promising technology, which is highly productive under correct set up and proper management by Lal (2013). First, fish feed is eaten by fish and converted into ammonia (NH_3). Some ammonia ionizes in water to ammonium (NH_4^+). Then, bacteria (Nitrosoma) convert ammonia into nitrite (NO_2^-) and consequently bacteria (Nitrobacter) oxidize nitrite into nitrate ($NO3^-$) by Tyson (2011). Finally, the water delivers nutrients and oxygen to promote plant growth. Graber and Junge, found similar yields between hydroponic systems and aquaponics systems. Finally, it is important to establish systems under "smart water" use and to balance nutrient concentrations in water to ensure maximum fish and plant growth by Graber (2009).

Aquaponics is considered a method where water and nutrients are efficiently used and maintained within the system by Liang and Chien (2013). In aquaponics it is possible to reduce daily water loss to 2% of the total water volume of the system. Due to the constant recirculation of water it is also possible to maintain evenly distributed high nutrient concentrations in the water (nitrate) as the small addition of water to compensate the daily loss will not dilute the nutrients by Rakocy (2006).

The critical bio-economic data that interacts with the feasibility results includes data associated with the size of the farm and other crucial assumptions which impact on the feasibility of an aquaponics venture. These data items include:

- ***Fingerling Price***: This price is either taken from commercial reality or calculated from on-farm nursery costs associated with raising a fingerling to a certain size.
- ***Number of Fingerlings***: The number of fingerlings for each stocking (one to twelve times per year) will determine the size of the farm and the revenue generated from product sold.
- ***Initial Weight of Fish***: This will determine what part of the growth table will be used to start the aquaponics operating.
- ***Feed Price*****:** This is an average price of feed per kilo over the grow-out period of the fish.
- ***Stocking Density (initial grow)***: This is described in kg per cubic metre.
- ***Stocking Density (final grow)***: This is described in kg per cubic metre.
- ***Production Sold Live***: The proportion of fish production sold live.
- ***Production sold HOGG***: The proportion of fish product sold HOGG (head on, gutted and gilled).
- ***Production sold fillet***: The proportion of fish product sold filleted.
- ***Price of fish and vegetables*****:** The farm gate sale price of fish product (live, HOGG and filleted).

Aquaponics Feasibility Results

The **Aquaponics Feasibility Results** are key profitability ratios and indices that have been calculated from reports and tables attached to the program. These include the following:

- ***Net Present Value (NPV):*** This is the discounted value of the ten year cash-flow stream. The NPV will depend on the discount rate (which is entered in the bio-economic variables input table); the value is usually equal to the current rate of interest.

- ***Internal Rate of Return[2]:*** The Internal Rate of Return (IRR) is the discount rate that equates the present value of net cash flows with the initial outlay. It is the highest rate of interest an investor could afford to pay, without losing money, if all of the funds to finance the investment were borrowed, and the loan was repaid by application of the cash proceeds as they were earned. Conventional projects involve an initial outlay followed by a series of positive cash flows. In this case, if the IRR is higher than the required rate of return then the NPV is positive.
- ***Benefit Cost Ratio***: Instead of showing the NPV as an absolute amount, the benefit cost ratio relates the present value of cash flows to the initial outlay. If the ratio (sometimes called the profitability index) is greater than one, then the project is acceptable.
- ***Profit Margin (PM)***: Profit Margin is the sales return *before* interest. The Profit Margin is equal to the Net Income (NI) before interest {NI + after tax interest expense (ATI)} (averaged over 10 years) *divided* Revenue (averaged over 10 years). This ratio indicates the percentage of sales revenue that ends up as income. It is a useful measure of performance and gives some indication of pricing strategy or competitive intensity.
- ***Asset Turnover (AT)*****:** The Asset Turnover is equal to Revenue divided Total Assets (applicable to the year of the ten year production cycle). This ratio relates to the farm's dollar sales volume to its size, thereby answering the question, "How much volume is associated with a dollar of assets?". This ratio tends to move in the opposite direction to the Profit Margin. Companies with high turnover tend to have low margins, and those with low turnover tend to have high margins.
- ***Return on Total Assets (ROTA)***: This is the operating return, which indicates the company's ability to make a return on its assets *before* interest costs. ROTA equals Profit Margin (PM) times Asset Turnover (AT).
- ***Debt to Equity Ratio (DER):*** This relates ratio reveals the extent of debt that is part of the venture's financing. The ratio equals Liabilities *divided* by Equity (Owners investment contribution plus the value of assets already owned that are used for the venture plus retained earnings).
- ***Leverage Return***: Measure the relationship between borrowings and equity. Financial leverage is measured by the Debt to Equity Ratio *times* {Return on Total Assets (ROTA) *minus* the Average Interest Rate after Tax (IN)}. The Average Interest Rate after Tax (IN) is equal to the After-tax Interest Rate Expense (ATI) *divided* by Liabilities.
- ***Return on Equity*** **(ROE)**: This is equal to Return on Total Assets *plus* Leverage Return. The company's return is made up of returns from operations and from borrowed funds. If there is a positive difference between the operating return and the cost of borrowing, a company may take advantage of this difference via using leverage to enhance its returns by borrowing relative to the owner's equity base.

- ***Hasegawa Index***: The Hasegawa index is a convenient way to obtain an indication of the profitability of an aquaponics venture (given that detailed economic data may not be available). This index compares the *ratio* of the selling price and the price of feed to the *ratio* of the conversion ratio and the ratio of feed cost to total costs.
- ***Contribution to Overhead (CTO)***: CTO is the portion of revenue from each unit of sale that remains after variable costs are covered.
- ***Cost per Kilo***: The cost per kilo of fish is equal to current costs (minus depreciation) divided by total production (tones).

Cash Flow Statement

The Cash Flow Statement shows the calculated Closing Cash Balance over the ten year cycle. This balance is assumed to be reported as cash in hand after each period, and can be used to reduce debt faster, buy more capital equipment or place in special savings portfolios such as a superannuation fund

Financial Ratios Module

This module details the Assets and Liabilities over each of the ten years. By inserting the Year number at the top of the screen, the accounts will change depending on the depreciation and liabilities.

The financial ratios calculated from this are:

- Profit Margin
- Asset Turnover
- Equity
- Return on Total Assets
- Debt to Equity Ratio
- Leverage Return
- Return on Equity.

Equity is calculated by subtracting total liabilities from total assets. It is calculated in the profit linkage model in a different way to show how the accounts interact.

Trading Results

The Trading Results Report summarizes the Assets/Liabilities and the resulting (Loss/Surplus) or equity and the trading results. This module is used to calculate the Cash Available for Debt Service (CAFDS) Ratio, which is used by financial institutions to determine the capacity of a proposed business to cover loan repayments. Financial institutions have certain performance measures that are used to determine the eligibility for a financial loan. For example, a bank may require that the minimum interest cover is a CAFDS which is twice the amount of an interest repayment. Equity is defined as the owner's capital investment for setup capital costs and the value of any assets contributed to the venture.

Volume Cost Analysis

This system module shows a breakdown of Fixed and Variable Costs and calculates the following major indicators:

- Contribution to overheads
- Breakeven Volume

Profit planning module is included to assist the farmer in determining what volume (sales) is required to attain a particular gross profit.

Fixed Cost module is included to assist the farmer in determining the amount of additional sales required to cover an addition to fixed costs (e.g. a new pump).

Variable Cost module has been included to determine the impact of expected inflation and its impact on variable cost.

Profitability Linkage Model

This screen shows how Return on Equity (ROE) is calculated. The calculations take into account the following data from the various accounts:

- Net Income
- Total Assets
- Total Liabilities
- Equity
- Return on Total Assets
- Debt to Equity Ratio
- Leverage Return

Print out Reports

Informational system produces a general report which summaries the farm scenario outlined in the assumptions laid down. Reports and graphics include:

- Consolidated Report
- Bio-economic variables
- Profit and Loss Account
- Financial Ratios (Assets and Liabilities)
- Trading Results (Cash available for Debt Service)
- Cash Flow Account
- Internal Rate of return Analysis
- Volume Cost Analysis
- Profitability Linkage Model (Return on Equity)
- Capital Start up Payback Period Bar Chart
- Current Costs Pie Chart
- Fish Tonnage Chart

The aquaponics can be developed in a sustainable manner to generate food and jobs and improve the income and livelihoods of rural and urban populations, thus alleviating hunger and poverty. Developing an accurate and practical tool to predict plant and fish growth and monitor nutrient concentrations in water, will improve the adoption and implementation small or commercial scale of aquaponic systems as urban farming or as a business model for household food security.

The informational model of business plan represent an engine for economically resilient and sustainable fisheries and aquaponics is the government's will and resolves to establish sound policies to support and develop the sector. The informational model allowed to analysis the influence of production system inputs to the farm yield and cost.

The input of aquaponics production system (fingerlings, feed, water, etc.) determines yield and cost in both a direct and indirect way. When an input is used more intensively (for example, when more fish are stocked per ha) yield may rise enough to offset the increase in cost, resulting in a more profitable farm. As production intensity increases, however, the greater use of an input, such as feed, can have an indirect and negative effect on yield via changes in pond water quality. This can result in a lower yield and higher cost per kg harvested, reducing profit to the farm.

Full employment of productive factors, including human resources, continuous improvements in the legal and regulatory framework for the development of the sector, and scientific breakthroughs in production technologies will strengthen aquaponics and ensure its sustainability.

The aquaponics represent a component of rural development policies. The aquaponics activites offers the perspective of multisectorial development in rural areas.

Sustainable and ecological farms which help agriculture businesses to achieve economic viability and competitiveness. Green is the management technique that has most contributed to support EU Europe 2020 strategy for smart, sustainable and inclusive growth, where the creation of new "green" businesses towards the transition to a low carbon economy by 2050, European Commission (2013).

In order to fulfill EU strategies for Sustainable Development of Smart and Green Agriculture, this analysis model aims to address the following key-questions:

- What are the best practices to develop an agricultural integrated project?
- What are the accumulated social, economic and environmental effects of the agricultural production system?
- What are the best strategies for installation, maintenance and operation of an integrated agricultural production system?
- What is the economic and environmental feasibility of an integrated agricultural production platform?

Over 90 % of the territory of the EU, and home to more than 56 % of the population, rural areas need to make a robust contribution if these strategic objectives are to be achieved, Eurostat (2014).

Integrated social services in rural areas have the principle objectives: to reduce pollution and to increase productivity, to increase value of the aquaculture products.

The integration of social services in rural area includes all agricultural and aquaculture activities using resources both from plants and fish, in order to promote tourism or generate therapy, rehabilitation, social inclusion, education and social services in rural areas. Social farming can also be regarded as a service provided by subsistence agriculture. This does not mean a reduction in quality of services in poorer areas, but rather serve as a way to improve their effectiveness by linking formal and informal professional services with more than one non-professional, Armstrong J.S., Morwitz V. G. (2000).

Social farming is an emerging concept in Europe that includes various participants interested in its development: farmers, farmer organizations, users of services provided by farms social welfare service providers and other health stakeholders in social services. Examples of services are: tourism, rehabilitation, therapy, job protected, lifelong education and other activities that contribute to social inclusion.

Social farming is a new concept and also traditional. It comes from traditional rural systems before modernizing agriculture and increasing civil service system. Today's concept was substantially reformed in an innovative way in evolution.

The main products of social agriculture, in addition to marketable products are health and employment, education or therapy. Agriculture provides opportunities for people to participate in various rhythms of day and year, in aquaculture. Social agriculture includes agricultural enterprises which integrate people with physical, mental or emotional, firm, providing openings for the socially disadvantaged, for young offenders or those with learning difficulties, people with drug addictions, senior long-term unemployed and actively citizens, strong schools and kindergartens, and more. Disease prevention, inclusion and a better quality of life are features of social farming.

The added value of social farming enables disadvantaged people to be integrated in a living context. The presence of farmers, contact and relationship with people, animals and vegetable crops, specific responsibilities of the person using the service are some of the key features of the social practices of agriculture, Di Iacovo F. (2003).

The methodology for assessment of the chance analysis model for the development of integrated production platforms entails the following general steps:

- The socio-economic characterization of the model of integrated production platforms when it comes to agriculture, aquaculture and social services.
- The production and demand structures of the proposed model of integrated production platforms are investigated. This is done by the identification and quantification of costs and benefits by using market and non-market methods in order to capture private, social and ecological effects.
- Policy recommendations derive from economic tools such as for instance Cost-Effectiveness Analysis, Cost-Benefit Analysis and other approaches to socioeconomic analysis such as for instance Multi-Criteria Decision Analysis.

The suggested methodology for socio-economic analysis includes a baseline profiling of case and socio-economic characterization pertaining to future economic activities (agriculture production, aquaculture and social services). A determination on whether full or limited data should really be collected for an effect assessment is taken. Thereafter data on the website are collected and costs and benefits are quantified. The assessment of impacts and evaluation of the assessment predicated on limited data approach, integrating results on Impact Assessment Analysis are conducted. Finally, policy recommendations predicated on impact assessment results and sensitivity analysis are provided.

This part of the framework targets gathering information regarding the socio-economic environment and context of the proposed development pertaining to production and social services. Hence, before achieving the evaluation of the socioeconomic impact, it's necessary to start with the baseline profiling of the case study areas in order to identify who is going to be impacted. Thus, this method is expected to enable the identification of the production and demand functions of the model.

To be able to assess indirect and induced impacts a regional profiling is necessary. The info typically gathered within a regional profile includes: the natural resources, the people characteristics, the political and social resources, an explanation of historical factors, identification of the relationships with the biophysical environment, culture, attitudes and social-psychological conditions, the current status of operations (production, social services) and the identification of individuals who are going to be impacted, in an investigation study by Social Sciences Program, Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry, Bureau of Transport and Regional Economics and Australian Bureau of Agricultural and Resource Economics, (2005). The first assessment must include economic and social analysis of the use of waste waters under current use and future autonomous developments. This assessment should include both market and non-market costs and benefits. The scope is the profiling of current uses and identifying businesses, households and individuals that could be impacted by the future installing of the model of multi-use aquaponics production platforms. Furthermore, broader social and environmental issues linked to current and future operations should really be highlighted.

These subsections identify economic issues, environmental issues and social issues concerning amount of employment, regional development and overall attitude of the people towards the technologies and specific options proposed. The production and demand analysis is dependent on economic data, environmental valuation surveys and benefit transfer techniques, Feldmann, B. (2008).

This analysis is dependent on proposed financial costs of the model of multi-use aquaponics production platforms structures along with social and environmental costs. The identification of the private costs of the suggested model of integrated production platforms structures pertaining to agriculture and social services is the first faltering step of the production-side analysis. Training costs are likely to cover working out of individuals who will run the platforms pertaining to the safety, financial and environmental implications.

Considering that the scope of the developed methodology is to integrate private, social environmental costs of the suggested model of integrated production platforms, it's equally important to take into account the latter in the suggested framework of analysis. The analysis here is focused on proposed financial, social and environment great things about the platform structures.

These challenges derive mainly from the varying degrees of accessibility of rural areas, the small size and low population densities of rural communities, their social and economic composition, and the nature of internal and external linkages. The small size of local markets and limited access to essential services, such as finance, information and advice, present further obstacles for rural entrepreneurs. Other issues include a lack of suitable business premises, less developed transport and communications infrastructure, and limited opportunities for networking and collaboration.

Economies of many rural areas are changing rapidly. The service sector is the most important sector in rural areas in terms of employment and Gross Value Added (GVA).

Whilst agriculture and forestry utilise 91 % of the EU territory, only 7.7 % of EU employment is generated in agriculture and related farm and agro-food activities. Instead, new activities and sectors are evolving within rural areas, such as tourism, business services, personal services, food production, specialised industrial production and other types of micro enterprise.

In the case of many businesses located in rural areas, the implementation of their development strategy is not just about location, but is also a process of interaction and integration. The importance of economic activities cannot be measured by the number of jobs created alone: it is part of a whole whose complementary aspects can join and contribute to sustainable development.

Challenges such as food security, preservation of natural resources and ecosystems, climate change mitigation and adaptation, the desire for local food systems and increasing rural-urban interdependency all present new opportunities for rural entrepreneurship. Among others, leisure related activities, personal and household services, renewable energy businesses and cultural services represent an important source of employment.

The growth of new rural service enterprises is influenced by two factors: rising demand in places close to urban centres following the arrival of new inhabitants and demand from long-established rural residents for existing services.

This activity not only provides the farmer with an opportunity for additional income, it also meets the needs of young families, whether they are existing residents, or people who have recently left the city for a better quality of- life.

The concept of agri-tourism – holidays on farms – has become increasingly popular. One of many examples of a successful agri-tourism business is the agri-ecology centre. Business innovation can also be seen in agriculture and the food processing sector, through the emergence of new modes of production and marketing. “Local food” initiatives and short supply chains are excellent examples of this and are the subject of growing interest from food producers, consumers and public bodies.

Economic activities in rural areas have to deal with the issue of product distribution: not only does this concern distribution within and between rural and remote areas but also distribution between rural and urban areas. Indeed, many rural businesses develop in response to demand in cities. Distribution can take two forms; short or long supply chains, but in both cases this demands a specific dynamic within the territory that can be built by the entrepreneur. The distribution sector can thus be a real opportunity for entrepreneurs in rural areas. Indeed, production and transformation units are often separated and the development of a distribution activity can help local actors to improve the supply structure. This can have a positive impact for producers, providing better access to markets and thereby increasing demand, but it can also be interesting for the territory as it supports economic activity and can encourage the development of new activities.

The social dimension of agriculture can be defined as its capacity to produce inclusive processes and social cohesion using local resources, and to respond to the specific needs of a particular target group. Social farming can improve the viability of rural areas by providing new opportunities for diversification.

The modernisation of agriculture, through mechanisation and the widespread use of fertilisers and plant protection products, increased productivity beyond the level of subsistence. It also changed the social image of the sector. Marginal areas were abandoned and migration to towns and cities led to the depopulation of rural areas, resulting in a deeply modified relationship between people and the countryside.

Many started to look upon rural areas as uninteresting wildernesses and became ignorant of agricultural processes. As a consequence, agriculture's contribution to added value and employment was reduced significantly and its social role diminished.

In the 1970s, contradictions inherent in the intensive farming approach – e.g. pollution, soil erosion, poor animal welfare – focused attention on the secondary effects of agricultural processes, and an increasing number of people began to take an interest in the “multi-functionality” of agriculture. Secondary functions also included social dimensions, as well as environmental issues. The social dimension of agriculture can be defined as its capacity to produce inclusive processes and social cohesion using local resources, and to respond to the specific needs of particular groups: namely people with physical or mental disabilities, children, the elderly, people with problems of social exclusion drug-addicts or prisoners, socially excluded women or young people. In other words, social agriculture is an innovative way of reviving the potential of traditional farming to include everyone, regardless of age, gender or ability, Biffl, G. (2012).

Social agriculture may include some or all of the following components:

- Work and training opportunities – where agriculture creates employment and income opportunities for the disadvantaged;
- Recreation and quality of life – mainly “not for profit” activities that are often managed at municipality level, whereby small allotments are given to the elderly

with the aim of creating the opportunity both to have fun and to socialise with neighbours;

- Education – creating actions to improve knowledge of agricultural practices and rural culture and to develop environmental awareness among young people (e.g. city farms, school gardens managed by pupils, etc.);
- Services to populations in rural areas – kindergartens; summer reception centres for children; homes for the elderly. This is very important for local development, since a lack of services, together with limited job opportunities, is one of the most important reasons for depopulation in rural areas;
- Rehabilitation and therapy – agriculture can be a tool to improve the welfare of individuals with mental or other health problems. Therapeutic agricultural activities can either be carried out on farms themselves, or in a medical environment with the input and expertise of farmers. In any event, these activities are planned by health experts (psychologists, psychiatrists, etc.) and – when they aren't directly managed by health staff – they are under health authorities' control, Riesenfelder, A., Schelepa, S. and Wetzel, P. (2011).

These types of social farming experiences can involve a variety of different agricultural activities: from vegetable, vine or olive growing to animal care, the making and/or selling of dairy products on farms, or even working in a farm restaurant.

In this way, people have the opportunity to increase their capabilities and skills, to improve their social life and to reduce time spent under medical care in hospital or elsewhere. These experiences are particularly important in periurban areas, where social and health care services are often insufficient, Schmitt, R. (2012).

Social farming can be considered as a diversification activity, which improves a farm's income and contributes to social well-being, while also boosting the image of agriculture in society. At the same time, since social farming deals with personal wellbeing and care, it requires strict adherence to the appropriate standards and procedures in order to protect users' welfare and interest.

At present, quantitative studies on the benefits of these practices for participants and the impact on rural areas are not available. A solution is to evaluate the opportunities for rural development arising from social agriculture, in terms of innovative socio-therapeutic services, social cohesion, and sustainable economic development;

The study analyses both the characteristics of farms supplying social services, with the aim of developing new multifunctional agricultural practices, and the effects of therapeutic interventions.

In this way, the aim is to contribute to identifying new therapeutic strategies in the field of mental health and to expand opportunities for health policy. The results show that social farming can improve the quality of life of participants and their families by giving them greater autonomy, a greater number of options, and improved prospects for the future. Social agriculture also has economic benefits: reducing public expenditure on drug consumption and hospital admissions; providing new job opportunities in rural areas; improving the public image of farms and farming; and building networks of actors that increase the competitiveness of rural areas. The education level is correlated positively to the image of social farming. The higher the education level increases, the farmer sees the social farming.

The absence of image of the social farming sector is still seen as a risk by some managers. Indeed, the image can then still be developed and hence be hijacked. To fill this gap, the image should therefore be considered as a strategic priority for the social farming sector. Farmers have a confused and slightly negative image of the social services sector. The image of social farming sector derives from the image of the social services sector.

If a specific promotion of social farming were to be preferred, it should base itself on the positive but often unknown attributes of these types of activities. Indeed, improving the image of social farming sector should be a priority of the public service sector, as it will contribute to improving acceptance of this type of services, on the long term.

Aquaponics is a food production system that combines soil-less vegetable growing (hydroponics) and fish farming (aquaculture) inside a closed re-circulating system. This mix of food production methods (hydroponics and aquaculture) removes the problems connected with the patient production methods, Holmer et al. (2008) and Soto (2010).

The population of the world is approaching 7 billion people and anticipated to grow to 9.5 billion people by mid-century. Land for agriculture is decreasing.

Sustainability of agricultural practices is becoming more important, including yielding greater production per acre of farm land.

Animal agriculture will also be a part of long term sustainability. Hopefully this talk will help establish why.

If there are serious problems with a system such as agriculture (plant or animal):

Does it prove the system is a failure?

Does it suggest that more work is needed to improve the system?

The role of the scientist/engineer and the farmer/producer is to work together to solve the problems identified.

Agriculture, like most human endeavors, has many problems that need improvement. What we do today is never enough!

Indoor agriculture does not use the most "productive" farm land. Indoors makes it possible to raise animals in three dimensions, i.e., in multi-story buildings!

Animal agriculture uses by-products of plant and animal agriculture that might otherwise be wasted. Provides manure as a resource for fertilization and/or biogas production.

Indoor agriculture (factory farms) permits farmers to control many more environmental factors for the benefit of the animal and of the owner.

But that requires greater responsibility for the complete stewardship of one's animals. Indoors is often less stressful for animals than outdoors – e.g., fewer predators!

Do you want to be outdoors on the hottest and coldest days of the year?

Taking into account changes in land use, results showed a carbon footprint of:

- 4.81 kg of CO2e/kg of live trout
- 5.07 kg of CO2e/kg for processed trout.
- 18 kg of CO2e/kg for beef,
- 14 kg of CO2e/kg for pork,
- 8 kg of CO2e/kg for chicken (SeafoodSource.com, October, 2012).

With such large variations in flavor, consumers might object to getting different flavor profiles with repeat purchases:

- Is an almost impossible challenge for the seafood industry
- Aquaculture can control this easier than the wild catch folks
- Freezing also provides another way to control this factor
- How many people actually detect these differences and in which products?

For aquaculture, the key problem with Recirculating Aquaculture Systems may be the production of Nitrate rich waste water that must really be treated or dumped, creating major environmental problems. For hydroponics, the key problem is the entire reliance on chemical fertilizers to cultivate the vegetables, Chopin et al. (2008) and Abreu et al. (2009).

Aquaponics is an effective response to the basic requirement of modern life, a source of clean food.

Aquaculture and traditional agriculture are out of reach of any individual. Not everyone can have a space that can be dedicated to a conventional garden of culture. Lack of usable space prevents people from cultivating their own food. Acvonics eliminates these problems because this type of system does not require much space.

Aquaponic is simply a hybrid of aquaculture and hydroponic (plant cultivation in a water-based environment). Aquaponic combines the best of both systems. This method offers many advantages to farmers using it.

How the aquaponic system works:

1. Freshwater fish such as tilapia are kept in pools. They have simple aeration systems for water oxygenation.
2. Fish are fed with pellets or feed for organic or natural fish.
3. Fish feed and produce residues. These fish residues are mixed with water.
4. Some of the water is pumped out to the culture medium.
5. Vegetables are planted in culture media. Plants use the nutrients present in the water from the pools, thus purifying the water.
6. Purified and oxygenated water from the culture medium is transported back into the fish pond.
7. Fish benefit from purified and oxygenated water, and the cycle repeats itself infinitely. Due to nutrient-rich water, plantations are continually growing. The aquaponic system can also be extended and this is very simple: add more pools or increase the capacity of the existing system and extend the culture medium.

When both methods are combined in an aquaponic unit, the nutrient-rich wastewater from the fish tanks, which must normally be treated or dumped, can be used as an organic fertilizer for plant production. Consequently, this removes the requirement for chemical fertilizers for plant growth using hydroponics, Vizzini, S. & Mazzola, A. (2004).

The main benefices of aquaponics:

1. Two agricultural products could be produced from just one input (fish food)
2. High density crop production is achievable as no real competition for nutrients on the list of plants
3. Aquaponics food production is quite water-efficient (units use significantly less than 20% of the water required for normal soil farming) and units could be installed in urban or peri-urban environments
4. Aquaponics food production creates zero waste and no chemical fertilizers or pesticides are utilized making it an extremely green method of producing food

Advantages for aquaponics food production:

- Uses organic waste since the plant fertilizer
- Uses natural pest controls
- Tends to make better tasting and occasionally more nutritional crops
- Possibility of year-round production if growing environment can be controlled (i.e. greenhouse)
- Imitates an all-natural eco-system thus making it a highly sustainable food production method
- Increasing population & Urbanization
- Declining land agricultural productivity
- Increasing demand for healthy, pesticide free produce

At the beginning of cultivation we have fish and plants. Bacteria occur when the fish begin to produce residue in the pool. Bacteria in the water will help decompose residual material from fish and chemicals such as ammonia. The chemical decomposition of waste water will increase the amount of nutrients usable by plants in culture media.

Rebecca Nelson and John Pade argue that if we compare the conventional aquaculture system using freshwater fish, it can be seen that the conventional system gets dirty very quickly. If the basin has 2000 l of water, about 200 liters should be removed to keep the system clean.

Waste from conventional aquaculture systems is not useful, but if aquaponics are available, they are used by plants.

A single 2000 l capacity can feed up to four culture media. In six months, this type of system can produce up to 70 kg of vegetables and more than 40 kg of adult fish. If two systems of the same size are available, that means more than 140 kg of vegetables and fish, 100 kg of fish every six months:

1. If the system has to provide food for a regular family of 3 or 4 members, it requires a reservoir that can overstock at least 2000 liters of water, but the ideal would be 3000 liters of water.
2. A 2000 to 3000 l water tank easily supports more than 100 freshwater fish such as tilapia. You can combine different species of fish or grow one species.

3. For 6 months, saplings weighing 50 g may reach up to 500 g or more depending on the species and the quantity and type of feed administered.
4. It is very important to raise raised beds to avoid the invasions of garden pests because the pest loves fresh vegetables. The product must be protected by the inhabitants of the incredible persistent garden. If prongs will protect without biocides or pesticides, this is a good thing, because in this way the production will be 100% organic and safe for consumption.
5. If there is extra time and extra budget, you can try installing a solar panel to take care of the aquaponic system's energy need. A 65-watt panel is sufficient in most cases. Some people may complain that solar panels are a bit expensive, but the solar panel configuration will pay for itself and the aquaponic system will be natural biological cycles, but the world's cleanest source of energy, namely the sun, will be used.
6. Aquaponic encourages creativity and inventiveness in all levels. You do not have to spend a lot of money to order special tanks. If there is a crack without cracks and at least 200 liters of water, the aquaponic project can be started at home. Some people even use large barrels of plastic or metal and other large containers to shelter fish. An important thing is to be taken into account when using plastic to be a plastic food.
7. The aquaponic system should be inspected for a few minutes a day. Once the system is in place, it all works so smoothly that it is only necessary to intervene when it is time to clean the pipes and tanks.

It is considered that the model multi-use aquaponics production platforms have socio-economic and environmental impacts on aquaculture, recreational fishing, yachting and boating and other water-based activities. There is also an impact on land-based activities, agricultural tourism, water waste management, regional employment (direct and indirect) and training opportunities, Mirto et all (2010). The tremendous impact of aquaponic in aquaculture has been particularly obvious in recent years. However, aquaponic needs to overcome a lack in standardization of methodologies and procedures.

Social farming adopts a multifunctional view of agriculture. The main products, in addition to marketable products, are health care, education or therapy. Agriculture provides opportunities for people to participate in the activities of the plant or animal. Social agriculture includes agricultural enterprises that integrate people with physical, mental or emotional, firm, providing openings for the socially disadvantaged, for young offenders or those with learning difficulties, people with drug addictions, long-term unemployed people, people with the old active engagement with schools and kindergartens, and more. Disease prevention, inclusion and a better quality of life are features of social farming. Social farming has widened the concept of the role of agriculture in the development of rural areas. Since the lack of social services is one of the reasons for the depopulation of rural areas, social farming can improve the attractiveness of these areas. It can provide new opportunities for diversification, which can increase farm income, while also providing important services for previously disadvantaged or excluded social groups.

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