Project Brief

Integrated Aqua-Agriculture for Enhanced Food and Water Security

Implementation of IAA systems at ICBA headquarter started in 2013 on 1.5 hectares to test the concept.

Healthy Tilapia and Sea Bream grown in tanks filled with brine water produced from the RO-unit exhibited an increase in weight (200%) and in length (60%) in just four months.

Thematic Area: Aquaculture and Bioenergy

Purpose: Examine the effectiveness, sustainability and scaling out potential of IAAS in marginal environments

Geographic Scope: Arabian Peninsula

Timeline: 2013 - 2016

Funding Agency: United States Agency for International Development (USAID)

Partner: International Water Management Institute (IWMI), Sri Lanka

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In arid and semi-arid regions like the Arabian Peninsula, water is a scarce natural resource exacerbated by salinity and other contaminants. In many of these marginal environments, improving water supply for human consumption and irrigation purposes requires desalination of groundwater. To-date, approximately 15% of farmers in the Arabian Peninsula install small-scale reverse osmosis (RO) plants to desalinate the groundwater for field crop irrigation. These plants produce highly concentrated brine which can be an environmental hazard if not disposed off safely.

Given that conventional disposal systems of desalination brine are expensive and unproductive, the International Center for Biosaline Agriculture (ICBA) has been collaborating since 2014 with the International Water Management Institute (IWMI) to examine the costs and potential revenues from a freshwater and brine-fed Integrated Aqua-Agriculture System (IAAS). The potential for replication and scaling out will be analyzed as a means not only for safe brine disposal but also for improvement of farmers' income. Specifically, the project aims to showcase how on-farm available water resources (desalinated and marginal quality) can effectively be managed to optimize crop production, seed production and grow aquatic species. Special emphasis is placed on developing an integrated aquaculture and crop production system suitable for desert areas that is technically and economically feasible.

Activities and Outcomes

A land-based IAAS supported by a RO-unit was established at ICBA in 2013 to demonstrate how less productive farms can be transformed into productive farms using different technologies.

The RO-unit that supports IAAS desalinates brackish groundwater of 25 dS/m and can produce desalinated water at 100 m^3/day and brine at 150 m^3/day.

The **desalinated water** is used to irrigate a large variety of high value crops such as radish, lettuce, spinach, carrot, cauliflower, tomato, asparagus, maize, eggplant, amaranthus, mustard and quinoa. On the other hand, about 150 m^3/day of the brine water is used for aquaculture followed by irrigating salt-tolerant forage grasses and halophytic plants.

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Various vegetables are being irrigated with desalinated water at the experiment plot in ICBA.

The **mariculture system** comprises fish, sedimentation and seaweed tanks in a sequential manner using brine water. Two fish species *Sparidentex hasta* (sobaity seabream) and *Oreochromis spilurus* (tilapia) demonstrated remarkable adaptability to the local conditions. Results obtained within four months demonstrate that fish weight increased by 200% and fish length by 60%. The fish wastewater flows to the sedimentation tanks where the suspended solids are removed. This partially filtered wastewater flows in a second tank where ICBA scientists are experimenting with growing seaweeds.

During the first year trial, *Ulva* spp., a green seaweed species will be grown. It can be used as soil amendment, pharmaceutical and medicinal purposes, for human consumption or animal feed. Seaweed absorbs dissolved remnants of nutrients and uses it for its own growth. Water from the seaweed tanks, is then directed to irrigate salt-tolerant grasses and halophytic species.

Salt-tolerant forages such as *Sporobolus arabicus*, *Distichlis spicata*, *Sporobolus virginicus*, *Paspalum vaginatum* and NyPa grass are cultivated under four irrigation treatments: a) direct RO-brine; b) RO-brine combined with groundwater; c) aquaculture-brine from the seaweed tanks; and d) aquaculture-brine combined with groundwater. Based on first year results, *Distichlis spicata*, *Sporobolus virginicus* and NyPa grass were shown to be the most productive among the salt-tolerant forages. These species have been further expanded in the experimental area to maximize the use of high saline water resources.

Salicornia bigelovii, a **multi-purpose** species, such as mustard and quinoa, all known for their salt-tolerance, are also being evaluated at ICBA for their growth performance under high salinity levels.

Monitoring of soil and all water treatments is periodically conducted to check the build-up of salts and other elements in order to sustain the plant and aquatic species production.

So far results show that these integrated systems can create an abundance of ecological and economic advantages in marginal environments. Benefits range from sustaining environment quality through productive use of brine and dissolved and particulate nutrients discharge to generate value-added by-products that increase farmers' income.

Future Directions

Based on investment costs and revenues, financial analyses will be conducted during 2015 to examine the economical feasibility and "Return on Investment" of such land-based IAA systems in order to assess the potential for replication and scaling out in marginal environments.

Outreach and communications programs that bring different stakeholders (farmers', extension officers, public-private sector) together to disseminate knowledge and build capacity on the most effective IAA application, management and marketing strategies will be a pre-requisite for any wide scale adoption of these IAA systems.

Additionally, ICBA will work on developing appropriate digital training and communications material that will be available on its website and social media platforms to ensure that the public has access to informative and comprehensive material on IAA systems. The need for, and benefit of establishing a platform for regional and interregional cooperation and networking will also be explored.

Agriculture consumes 70% of global water resources, causing enormous pressure on fresh water reservoirs. Halophytes such as Salicornia irrigated with aquaculture effluents from the IAAS offer an alternative to using fresh water for agricultural production.