IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 13, Issue 12 Ser. II (December 2020), PP 01-09
www.iosrjournals.org

The Benefits Of The Integration Of Aquaculture And Irrigation For An Efficient Use Of Blue Water In Order To Strengthen Food Safety In Morocco

ABA Mustapha[1], Maryam El Bakali[2]
[1]*Aquaculture Scientific Expert in Fish Nutrition. Region Rabat-Kenitra. Moroco.*
[2]*Biological Engineering Agro-Food and Aquaculture. Department of Life Sciences Polydisciplinary Faculty Larache. Morocco.*

Abstract
Agricultural production is threatened by population growth, shrinking arable land and water scarcity under the impact of climate change. To ensure growing food security, sustainable agricultural innovations are needed to meet future food needs. New agricultural systems will need to evolve in such a way as to improve water productivity for its efficient use to ensure nutrition and food security while ensuring the sustainability of agricultural production. Although aquaculture uses non-consumptive water, in addition, global climate change is affecting the availability of water for both aquaculture and agriculture, which in turn affects the production of food needed to ensure food security. Due to the water scarcity experienced by Morocco, a country with a semi-arid climate, it is necessary to research new techniques to efficiently use water in agriculture, such as the integration of aquaculture into irrigation, thus exploiting aquaculture effluents for irrigation. This open system food production technology that integrates aquaculture with irrigation in agriculture is based on the exploitation of irrigation water storage basins for aquaculture and will create a synergy of recycling fish effluents rich in nitrogen and phosphorus materials needed by plants. The rational use of water in arid and semi-arid zones is fundamental to the sustainability of resources, and the integration of aquaculture into irrigation appears to be an efficient technique for water saving, to eliminate and exploit aquaculture effluents and to provide additional fertilisers for agricultural crops. Within this framework, in order to meet the various challenges of water shortages facing Moroccan farmers and to increase and diversify their animal and plant productivity, this strategy could be adopted and developed for the first time in Morocco, with the objective of an agricultural development model with multiple benefits that is more environmentally, economically and socially sustainable.Key words: Aquaculture integration Irrigation, water, food security, sustainability, social, environment; economy.

Key Words: Agriculture, Irrigation, Aquaculture, Climate change, Food Security, Sustainability, Water.

Date of Submission: 01-12-2020 Date of Acceptance: 15-12-2020

I. Introduction

Agricultural production is threatened by population growth, shrinking arable land and water scarcity under the impact of climate change (Fedoroff et al, 2010). According to the FAO (2016), to achieve food security objectives, while facing the threat of climate change, transformation and adaptation of agricultural systems that require significant water resources, especially in semi-arid and arid areas, will be required.

Sustainable agriculture is at the heart of the global agenda for 2030 (United Nations 2019). Moreover, sustainable agriculture promotes the wise use of natural resources, including water and land, and because healthy ecosystems depend on the preservation of freshwater aquatic ecosystems, sustainable management of agricultural water and irrigation is essential for achieving sustainable agriculture (FAO, 2020a), the use of water must face not only a limited resource, but also competition from other sectors, namely, drinking water and industry (McCartney *et al.*, 2019).

To ensure growing food security, sustainable agricultural innovations are needed to meet future food needs. New agricultural systems will need to evolve in such a way as to improve freshwater productivity for its efficient use to ensure nutrition and food security while ensuring the sustainability of agricultural production (Giovannucci *et al.*, 2012).

Morocco is a Mediterranean country with an essentially semi-arid and arid climate, these water resources are limited due to its geographical location and its exposure to climatic hazards. Morocco's agricultural sector, the mainstay of the country's food security, is highly dependent on climatic hazards, particularly drought and scarcity of water resources (Bouachou *et al.*, 2011). From the perspective of water

saving in the agricultural sector, Morocco has become actively involved through major agricultural irrigation projects, knowing that agriculture which is the principal driver for ensuring food security and economical development, the use of irrigation is a key factor in the rational and efficient use of water in agriculture, and one of the tools for achieving this efficiency is localised irrigation(Fetouani *et al.*, 2008).

Indeed, the productive advantages that can be derived from the irrigation technique result from the construction of water storage basins that should take place over years, in continuous flow, thanks to the Morocco Green Plan, which aims at the reconversion from conventional to localised irrigation, for a better rationalisation of water use and to avoid wastage and leakage of this resource (El Bilali *et al.*, 2018). In Morocco, irrigation water is under-used in conventional (i.e. generally single-use) agricultural systems, however, water stored in basins has the potential to increase in value, sustainability and production through the application of the technique of integration of aquaculture with irrigation (IAI).(Mustapha Aba *et al.*, 2014a), especially since the rapid population growth with increased competition for land and water has already affected human ability to produce food (Godfray *et al.*, 2010), this requires looking for alternatives to produce more food with less water.

In this context, the integration of aquaculture with irrigated (IAI) in agriculture is a strategy for the sustainable use of water resources, thus contributing to greater water efficiency and productivity. Gooley and Gavine (2003), recall that the development of such systems has been driven by different needs in different parts of the world, such as the desire to improve food security on small family livelihood farms, or to minimise pollution caused by aquaculture effluents and use precious resources such as water more efficiently (Gurung, 2012 ; Abdelraouf and Ragab, 2017). Indeed, in a context of increasing pressure on natural resources and land, aggravated by the uncertainties of climate change, this technique, offers new opportunities to build more sustainable food systems through new practices that allow producing vegetables, fruits in addition to fish, while also creating sustainable benefits (FAO, 2019). Its adoption will helps to ensure the productive efficiency of the water available for agriculture as well as for fish farming for the country of Morocco.

This Review article examines the benefits of IAI in Morocco, who can also bring a wide range of social, economic and environmental benefits, the 3 pillars of sustainable development.

II. Agriculture In Morocco

The agricultural sector in Morocco has been, and is still at the core of the State's socio- economic development pillar given its strategic importance with respect to issues pertaining to employment, food security, poverty alleviation. The Moroccan agriculture sector employs 50 % of the economically active population of the country. This sector is dependent on climatic fluctuations, its contribution is between 12 and 24% of the gross domestic product GDP (HCP, 2017).

Morocco as for all countries in the world faces multiple challenges to food security and the level of productivity in the agriculture sector, by food production increases the availability as well as access to food (Toumi, 2016). But, agriculture is the most susceptible economic sector to climate change related hazards, due to the fact that climate impact affects the two most important direct agricultural production inputs and these are precipitation and temperature, since, changes in precipitation patterns increase the likelihood of short-run crop failures and long-run agricultural production declines (Philip et al., 2014).

Moreover, the effects of climate change on farmers will vary depending on the production methods used, rain-fed farmers will be more vulnerable (especially in the semi-arid and arid regions of the country) to temperature increases than irrigated farmers, and the impact of climate change on crop net revenue varies by season and by region, hence the importance of irrigation in agriculture (Hashem, 2020).

Since Morocco's economic growth is closely linked to that of the agricultural sector and since the strong variations in the added value of the agricultural sector reflect the dependence of this sector on climatic conditions, and in particular on rainfall (Harbouze et al., 2019), Morocco has adopted several strategies to combat climate change by developing agricultural production to ensure food security and efficient use of water resources, given that this vital sector of the Moroccan economy is constantly threatened by the growing effects of climate change.

2.1 THE GREEN MOROCCO PLAN : GMP

In 2008, , the Ministry of Agriculture launched the Green Morocco Plan (Plan Maroc Vert (GMP), the primary objective of the GMP is for agriculture to become the main lever for Morocco's economic growth , within a sustainable rural development framework (General Council of Agricultural Development, 2009). This Green Morocco Plan (GMP) is a national strategy, launched in 2008, whose main objectives, by 2020, are the improvement of the Moroccan agriculture productivity on the basis of modern technologies, in order to rationalize water consumption and combat degradation of natural resources as it contributes to adopt the ecological and biological practices. The primary objective of the GMP is for agriculture to become the main lever for Morocco's economic growth, within a sustainable rural development framework. In general, Morocco

should encourage practices that locally and sustainably ensure the availability of basic foodstuffs for its population. Its food policy should also aim at increasing fish consumption, from 12 kg per capita per year to a global average exceeding 20 kg (Saidi and Diouri, 2017).

2.2 THE NATIONAL IRRIGATION WATER SAVING PROGRAM

In 2009, the Moroccan authorities adopted the national programme for water savings in irrigation (PNEEI in French), which aims to protect water resources against the impacts of climate change and to improve the living conditions of rural populations through sustainable management of these resources.This National Irrigation Water Saving Programme (PNEEI) targets the mitigation of water stress and a conservative and sustainable management of water resources for irrigated agriculture. To achieve this, it is planned to switch to localised irrigation on a surface area of 555,000 ha, which would allow a considerable saving of water resources of nearly 1.4 billion m3 /year by 2020 (Dahan Stephane, 2017). This is a project of conversion to localised irrigation, the impacts of the project on the environment are positive and appreciated compared to the current situation of gravity or aspersive irrigation techniques.

2-3 CLIMATE CHANGE POLICY (CCP)

In a context of increasing constraints on access to water resources, aggravated by the present and future effects of climate change, water saving is an essential part of Morocco's new water policy, particularly in the agricultural sector. Due to the dominance of agriculture in the use of water resources, will be the sector most affected by the expected drop in rainfall, both for rainfed and irrigated crops. In March 2014, Morocco adopted its Climate Change Policy (PCC), which constitutes the operational framework for the development of a medium- and long-term strategy to respond proactively and ambitiously to the challenges posed by climate change (Ait Houssa et al., 2017). This policy takes up the elements of the strategy for water saving and its valorisation in irrigated agriculture developed by the Ministry of Agriculture within the framework of the Green Morocco Plan to to improve the adaptive capacity and resilience of the agricultural sector to climate change.

III. Water Resources And Irrigation In Morocco

Water is a vital resource for sustaining life, economic development, food production, for hygiene, health and for preserving the environment. However, freshwater resources are limited. Freshwater constitutes just 2.5% of the world's water resources, of which about one third is groundwater (FAO, 2013). Although water is a renewable resource, the rate of water use and the growth in demand for agricultural and non-agricultural uses (industrial, municipal and domestic consumption) means that this use could exceed the rate of water renewal, increasing the threat of scarcity and the likelihood that water scarcity is a major social, political and economic problem (FAO, 2020b).

The ever-increasing demand for water in agriculture in Morocco is one of the main factors limiting food production. Thus, producing more food for every drop of water is essential to address water scarcity and food insecurity. The hydrologic constraints in the Moroccan country, owing among other things to climate change and its impacts on precipitation patterns, will be one of the major challenges in subsequent decades due to increased scarcity of water resources and demand driven by demographic pressure (Ouraich and Tyner, 2014).

Water resources in Morocco are potentially limited; water demand management, particularly in agriculture, represents considerable potential in the face of a limited resource with high mobilisation costs. In agriculture, the use of water must face not only a limited resource, but also competition from other sectors, namely, drinking water and industry (EESC, 2014). From the perspective of water saving in the agricultural sector, irrigation is a key factor in the rational and efficient use of water in agriculture, and one of the tools for achieving this efficiency is localised irrigation. Indeed, this irrigation system allows water savings of around 50% compared to gravity-fed irrigation (Molle and Tanouti, 2017), an opportunity to ensure the sustainable development of this sector and a necessity in order not to jeopardise the country's food security.The low water availability, combined with a high demand for water, forced the Moroccan farmers to adopt deficit irrigation programs, whose severity could increase in future years according to climate change predictions (El Jaouhari et al., 2018).

Agriculture in Morocco, is the highest sector consumer of the scarce water resources; about 80% of water resources in the country is used in irrigation The inefficiency of irrigation water use is due to the dominance of surface irrigation. Conscious of the problem of the management and saving of water, the public authorities have invested considerably for a better valorisation of the country’s limited water resources through the Green Morocco Plan (GMP) and the National Irrigation Water Saving Program (PNEEI), which have encouraged farmers to convert from surface irrigation to localized irrigation (DRH, 2016). Morocco has well developed irrigation facilities that range from small scale communal systems based on springs, qanats or river diversions to groundwater-based individual initiatives by water storage basins. (Molle et al., 2019).

The benefits of irrigation are an increase in production, higher yields, less dependence on climatic conditions, reduced risks and an increase in agricultural activity throughout the year. In addition, irrigation allows smallholders to adopt more diversified cropping patterns and to shift from low-value subsistence production to high-value, market-oriented production (Unver et al, 2018).

Climate change has forced a re-examination of the issue of water storage to cope with the effects of increasingly extreme rainfall regimes, which is why the Moroccan authorities are using subsidies to encourage the construction of water storage basins for localised irrigation (Aba Mustapha et al., 2014a), irrigation must move from simple maximisation of crop yields to a much more ambitious approach consisting of multiple use and both agriculture and aquaculture.

IV. Aquaculture

According to the FAO (2020a), all the data and analyses of aquaculture agree on the very rapid growth of this sector in recent decades. Compared with the stagnation in fish catches, the growth in aquaculture production is seen as a way of responding to the increase in demand generated by population growth. Fish aquaculture production plays an important role in contributing to the food security of the poor, who are most susceptible to malnutrition (Aba Mustapha, 2020).

Aquaculture is the fastest growing food production system in the world as the sector has expanded at an average annual rate of 9 to 10 % over the last three decades (1990–2020). Globally, aquaculture fish provides about 52 % of World fish consumption. In 2018, inland aquaculture was the source of 51.3 million tonnes of farmed food fish, or 62.5 percent of the world's total farmed food fish production, as compared with 57.9 percent in 2000 (FAO, 2020b).

4.1 AQUACULTURE IN MOROCCO

In Morocco the aquaculture sector is under the authority of two independent directorates :

4.1.1 MARINE AQUACULTURE

Marine aquaculture was introduced in Morocco in the 1950s (Kaddioui et al., 2018), the marine aquaculture is managed by National Aquaculture Development Agency (NADA) of the Ministry of Agriculture and Marine Fisheries, created in 2011, its mission is to promote the development of marine aquaculture.

4.1.2 FRESHWATER AQUACULTURE

Freshwater aquaculture started in Morocco in 1924 by the breeding of rainbow trout , when the initial objective was the promotion of sport fishing in lakes and dam reservoirs of the Middle Atlas region, this species of fish, well acclimatised in Morocco and recognised for its nutritional quality, is produced in aquaculture by the private sector (Mustapha Aba, 2014b). Freshwater aquaculture is under the supervision of the High Commission for Water, Forests and Fight Against Desertification (HCEFLCD).

4.2 AQUACULTURE STAUT IN MOROCCO

Moroccan aquaculture production is estimated at a few thousand tonnes (marine and fresh water). The reasons for the poor performance of the aquaculture sector in our country are multiple; often linked to the absence of national and regional policies during the last century to promote this sector, but also given that Morocco is the leading producer of marine fisheries in Africa, finally the public sector is predominant and there is a modest participation of the private sector. However, the Moroccan authorities have currently recognised the importance of aquaculture and have launched ambitious projects to boost this sector, both in the marine environment through the Halieutis project under the direction of NADA (National Aquaculture Development Agency) and in freshwater through a project under the authority of the High Commission for the Development Water, Forests and Desertification Control (HCEFLCD) which runs from 2015 to 2024 to develop and promote aquaculture in Morocco,all these projects will have an impact on food security, job creation and the fight against poverty (Mustapha Aba, 2014b).

As the aquaculture sector continues to expand in a world in which water, land, are under pressure to meet multiple human demands, As competition for these resources increases, integration of diverse food production systems will become increasingly attractive to improve the efficiency of resource use (Klinger and Naylor, 2012).

Aquaculture is facing a great triple challenge that involves producing more food for a growing population, conserving the aquatic resources against pollution and ensuring food security (HLPE, 2014). In this context the technique of integration of aquaculture to agriculture through irrigation is an alternative to achieve the objective of food security in the face of climate change responsible for water scarcity especially limiting the pollution of aquaculture effluents in semi-arid and arid regions of Morocco.

V. Integration Aquaculture-Irrigation (Iai)

The impact of climate change on agriculture, agricultural water management and water availability will be a critical factor, substantial adaptation will be required to ensure adequate supply and efficient use of water resources (Hugh et al., 2011). In this context, the technique of integrating aquaculture with irrigation proves to be an adequate alternative, and highly recommended for a better optimisation use efficiency of water use (Gurung, 2012), because the farmer ends up producing two foods instead of fruit or vegetable, he can produce in addition fish.

However, aquatic marines resources are limited, the search for new fish sources is essential to ensure food security for a growing population (HLPE, 2014). The opportunities offered by the irrigation ponds storage of water for fish production can contribute significantly to the overall production of animal protein, especially in developing countries, and in this context the technique of integrating aquaculture with agriculture in Morocco proves to be a sustainable alternative for fish production , since the aquaculture sector is not water consuming.

Morocco is one of the countries most threatened by climate change, these changes will have a negative impact on key sectors of its national economy, namely water and agriculture. Projections predict that the water available for agriculture will decrease by 16 per cent by 2030 and 34 per cent by 2050 (Boretti and Rosa, 2019). The main strategy for adaptation to this change is the conversion from surface irrigation to drip irrigation (Boughlala, 2013, Aba Mustapha et al., 2014a). This transition has prompted Moroccan farmers to establish water storage ponds in their agricultural fields, which are built by the dozens every year. This large number of ponds can be exploited in the technique of integrating aquaculture with irrigation in order to use irrigation water in aquaculture, whose water rich in phosphate and nitrogenous from fish waste for irrigation, without the use of fertilizers. This technique has given good results in many countries including Egypt (Abderaouf and Ragab, 2017).

In fish farming, the food is the ultimate source for the production of nitrogen and phosphorus wast, these discharges have a close relationship with the feed conversion ratio, nutrient composition, method of production (extruded vs pelleted), ratio of feed size to fish size, quantity of feed per unit time (Aba Mustapha et al., 2015).The use of these aquaculture effluents by the combination of agriculture and aquaculture production, referred to as Integrated AgriAquaculture or IAA, allows food production to increase and become more productive whilst also making efficient use of water resources. At its heart, freshwater is a fundamental requirement to both agriculture and aquaculture, but stocks are finite in arid regions and semi arids (Corner et al., 2020).

According to S. Farid (2017) in Morocco , freshwater fish farming, represented by silver and herbivorous carp, are introduced in Moroccan irrigation canals and dam lakes to fight against eutrophication and develop artisanal fishing. According to Mustapha Aba, (2014a), it is perfectly possible to produce fish in irrigation water storage basins, intended for localised irrigation, and then use the water rich in effluents as fertilisers, this technology, from the integration of irrigated agriculture to aquaculture, in which the aquaculture production system is located between the water source and the area to be irrigated, so that the same water is used twice, first for the production of non-water consuming fish and then for water consuming irrigation.

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In order to meet the demand for food to ensure food security, the active search for synergies with agricultural and livestock farming has led to a number of developments and management concepts, that together are referred to as Integrated Agriculture-Aquaculture (IAA). The Integrated Irrigation Aquaculture (IAA) systems, under such systems water is re- used on site to support agriculture and is not directly wasted as it might be in other fish production systems (Corner et al., 2020), for its most important use in primary crop production where it is used for irrigation purposes. These integrated irrigation-agriculture and aquaculture systems can be particularly important in mountainous and remote areas, depending on the weather, where poverty and

malnutrition are widespread. This will help to ensure that people have access to animal and crop production for food. (FAO, 2020b). In this technique, water serves dual purpose of usage in fish production and crop irrigation, and also maintained increase productivity of agriculture produce (Onada and Ogunola, 2016). A perfect synergy will be created between the two aquaculture and irrigation systems, through a balance with the plant and the fish through the fertilisation needs using the main aquaculture wastes which are nutrient-rich effluents from the plants (Neori et al., 2004). According to Van der Heijden (2012), fish can be farmed in water storage reservoirs and the water can then still be used for irrigation. This approach is also taken in the Czech Republic where large fish ponds are part of the natural environment (Adamek et al., 2012).

In order to maintain sustainability, however, there may be a need to move towards integrated farming systems where the waste from one farming activity becomes the supply for another (Walia and Kaur, 2013). In this context, the Food and Agriculture Organization of the United Nations (Halwart and van Dam, 2006) reported on 'integrated irrigated agriculture', where the productivity of water may be increased by growing fish in the fresh water of irrigation canals and using that water for irrigation as well as growing fish in the slightly saline drainage water that, eventually, can again be used to irrigate crops.

The use of fish farms effluents in plant production has been studied for the cultivation of several species such as lettuce (Baumgartner et al., 2007), melon (Medeiros et al., 2010), and tomato (Castro et al, 2006 and Rodrigues et al., 2010) radish (Abdul-Rahman et al., 2011), legumes (Lacerda et al., 2011), Broccoli (El-Helaly and Suloma, 2012), petunia (Danaher et al., 2013), basil (Hundley et al., 2013) watermelon and zucchini (Zouakh et al., 2016), Purslane (Kaab Omeir et al, 2020). While the same results are obtained in the work of Hailu, et al (2019), improved tomato production in the Oromia region of Ethiopia using aquaculture effluents. Recent work by Pickens et al (2020) has shown that the integration of intensive aquaculture systems with Nile tilapia (Oreochromis niloticus) effluents, associated even with the technology of biofloc improves the production of greenhouse cherry tomatoes (Solanum lycopersicum var. cerasiforme).

VI. Potential Benefits Of Integration Aquaculture-Irrigation

In order to truly speak of the sustainable development of the technique of integrating aquaculture into irrigation, the three poles of social, economic and environmental issues must be inseparable, n innovative systems approach in Morocco, that can bring benefits on all three dimensions of sustainability (climate/environment, economic, social/health), increasing the resilience of food systems to various shocks and water stresses, and enabling them to operate in a safe and equitable space and to ensure sufficient food for food security.

6.1- ECONOMIC BENEFIT

The economic benefit of integrated aquaculture with irrigation (IAI) can to contributes immensely to the economic empowerment of many families especially in the rural communities, by the enhancement of food production and self sufficiency, and can generate income and provide Regular source of income throughout the year by the production of plants and fish (Castro, 2006; Gabriel et al., 2007) and the additional source of income (Nishan et al., 2015) . The income generated by the IAI can exceed that of other conventional agricultural activities, due to the high prices earned by both animal and plant products that can reach the consumer market. The integrated aquaculture irrigation system is more profitable, farmers take advantage of relative higher profit of integrated fish farming to achieve food security (Bekibele and Onunkwo, 2007; Oladimeji and Isah, 2019).This technique can also reduce the costs of obtaining water, impoverished soil fertility is a major biophysical cause of low food production and is a threat of productive land (Mafwila Kinkela, 2019), aquaculture effluents rich in fertilisers provide the soil with the necessary fertilisers for plant development, thus reducing costs for the farmer.

6.2 SOCIAL/ HEALTH BENEFIT

The social dimension is of particular importance, since the human being is at the heart of the subject being seen. Many people living in desert and remote rural areasare not used to eating fish. This technique will makes it possible to provide them with the nutritious fish (Corner et al., 2020) a protein-rich, necessary to improve their nutritional quality to improve the health and especially of their children, in order to limit deficiencies and malnutrition.

This technical social, equitable and Human dimension of IAI can have several impacts on farmers through the development of new fish breeding (Dey et al., 2010), and to adopt new technologies such as IAI more easily, and presents itself as an excellent alternative for increasing production and improving the quality of life of local populations, to lead to increase employment opportunities, (Mafwila et al., 2019) the creation of jobs within the family, or in the rural environment for rural development. without forgetting the gender approach where the woman can intervene and participate without difficulty in this technique, by feeding the fishes and preparing fish dishes.

6.3 ENVIRONMENTAL/CLIMATE BENEFIT

The production of today's food systems is increasingly called upon to minimise environmental impacts and support livelihoods while producing food in sufficient quantity and quality to meet the growing needs and demands of people around the world (Schipanski et al., 2016). This production relies on freshwater, which is a fundamental component of agriculture and aquaculture, but stocks are limited with the impact of climate change, particularly in semi-arid and arid regions where water is in short supply. Moreover the agriculture and aquaculture sectors compete for the distribution of these water resources with other major sectors, including domestic and industrial use, with a focus on water resources (Corner et al., 2020) .

The increase in agricultural production worldwide has contributed significantly to global food security, but most often at the expense of environmental degradation. The technique of integrated aquaculture can guarantee and maintain adequate food security while respecting the environment (Onada and Ogunola, 2016) .Increasing pressures from aquaculture effluent from aquatic environments in the aquaculture sectors, as well as growing environmental awareness, mean that the technique of integrating aquaculture with irrigation is increasingly being called upon to be more efficient, and more acceptable, to simultaneously improve food security (Mccartney et al., 2019) , rural livelihoods and nutrition, as well as supporting the conservation of the aquatic environment and enriching soils with nutrients by making them more fertile. This technique offers an ideal solution for converting fish farm excreta into beneficial vegetable or fruit products and through this reuse contributes to good water resource management (Nascimento and Heller, 2005), thus, this integrated system is a kind of recycling process in which resources are well-utilized, in order to limit pollution.

VII. Conclusion

Systemic perspectives on the simultaneous social, economic, environmental, food and nutrition security challenges faced by all countries are gaining more importance, thus providing an opportunity for better reflection on the diversity of visions of agricultural system change. By creating synergies, the integration of aquaculture with irrigation offers an ideal solution to reduce nutrient release levels, increase profitability and convert fish farming excretion into beneficial vegetable or fruit products. This technique will not only contribute to food production and food security, improving the standard of living and productivity and through job creation, but it can play an important role in building resilience and adaptation to climate change, represents an important and innovative technological breakthrough, never before achieved in Morocco.

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