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Sustainable Aquaculture Development Strategy for Niger Towards 2035: A Review

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ABSTRACT: This paper highlights the potential of fisheries and aquaculture in addressing challenges such as poverty, food insecurity, population growth, and environmental degradation in Niger. With the population expected to reach 38 million by 2035, there is a need to develop strategies to ensure food security and reduce poverty in the nation. The focus is on strengthening communities to seize new opportunities and increase resilience while also improving the ecosystems they depend on. Niger is currently one of the poorest nations globally, but the development of aquaculture and fisheries could significantly contribute to economic growth through exports, job creation, and income generation for rural families. Our vision is to raise the amount of fish available for consumption and supply so that by 2035, Niger's per capita fish consumption will have increased from 0,9 kg in 2022 to 15 kg, which is closer to the average annual per capita intake of 17.8 kg worldwide. Accordingly, Niger's overall fish production must rise from 48,170 tonnes in 2022 to 500,000 tonnes by 2035. The key strategies include enhancing inland fisheries and adopting low-cost aquaculture technologies to establish aquaculture sector by 2035.

KEYWORDS: aquaculture, fishery, population growth, environmental degradation, food insecurity, Niger.

1 POPULATION AND FOOD SECURITY: NIGER'S CHALLENGE

The challenge is how Niger is going to feed a population growing from 26 million today to 38 million in 2035 in a semi-arid country that may be facing adverse climate change is unclear". In 1960, Niger's population was just 1.7 million. Niger was classified as one of the poorest countries in the World. It is however necessary to have a reliable and tested policy to reduce poverty in the country. Niger, with the world's fastest growing population (3.73%), its highest total fertility rate (7.4), a small and diminishing amount of arable land, low annual rainfall, a high level of malnutrition, extremely low levels of education, gross gender inequities and an uncertain future in the face of climate change is the most extreme example of a catastrophe that is likely to overtake the Sahel (Figure 1 & 2). The policies chosen by Niger's government and the international community to reduce rapid population growth and the speed with which they are implemented are extremely importance (Potts et al., 2011). Just 5% of Nigeriens use family planning and contraception, according to the institute for national statistics (INS). People aren't informed enough about the negative consequences of having so many children (IRIN, 2014).

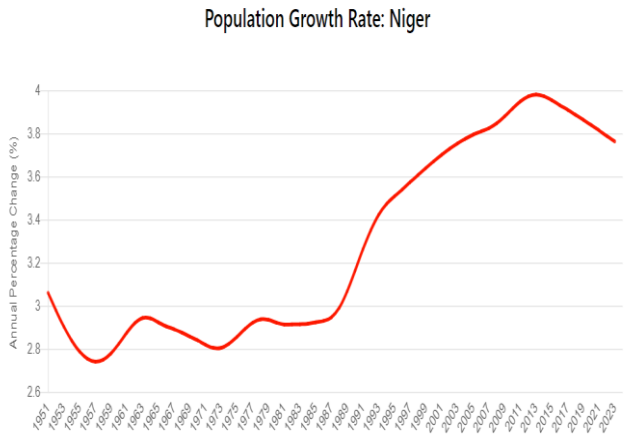

Fig. 1. Niger population growth rate (%) from 1951 to 2023

Source: World Economics & United Nations, 2024

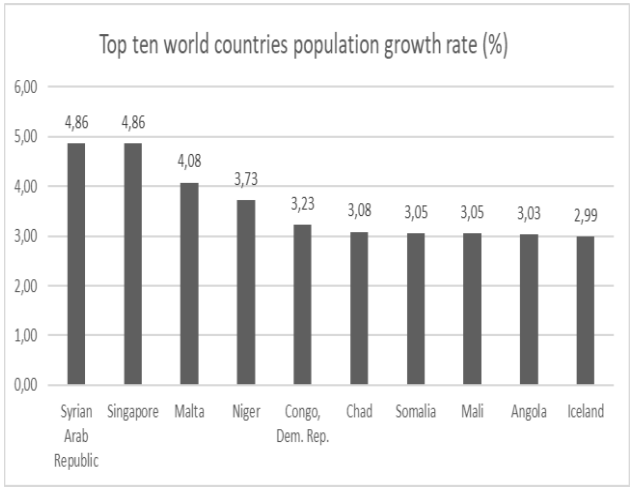

Fig. 2. Top Ten world countries population growth rate (%) in 2023

source: world bank group

The increase in the population will continue to accentuate the cereal production and wood-for-fuel deficits, if alternative solutions are not found, the INS states. Niger's population will also quickly overtake the government's ability to provide adequate health, education, jobs and even water points tasks that it is already failing at today, with a fraction of the population (IRIN, 2014). The need for animal protein is intensifying, as well as the nutritional deficiency levels among a significant part of the Niger population. What could offer a solution? According to Larive International, a market entry specialist focused on high growth markets, and their initiative Food Tech Africa (FTA), which aims to improve food security in Africa, the answer is fish production (Figure 3 & 4).

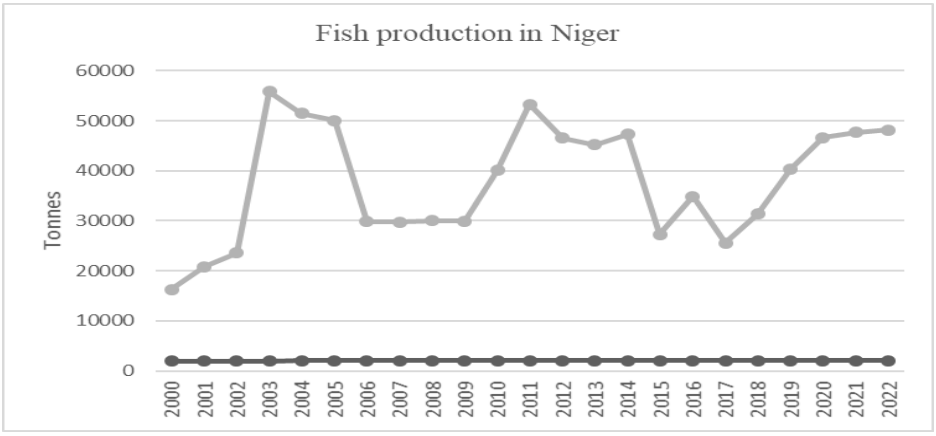

Fig. 3. Fish production in Niger (tonnes) from 2000 to 2022 calculated from FISHSTAT data (2024)

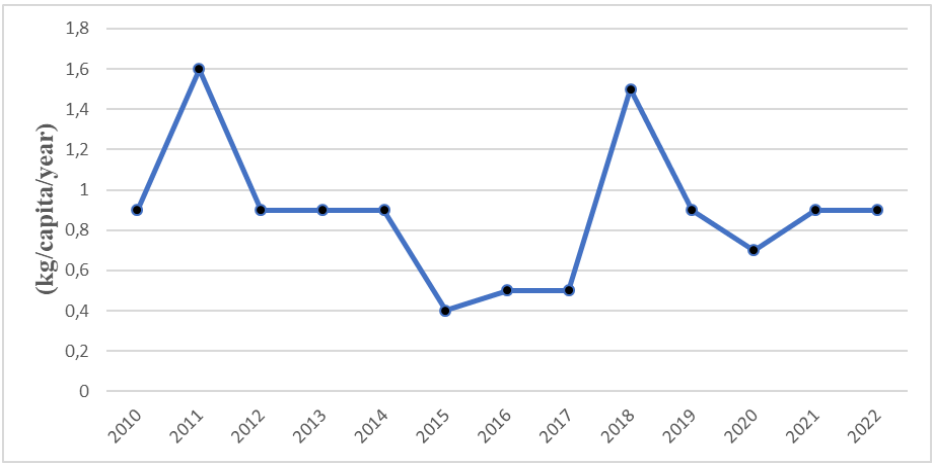

Fig. 4. Per capita fish consumption in Niger (tonnes) from 2010 to 2022 calculated from FAOSTAT data (2023)

2 THE CONTRIBUTION OF FISH INTAKE TO HUMAN NUTRITION

Fish is more nutritious than staple foods such as cereals, rice and maize, providing animal protein, essential fatty acids and micronutrients. The interventions of food-based strategies which Promote production and consumption of locally available nutritious foods have utilized fish instead of supplement distribution as a sustainable way of tackling micronutrient deficiencies (Gibson et al., 2000; Tontisirin et al., 2002; Roos et al., 2007). In addition to this direct contribution to dietary intake, fish is sold, contributing to household food security indirectly through increasing household income which can be utilised to purchase other food commodities, including lower cost staple foods (Béné et al., 2007; Aiga et al., 2009).

Protein from fish contributes to the overall protein intake significantly as the digestibility of protein from fish is approximately 5–15% higher than that from plants (WHO, 1985). Furthermore, protein from fish helps in the absorption of protein from plants. Staple foods such as rice or maize contain only a small amount of lysine, an essential amino acid, limiting the total absorption of protein. In contrast, animal sources of food such as fish have more balanced concentrations of all essential amino acids, and the concentration of lysine is particularly high (WHO, 1985). When fish is added to a plant-based diet, the total protein intake increases as lysine in fish compensates for the shortage of lysine in the rest of the diet. Therefore, fish play an important role in plant-based diets in LIFD countries.

In developed countries, the major focus has been on PUFA from fish and fish oil, which lowers blood pressure, reduces the risk of heart disease (Wang et al., 2006) and boosts infant growth and cognitive development (Koletzko et al., 2007). The lipid composition of fish is unique, having PUFA in the form of arachidonic acid (20: 4n-6), EPA (20: 5n-3) and DHA (22: 6 n-3), with many potential beneficial effects for adult health (Wang et al., 2006) and child evelopment (Koletzko et al., 2007; Suloma et al., 2008). The amount of PUFA in large freshwater fish such as carp and tilapia is relatively low, whereas the amount in smaller indigenous species is yet to be determined. Fish intake influences the PUFA levels in the breast milk of lactating women. While the importance of fish as a source of animal protein and essential fatty acids is well known, little attention has been given to the role of fish as a source of micronutrients. Small fish species are rich in micronutrients, in particular, vitamin A, calcium, iron and zinc (WHO, 2004; Roos et al. 2007**;** Chamnan et al., 2009), as they are consumed whole with bones, heads and viscera where most micronutrients are concentrated. These species are commonly consumed by the poor, and thus have a high potential to address micronutrient deficiencies.

3 ROLE OF INLAND FISHERIES AND AQUACULTURE FOR FOOD SECURITY

As over-fishing continues to deplete the world's stocks of marine fish, fish-consuming countries will be compelled to turn to aquaculture, or internal fisheries, to ensure future food security. Inland fish production provides significant contributions to animal protein supplies in many rural areas. In some regions freshwater fish represent an essential, often irreplaceable source of high quality and cheap animal protein crucial to the balance of diets in marginally food secure communities. Most inland fish produce is consumed locally, marketed domestically and often contributes to the subsistence and livelihood of poor people. Inland fisheries are often critical to local food security (Suloma and Ogata, 2006; Patrick, 2007). Competition for water and aquatic habitat is the most critical challenge facing inland fisheries in many countries. the need for water to support fish and fisheries can conflict with the needs of other sectors, in particular agriculture, in both water quality and flow requirements for sustaining aquatic habitat. Decisions on water management frequently do not take into account the impact on fish, fisheries, and the rural livelihoods of the populations that depend on them. In part this is because inland fisheries are greatly undervalued in water management at local, national, and basin levels. Equally, there is a lack of knowledge of how to optimize ecosystem services, for example, through environmental flow and water productivity approaches that are needed to guide the allocation of sufficient water to sustain fish and fisheries (Patrick, 2007).

Aquaculture is better defined, although the reporting of fisheries that interface between enhanced natural fisheries and extensive aquaculture is less clear and makes the relative contribution of each sector difficult to assess. Aquaculture remains one of the fastest-growing food-producing sectors in the world, contributing one-third of global food fish production. The nutritional benefits of fish consumption have a positive link to increased food security and decreased poverty rates in developing states (Suloma and Ogata, 2006). According to the FAO, over one billion people worldwide rely on fish as their primary source of animal protein. Around the world, average annual fish consumption is 16.1 kg per capita. In the last 30 years, animal protein consumption per capita in developing countries has more than doubled, as a direct result of technology advancement in aquaculture (FAO, 2008).

Indirectly, commercial aquaculture leads to increased food security by providing opportunities for employment and income generation for local communities. More than 500 million people in developing states reportedly depend on fisheries and aquaculture for their livelihood. As a majority of aquaculture production occurs in developing states, a rise in income leads to an increase in food purchasing power and, more importantly, diversification. The consumption of non-staple foods, including fish and vegetables, has a positive correlation with income growth, supporting food security and greater nutritional content in diets (Lehane, 2013).

There are considerable constraints on aquaculture, particularly when intensive production is the key income generator for a farmer. Poorly developed infrastructure and limited access to transportation or urban centers, can challenge its effectiveness. Where transportation is difficult, communication services are basic and access to markets is limited, it is challenging for a farmer to generate an income through aquaculture (Lehane, 2013).

Access to financial and social assistance is also a driving factor in successful aquaculture production. Because they are vulnerable to price volatilities, small-farm holders rely on access to capital for farm development and financial and social assistance to provide a safety net. Intensive aquaculture is a particularly high-risk enterprise, as a failed harvest leaves no alternative income stream. Small loans and credits to purchase fish feed, chemicals and seeds are often required to begin a production cycle. In Vietnam, collectors and traders are of particular importance, as they often provide loans in advance and take payment at harvest time. Another limitation is access to markets, particularly in urban centers. Prices for fish are highest in urban centers and the ability of farmers to access and sell fish in these markets can greatly influence potential income generation (Lehane, 2013).

4 FISHERIES AND AQUACULTURE IN NIGER

The fisheries and aquaculture throughout the world were until recently very little reflected in the policies and plans of economic development. In Niger, this situation has been exacerbated by recurrent climatic hazards (drought, erosion) with diminished resources of surface water and fish stocks over time. This resulted in the non-visibility and legibility of the sector in the economic development and therefore their marginalization, despite its financial contribution and its role in improving the living conditions of rural and urban populations (PGIPAP, 2012; DPA, 2021).

Fish production, composed mainly by capture fisheries has evolved during the period from 2000 to 2022, characterized by an upward trend marked, due to various initiatives fisheries development and amplified back of Rive Niger and Lake Chad in Niger territory. Fish production from Lake Chad, which consists mainly of three species of fish inhabit the waters for now (*Heterotis niloticus, Clarias gariepinus* and *Oreochromis niloticus*), has experienced a steady increase very significantly between 2002 and 2022 and represents 80% of national production. Total fish production from aquaculture in Niger increased from 15 tonnes in 2000 to 500 tonnes in 2022. While, total fish production from inland fisheries in Niger increased from 16265 tonnes in 2000 to 48170 tonnes in 2022 (Figure 5 & 6; FISHSTAT, 2024).

The contribution of inland fishery resources to food security is greatly underestimated. A large part of the problem is that in some countries the inland capture statistics overlook perhaps as much as two to three times the production that is reported. This is because

of the dispersed and informal nature of the fisheries, especially those that are practiced, for example, for subsistence, individually, by children, in non-perennial water bodies, and seasonally in alternation with agriculture (FAO, 1998).

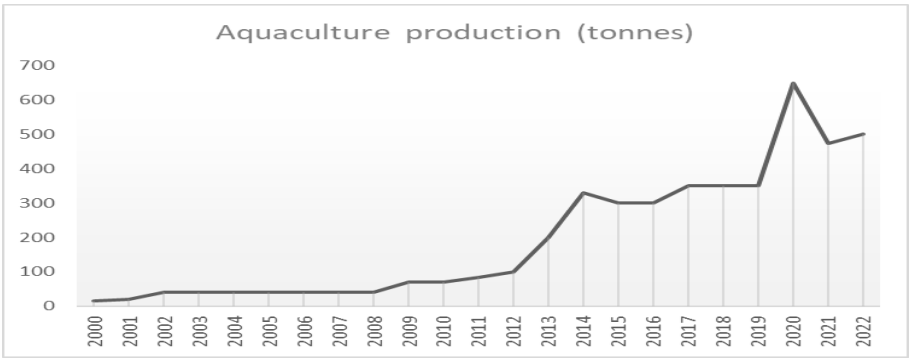

Fig. 5. Aquaculture production (tonnes) from 2000 to 2022 calculated from FISHSTAT data (2024)

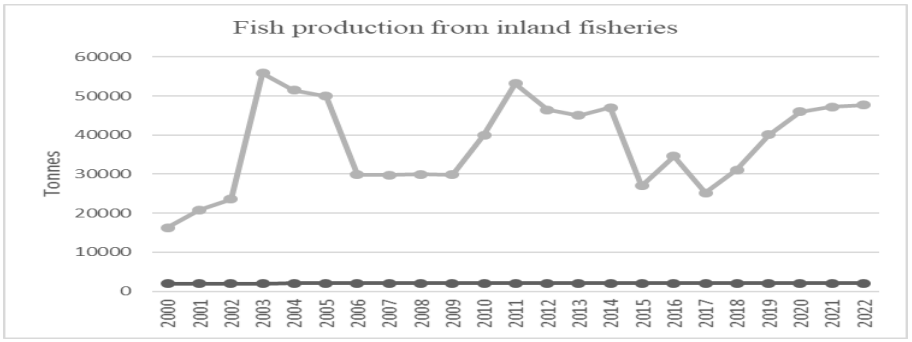

Fig. 6. Fish production from inland fisheries (tonnes) from 2000 to 2022 calculated from FISHSTAT data (2024)

5 FISH SPECIES CULTURED IN NIGER

Nile tilapia (*Oreochromis niloticus*) is the most predominant single species, other species, particularly the catfishes (*Clarias sp*). These species need immediate attention in terms of developing less expensive and efficient feeds to increase their production since production has been very low due to lack of practical feeds. Other potential aquaculture species include; Redbelly tilapia (*Tilapia zillii*) and Africa bonytongue (*Heterotis niloticus*). Most of the fish species mentioned are omnivores, which should facilitate development of aqua-feeds with or without fish meal (FM) and oil. Some of these endemic species are already being cultured by some farmers, and it would be beneficial to expand culture of local species to facilitate expansion of environmentally sustainable aquaculture in Niger. The traditional feed mixture employed in the culture of fish is mostly supplementary and unbalanced. There is an urgent need to develop low-cost, nutritionally balanced diets that can support increased intensive and semi-intensive systems. The use of fish meal at high levels in fish feeds is not feasible in Niger because of its high price and limited supply. However, a large number of less expensive oilseed and cereal by-products are available (PGIPAP, 2012).

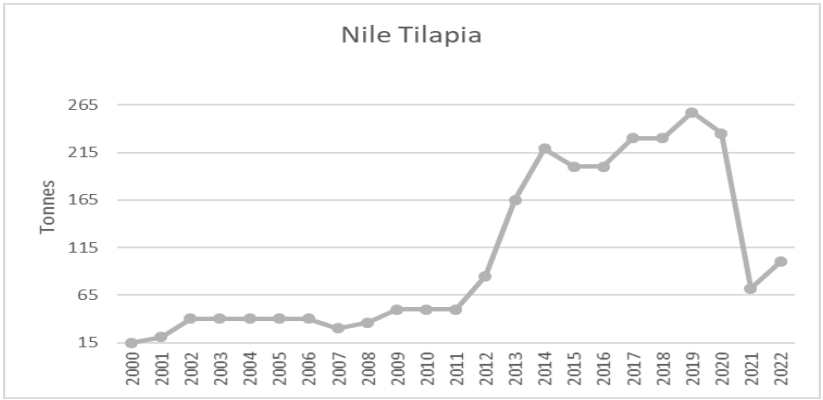

Fig. 7. Nile tilapia production (tonnes) from 2000 to 2022 calculated from FISHSTAT data (2024)

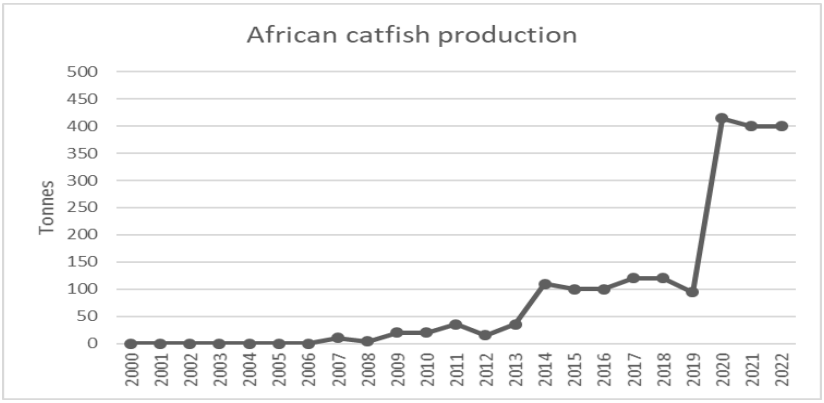

Fig. 8. African catfish production (tonnes) from 2000 to 2022 calculated from FISHSTAT data (2024)

6 SUSTAINABLE AQUACULTURE DEVELOPMENT STRATEGY FOR NIGER TOWARDS 2035

6.1 THE MAIN TARGET

Our target is to increase fish supply and consumption, with the objective of raising per capita fish consumption in Niger from 0,9 kg to 15 kg by 2035 (closer to the global average annual per capita consumption of 17.8 kg). The expectation is that aquaculture will by 2035 contribute up to 60% of domestic fish supplies, with the remainder coming from fisheries. The following two strategies have been developed to guide and direct fish production sector in Niger:

- Development of aquaculture based on low-cost technologies that are environmentally benign, socially acceptable and economically viable.
- Improve inland fisheries.

6.2 STRATEGY 1. DEVELOPMENT OF AQUACULTURE BASED ON LOW-COST TECHNOLOGIES THAT ARE ENVIRONMENTALLY BENIGN, SOCIALLY ACCEPTABLE AND ECONOMICALLY VIABLE. AND THE GOAL FOR THIS STRATEGY WILL BE AS FOLLOW:

i. There will be a significant and measurable increase in average per capita fish consumption by 2030 leading to a reduction in malnutrition rates and improved nutrition security;
ii. Aquaculture will provide a range of new livelihood options in inland communities contributing to greater social resilience and reduced poverty.
iii. New infrastructure and technical capacity will be developed to support aquaculture enterprises leading to improved economic growth.

STRATEGY 1 APPROACHES

6.2.1 SUPPORTING THE EMERGENCE OF SMALL AND MEDIUM AQUACULTURE BUSINESS ENTERPRISES IN SUITABLE AGRO-ECOLOGIES

6.2.1.1 VIABLE AQUACULTURE TECHNOLOGIES DEVELOPED AND DISSEMINATED

Low-cost but profitable technologies which effectively utilize locally available resources will be the focus of aquaculture interventions. Development and dissemination of technologies will be based on farmers' participatory on-farm trials in agro-ecological locations with good aquaculture development potential.

6.2.1.2 PRIORITY DISTRICTS WILL BE

Investments in fish farming with rural households in resource–poor areas will be achieved by investments in small ponds. Niamey, Diffa and Agadez offer greater potential for aquaculture to impact food and nutrition security (Table 1).

Table 1. Action plan for aquaculture system development

Activities	Time	Key partners
Accelerate up take of viable fresh water aquaculture technologies for African catfish and tilapia production in existing and new ponds through participatory on-farm trials in Niamey, Diffa and Agadez (desert model):		
• 50% of small scale-freshwater fish ponds (extensive) with pond productivity over 4.0 t/ha/year.	By end 2025	100% government sector
• 75% of small scale-freshwater fish ponds be shift to semi intensive farm with pond productivity over 10 t/ha/year.	2030	50% government sector + 50% private sector
• 50% of semi intensive farm will be shift to intensive with pond productivity over 20 t/ha/year	2035	100% private sector

6.2.2 CAPACITY BUILDING AND TRAINING

Aquaculture development in Niger is constrained by virtue of inadequate human resources, and limited extension systems. Government agencies promoting aquaculture require strengthening through increasing the number of skilled aquaculture staff. The short-term focus will be to build the capacity of existing human resources through short term training courses, and to build capacity in partner organizations so that they also have the skilled personnel and resources to plan and support aquaculture development.

It is important to develop a strong team of staff in Niger that can conduct research and planning and then implement sustainable aquaculture development interventions producing lasting impact. In the medium term, qualified staff members should be encouraged to pursue advanced degrees in priority subject areas. This activity should dovetail with the human resource development strategy with support from FAO executed Regional Fisheries Livelihoods Program (RFLP). Other aspects of institutional development are also important. These include development of an effective extension services to support rural farmers and an improved statistical system. Regular monitoring of the adoption and retention of aquaculture technologies by farmers, and the changes realized in fish production and productivity over time, is essential. Ministry of agriculture will establish National Authority for Fisheries and Aquaculture Development (NAFAD) by 2025 (Table 2).

Table 2. Action plan for capacity building and training

Activities	Time	Key partners
NAFAD staff will increase their aquaculture and extension skills through short term training:		
• Provide training on fish hatchery and brood stock management to all NAFAD staff	2025	NAFAD
• Provide training to 50% of NAFAD aquaculture staff on development and dissemination of Low-cost but profitable aquaculture technologies through participatory on-farm trials.	2026-2030	NAFAD
NAFAD builds a team of aquaculture experts through advanced academic degree training:		
• 10% of aquaculture staff will be selected to complete advanced level academic degrees.	2030-2035	NAFAD and Nigerien University
Extension services developed for supporting rural households and enterprises in development of aquaculture	2025-2035	NAFAD, private sector and Nigerien University
Establishment of aquaculture statistical system and select responsible staff for collecting data.	2025-2030	NAFAD
NAFAD coordinates the organization of vocational raining on aquaculture to respond to Human Resource Development (HRD) needs at grass root level	2030-2035	NAFAD and private sector

6.2.3 SUSTAINABLE INPUT SUPPLY SYSTEMS ESTABLISHMENT

6.2.3.1 FISH SEED

Ensuring farmers have access to quality fish seed is crucial to the expansion of aquaculture. The NAFAD will establish three freshwater fish hatcheries with modest facilities in Niamey, Diffa and Zinder. The expected annual demand for seed by 2030 will be over 100 million fry/fingerlings. NAFAD hatcheries should focus their activities beyond seed production and distribution, and diversify into serving as a reliable source of quality brood-stock for private hatcheries. A clear business plan should be established for each hatchery to ensure sustainability.

6.2.3.2 FISH FEED AND FERTILIZERS

In the short term, promoting small-scale aquaculture systems reliant on commercial pellet feeds is not likely to be viable because of high production costs which would be unsustainable when subsidized. Freshwater fish farming in the country will initially target small enterprises, with a view to improving household food and nutritional security. The initial target will be to produce sufficient volumes of lower priced aquatic products that are affordable to a wide range of households, and can still generate income for farmers. Initially technologies that are efficient and profitable but based on low-cost farming systems will be promoted. This approach will require low-cost fertilization and feeding strategies, most appropriately through the utilization of locally available resources. Enhancement of normal pond productivity using natural organic fertilizers and composts, or 'green water technology' for tilapia culture, and the use of on-farm supplementary feeds will be promoted (Suloma and Ogata, 2006). Formulation of feeds utilizing crop by-products (rice bran, cassava leaves and roots, grasses, corn, coconut by-products, etc.) can be researched and promoted as low-cost feeding systems. The variety of ingredients and their proportions in on-farm feed preparation will vary according to the resources available at the local level. Production of feed pellets in-country may be an option for intensification of fish production systems over the longer term (Table 3).

Table 3. Action plan for Sustainable input supply systems establishment

Activities	Time	Keypartners
Fish seed will be available to fish farmers through a	2025-2027	NAFAD
self-sustaining network of hatcheries, nurseries and trading:	2026-2030	NAFAD
Establishment of NAFAD hatcheries to full capacity, and operational on a sustainable basis NAFAD hatcheries serve as source of quality broodstock for private hatcheries New fish hatcheries and nurseries established through private or public–private partnerships	2027-2035	Privatesector
Fish feeds based on locally available ingredient will be available to fish farmers: On-farm trials of feed and fertilization systems accomplished; wide spreads haring of suitable technologies; majority of fish farming households formulate and feed with fish feed based on locally available resources	2025-2030	NAFAD, Privatesector
Small scale aquafeed processing plants, based on locally available feed ingredients, are established at the community level and supply 50% of the total fish feed demand.	By 2035	Privatesector

6.2.4 IMPLEMENT A COLLABORATIVE STRATEGY FOR INTEGRATION OF FISH INTO SMALL SCALE IRRIGATION/POND.

Integrated irrigation and aquaculture (IIA) are a strategy to achieve agricultural productivity from every drop of water while improving the financial sustainability of investments in irrigation. Adopting integrated irrigation and aquaculture through a program of Integrated Inland Water Resources Management will contribute to improved food security in drought-prone West African countries.

In practice, IIA is not new but simply a statement of a logical approach to resource use that has, in one way or another, been employed by residents of water-scare areas for centuries. IIA technologies seek to reuse resources such that the whole is greater than the sum of the parts. To a large extent, these technologies remain to be aggregated and collated in a form that can be effectively distributed to stakeholders. The current activities, potential sites and constraint to IIA development in Niger are summarize in Table 4.

Table 4. The current activities, potential sites and constraint to IIA development in Niger

IIA activities carried out	**Indirect rice-fish integration in the Saga, Commune *Niamey III* irrigation scheme. Fish in ponds adjacent to lowland rice fields in peri-urban zones.**
Potential sites for developing IIA	South and West of the country: perennial streams and higher rainfall Fully controlled irrigation: • The lake *Chad Basin*. • The floodplain of the Niger River is considered the greatest untapped potential for irrigation development, along with the River Benue and artificial reservoirs, could accommodate fish culture and IIA activities. • The desert model of IIA which design by Suloma and Ogata (2006) may be recommended for Agadez to improve the utilization of underground water in this desert area .
Constraints to IIA development	Little potential for IIA in flood-dependent irrigation schemes (e.g. Niger River) due to reduced peak floods. Constraints mainly linked to aquaculture development: - Lack of extension officers and limited promotion of the activity among rural populations Seasonal water availability Lack of institutional support and funds for aquaculture development Single purpose management of irrigated rice areas Low priority amongst farmers Lack of rice-fish farming experience Competition for on-farm resources, conflict over water allocation Poor communication networks Lack of funding (international agencies) Lack of government direction in rice-fish development. - Lack of information and high irrigation costs which farmers cannot afford. Lack of fish seed, feed, capital and information for farmers High investment for irrigation development

6.2.5 IMPROVING THE SUPPLY CHAIN OF NATIVE SPECIES INDUSTRY IN NIGER.

Fish products need to be inexpensive and to reach consumers, especially the poor and malnourished, if aquaculture is to create impact. Markets within Niger for farmed fish are currently rudimentary, and fish marketing systems will need to be developed in parallel with production systems the expected increase in fish production in the future.

6.2.5.1 SUPPLY CHAIN MANAGEMENT IN THE FOOD SECTOR

- Food sectors such as agriculture and aquaculture involve a diverse range of distinct enterprises (producers, processors, marketers and distributors) and rely on inputs from various sources, often at distinct geographical locations (Hobbs, 1996; Williamson, 1979). In developing countries these sectors are mostly composed of small hold producers. These producers are information-poor and usually viewed as being the least powerful in the marketplace.
- Small holders operate in critical supply chains; thus, value chain becomes necessary for sustaining small holder growth. A primary driver of the growing focus of the food sector on supply chain management is the changing competitive environment. Supply chain management provides one conceptual approach to build the capacity of domestic producers to match the products that exporting countries will be aiming to put into world markets. Thus, supply chain management in the food sector is an essential tool for integrating each step in the entire production and distribution process (Tveteras and Kvaloy, 2004).

6.2.5.2 BENEFITS OF SUPPLY CHAIN MANAGEMENT

- Specific gains in supply chain management include; reduction of product losses in transportation and storage, increase in sales, foster dissemination of technology and advanced techniques, provision of capital and knowledge among the chain partners, better information about the flow of products, markets and technologies, greater transparency in the supply chain, accurate tracking and tracing of product flows, better control of product safety and quality and large investments and risks are shared among partners in the chain (Vivanco-Aranda, *et al*., 2010).

6.2.5.3 STRATEGY TO DEVELOP FISH MARKET SYSTEM

The proposed strategy is therefore to concentrate investment into carefully selected regions. Developing "clusters" of farmers in the specific geographical locations with the greatest potential for development, together with the necessary services such as a hatchery and feeds, is an approach that has already proven successful in supporting the emergence of small and medium scale aquaculture elsewhere. Value chains need to be understood, and investment made to address market access constraints and gaps (Table 5).

Local markets for fish sales and production inputs will be developed through joint collaboration between Ministry of Agriculture and Ministry of Economy and Development. The NAFAD and the private sector will play important roles in establishing linkages between fish producers and local markets.

Table 5. Recommended strategy to improve fish market system

Activities	Time	Key partners
Fish marketing facilities are developed in all districts/sub districts and fish farming production groups are linked to these markets.	By end 2020	NAFAD
Over 50 % of households producing fish sell surplus fish beyond household consumption in district/sub district Markets.	By end 2025	NAFAD and private sector

6.3 STRATEGY 2. IMPROVE INLAND FISHERIES

- Improving the consideration of fisheries in water management decisions requires better valuation methods and improved governance. Valuations need to pay more attention to nonformal values, especially those concerning livelihoods and food security. Governance systems need to incorporate such values into cross-sectoral water management that recognizes the importance of ecosystem services.
- Decentralization may be a possible avenue toward these governance improvements but should be planned and implemented with care if equity in access to the resource, and its full development value, is to be fostered. There are two broad challenges for fisheries production. The first is to sustain current levels of fisheries production and other ecosystem services through the provision of target directed environmental flows that sustain or restore the aquatic environment, including its diversity, and improved management of capture fisheries. The second is to increase current levels of fisheries production through the wider adoption of methods for enhancing and intensifying production, such as stocking and aquaculture, which require adequate quantities of clean water, suitable habitat, and appropriate management arrangements. These challenges will be more successfully addressed by building partnerships between fisheries and other interest groups concerned with water management, especially those engaged in water management for agriculture, which are also searching for more efficient ways to increase the overall benefits of water productivity to food security and poverty reduction. To increase fisheries production from 55,000 metric tonnes to 100,000 metric tonnes per year within a few years, the following recommendations have to be considered:
- Urgent need for a workshop on the status and trends in the collection of capture fisheries and aquaculture statistics in Niger as a first step to critically analyze the situation, learn from the positive experiences of some countries and seek to mobilize national resources as well as other assistance to reverse the existing negative trend.
- Improvement of information on the status of the Lake Chad and Niger River fisheries by national sectors.
- Promote responsible practices in culture-based fisheries through regional collaboration on stocking programs and coordination of measures relating to stocking practices in shared waters, formulation of technical guidelines for responsible stocking programs, feasibility studies of risk evaluation of transfers of selected species, and case studies of successful stocking practices.

7 CONCLUSION

Increase fish production to a level that reaches the consumption of 15-17 kg per capita per year are the key to improving food security in Niger until 2035, with the steady increase in the population expected. And to reach this goal, we must apply the strategies to increase the production of fish from aquaculture and inland fisheries under sustainable development. We hope that our vision of this research through a means which may help to reach this goal and that the government of Niger to apply this vision during the period of 2025-2035.

REFERENCES

[1] Aiga H, Matsuoka S, Kuroiwa C, Yamamoto S, 2009. Malnutrition among children in rural Malawian fish-farming households. Transactions of the Royal Society of Tropical Medicine and Hygiene, 103, 827 - 833.

[2] Béné C, Macfadyen G, Allison EH, 2007. Increasing the contribution of small-scale fisheries to poverty alleviation and food security, FAO Fisheries Technical Paper 481, Rome: Food And Agriculture Organization.

[3] Castenmiller JJM, West CE, 1998. Bioavailability and bioconversion of carotenoids. *Annual review of nutrition,* 18, 19 – 38.

[4] Chamnan C, Thilsted S, Roitana B, Sopha L, Gerpacio RV, Roos N, 2009. The role of fisheries resources in rural Cambodia: combating micronutrient deficiencies in women and children. Phnom Penh: Department of Fisheries Post-harvest Technologies and Quality control, Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries.

[5] FAO. 1998. Département des pêches. Développement de l'aquaculture. FAO Directives techniques pour une pêche responsable. No. 5. Rome, FAO.

[6] FAO. 2008. Report of the Expert Consultation on Improving Planning and Policy Development in Aquaculture. Rome, 26–29 February 2008. FAO Fisheries and Aquaculture 40 Report. No. 858. Rome, FAO.

[7] FAO. 2009. Aquaculture production 1950-2007. FISHSTAT Plus—Universal software for fishery statistical time series [online or CD-ROM]. Food and Agriculture Organization of the United Nations.« *Food and Agriculture Organization of the United Nations.*

[8] Gibson RS, Hotz C, Temple L, Yeudall F, Mtitimuni B, Ferguson E, 2000. Dietary strategies to combat deficiencies of iron, zinc, and vitamin A in developing countries: development, implementation, monitoring, and evaluation. *Food and Nutrition Bulletin,* 21 (2), 219 – 231.

[9] Hobbs JE, 1996. A transaction cost approach to supply chain management. Supply Chain Mgt 1 (2): 15-17.

[10] IRIN. 2014. NIGER: Population explosion threatens development gains. http://www.irinnews.org/report/75801/niger-population-explosion-threatens-development-gains.

[11] Koletzko B, Cetin I, Brenna JT, 2007. Dietary fat intakes for pregnant and lactating women. British Journal of Nutrition, 98, 873 – 877.

[12] Lartey A, Manu A, Brown KH, Peerson JM, Dewey KG, 1999. A randomized, community-based trial of the effects of improved, centrally processed complementary foods on growth and micro-nutrient status of Ghanaian infants from 6 to 12 mo of age. *American journal of Clinical Nutrition* 70, 391-404.

[13] Lehane S, 2013. Fish for the Future: Aquaculture and Food Security. http://www.futuredirections.org.au/publications/food-and-water-crises/1269-fish-for-the-future-aquaculture-and-food-security.html.

[14] Olson JA, 1996. Biochemistry of vitamin A and carotenoids. In: Sommer, A., West, K.P. Jr. (edt). Vitamin A deficiency: health, survival, and vision (pp. 221 - 250). New York: Oxford University Press.

[15] Patrick D, 2007. Inland fisheries and aquaculture. Veliyil Vasu Sugunan, Robin L. Welcomme, Christophe Béné, Randall E. Brummett, and Malcolm C.M. Beveridge http://www.iwmi.cgiar.org/assessment/Water%20for%20Food%20Water%20for%20Life/Chapters/Chapter%2012%20fisheries.pdf

[16] PGIPAP. 2012. Répertoire de la faune aquatique de la zone d'intervention du projet. Direction de la Pêche et de l'Aquaculture, Niger. 24p.

[17] Potts M, Virginia G, Martha C, Sarah Z, 2011. Niger: Too Little, Too Late. International perspectives on sexual and reproductive health. Volume 37, Number 2, June 2011.

[18] Roos N, Wahab MA, Chamnan C, Thilsted SH, 2007. The role of fish in food-based strategies to combat Vitamin A and mineral deficiencies in developing countries, *The journal of Nutrition,* 137, 1106 -1109.

[19] Suloma A, Ogata H, Garibay ES, Chavez DR, El-Haroun ER, 2008. Fatty acid composition of Nile tilapia (*Oreochromis niloticus*) muscles: a comparative study with commercially important tropical freshwater fish in Philippines. Proceedings of the Eighth International Symposium on Tilapia in Aquaculture. 12-14 Oct. Cairo, Egypt, 2: 921-932.

[20] Suloma A, Ogata HY, 2006. Future of Rice-Fish Culture, Desert Aquaculture and Feed Development in Africa: The Case of Egypt as the Leading Country in Africa. JARQ., 40 (4): 351-360.

[21] Tontisirin K, Nantel G, Bhattacharjee L, 2002. Food-based strategies to meet the challenges of micronutrient malnutrition in the developing world. Proceedings of the Nutrition Society, 61 (2), 243 - 250.

[22] Tveteras R, Kvaloy O. 2004. Vertical Coordination in the Salmon Supply Chain. Centre for Research in Economics and Business Administration, Working Paper No 7/04.

[23] Vivanco-Arandaa M, Francisco JM, rMartínez-Cordero FJ, 2010. Foresight analysis of tilapia supply chains (Sistema Producto) in four statesin Mexico: Scenarios and strategies for 2018, Technol. Forecast. Soc. Change., 78 (3): 481–497.

[24] Wang C, Harris W, Chung M, Lichtenstein A, Balk E, Kupelnick B, Jordan HS, Lau J, 2006. n–3 Fatty acids from fish or fish-oil supplements, but not linolenic acid, benefit cardiovascular disease outcomes in primary and secondary-prevention studies: a systematic review. American Journal of Clinical Nutrition, 84 (1), 5 - 17.

[25] WHO. 1985. *Energy and protein requirements,* Geneva: World Health Organization.

[26] WHO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva: World Health Organization and Food and Agriculture Organization.

[27] Williamson O, 1979. Transaction-cost economics: the governance contractual relations. J. Law and Econ. 22: 233-261.

[28] World Economics & United Nations, 2024. Niger's Population Growth Rate: 3.8%.

[29] https://www.worldeconomics.com/Demographics/Population-Annual-Growth-Rate/Niger.aspx.