A way forward for utilisation of aquatic genetic resources in Asia-Pacific: Synthesis from deliberations during the Regional Workshop on Underutilized Fish and Marine Genetic Resources and their Amelioration 2019

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The world is facing multiple interlinked problems with cascading impacts. The world population is rising and likely to reach 9.8 billion mouths to feed by 2050. The need for more job opportunities, livelihoods, nutritional security, quality of life and of environment demands an innovative sustainable growth pathway, to check the risk from societal inequalities. In this context, genetic resources are poised to play a significant role in the future and considerable attention must also be given in the various global treaties and actions not only to conserve resources, but to sustainably utilise them, also. This is reflected through the developments after the Convention on Biological Diversity (CBD) and many other instruments, such as Nagoya Protocol, Sustainable Development Goals (SDGs), and Aichi's Biodiversity Targets. The majority of the countries including from the Asia-Pacific region are committed to fulfill these international obligations.

Aquatic genetic resources, unambiguously, are important for enhancing food production and their diversity is important for future food security, especially in view of climate change. These resources are the outcome of natural forces and evolution of biological systems and represent the adaptations to the changing environment happening through millions of years.

Aquatic genetic resources can be propagated to meet human needs. The carbon-based economy, which has been driving economic growth in the industrial era, is dependent upon finite resources, therefore the bioeconomy is now been looked upon as a future source of intensified growth. Hence, it is an important perspective that countries in Asia-Pacific, with rich and diverse biodiversity, need to consider genetic resources for their economic growth and nutritional security. Going forward, technology and knowledge can be major drivers in this movement of enhancing the utilisation of diversity and with minimum risk to the environment.

Utilisation of aquatic genetic resources is a concern

Fish genetic resources have an important place in meeting future food production demands, however, as capture fisheries are stagnant and to meet the additional expected requirement of 40 million tonnes of fish after 2030, intensification of aquaculture production is important. Among all the food production sectors, aquaculture is growing among the fastest at a pace of over 6% globally since 1970, and now contributes nearly 50% to global fish production. Asia contributes over 70% to global fish production and 38% is traded mostly from developing countries to developed countries. This trade is a source of livelihoods in the small-scale farming context, which makes up the bulk of Asian aquaculture. In many Asian countries, per capita fish consumption has reached over 40 kg against the global average of around 20 kg. Aquatic genetic resources are also products of commercial importance.

FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA) has published the Report on the Status of World Genetic Resources Aquatic Genetic Resources with input from 92 nations, including 21 countries from Asia. This report covers all the major fish producing countries. The report emphasises the vast untapped potential which should be a joint concern for all nations. Globally, out of the known 163,588 species, only 554 species (0.003%) are in farming and 1,839 (0.011%) are used through capture. The group-wise details are given in table 1, which shows that the current utilisation of genetic resources is a tiny fraction of the total available potential.

Table 1. Global utilisation of aquatic genetic resources through aquaculture and capture as proportion of total species diversity available.

	Aquaculture	Capture
Finfish	1.09	4.59
Molluscs	0.17	0.28
Crustaceans	0.09	0.28
Other aquatic animals		
Aquatic plants	0.27	0.20

In aquaculture, the species used are still mainly wild types in contrast to other livestock and crop industries where cultivation is based on domesticated and improved varieties developed through human intervention. Genetic improvement is an important issue fundamental to farming. This practice is still very low in aquaculture, as the genetic diversity below the level of species is still inadequately documented and utilised for most of the important aquatic species, particularly in the Asia-Pacific region. The discoveries of species which are new to science is still happening with the increased use of integrated taxonomy. Moreover, some nations are also developing advanced research capabilities for management of aquatic genetic resources. Countries that are rich in aquatic genetic diversity, both at inter and intra-species levels have potential to harness improved benefits from the bioeconomy. In this scenario, knowledge, technological developments, inclusive strategies to manage aquatic genetic resources, enabling environment and policy support can be the key drivers. There will be enormous significance of cross learning

and mutual support for technological capacity building. Some of the important perspective elements of bioeconomy with respect to aquatic genetic resources are given in table 2.

Table 2. Elements of bioeconomy based on utilisation of aquatic genetic resources.

Element	Utilisation
Technological innovations & scientific findings from life forms	AqGR as model in medical science Genomic selections for improvement Genome editing Genes & alleles discovered for traits Transgenics
Production, processing & use of aquatic genetic resources	Aquaculture Capture fisheries Processing & trade Commercial & pharmaceutical products Disease diagnostics & management Ornamental fish trade Material & infrastructure manufacturing Services & consultancies

Information and databases to support utilisation of aquatic genetic resources

Aquaculture is remarkably diverse compared to terrestrial livestock industries, involving hundreds of species cultured across a wide range of taxonomic groups, and with constant exploration of new species. However, outside a small handful of mainstays, little is known about most aquatic species in terms of their biology, health, precise nutritional needs, behaviour, ecology and environmental requirements.

As we document and build our knowledge of aquatic genetic resources it is increasingly important to capture data in information systems where it may be searched, accessed, and archived online in perpetuity. There are several ways that information systems can contribute to the sustainable utilisation of aquatic genetic resources:

Documenting biodiversity: Identifying new species with high potential to be farmed; or that would make useful alternative species under some circumstances (eg. due to an environmental tolerance or resistance to a pathogen); or that can fill vacant/underutilised niches in our farming systems and provide supplementary crops.

Documentation of improved varieties: Selecting the best performing genetic resources to develop high performance lines or improve overall performance. In terrestrial agriculture, selective breeding is taken for granted; genetic profiling of dairy cattle and exchange of genetic materials to improve the herd productivity is widely practiced in Australia and elsewhere, using online information systems to share data and select appropriate material.

Documentation of molecular genetics: Markers, sequences, genomes and related data can inform breeding programmes for improved productivity or conservation purposes.

Development and maintenance of such information systems is a large and expensive undertaking, and one that requires an ongoing commitment. However, it is also an endeavour that rewards collaboration and is ideally suited to an international effort, with economies of scale easily realised.

Way forward

To tread on the path of bioeconomy, there is urgent need of strategies, policies and capabilities to enhance the utilisation of species diversity. One of the important aspects of such strategies is prioritisation of resources for use and development of appropriate processes and practices to derive sustainable production and revenues from genetic resources. In this context, the successful Regional Workshop on Underutilized Fish and Marine Genetic Resources and their Amelioration organised by the Asia-Pacific Association of Agricultural Research Institutions (APAARI) is an important milestone. The workshop was organised on July 10-12, 2019, in collaboration with the Sri Lanka Council of Agricultural Research and Policy (SLCARP) and National Aquatic Resources Agency (NARA) in Sri Lanka. About 95 participants from thirteen countries of Asia-Pacific region participated in the workshop. The perspective emerging from this workshop holds immense significance to Asia for two very important reasons: These nations are virtually endowed with diverse genetic resources. Hence, on one side while this genetic diversity between and within species, is an opportunity for diversification and productivity improvement, on the other side the required knowledge generation and technology development for utilisation and conservation is a challenge.

The workshop proved an excellent opportunity to take a birds-eye view of the current status of aquatic genetic resources utilisation in the region, R&D status of priority species, knowledge gaps and most importantly, to identify the opportunities and capacities that are available. The perspectives gained will be instrumental in increasing awareness of the importance of underutilised aquatic genetic resources and to formulate strategies for strengthening their sustainable use at the regional level. This event also emphasised the importance of sharing knowledge, resources, and experience for capacity building, developing research programs on areas of common interests, harmonised policy frameworks on the introduction of alien species, checking biopiracy, access-benefit sharing, implementing international treaties, transboundary disease management and common infrastructures wherever possible for conservation, characterisation and evaluation of resources.

Existing regional networks such as APAARI and NACA, which have played significant role in the past in improving production and income for rural farmers, have a greater role to play in the changing scenario, where productivity and sustainability is the aim. These networks can play a greater role than before in systematic exchange of resources including knowledge and germplasm, sharing experience and capacity so that countries can build on each other's strengths and resolve each other's weaknesses. It is significant to note that some of the countries in the region have developed good capacity and research infrastructure on conservation and management of aquatic genetic resources. This gives an opportunity of horizontal expansion of such capacities through linkages among countries. Active networks can develop linkages such as hub and spoke models for capacity development, where the

capacity developed by one nation serves as hub of learning, knowledge sharing and developing research programs with others in areas of common interest. Such programs will help nations to imbibe new technologies and carry out research in a cost-effective manner. Conservation programs, when taken up jointly by nations, will permit conservation of the genetic diversity of species over their complete native distribution, and across political boundaries. Such joint programs are likely to bring opportunities for funding from international donor agencies, which might be attracted to the possible multiple benefits to large populations and ecosystems. It is important to mention that countries with shared water resources also have shared gene pools which are linked by evolution and history.

Epilogue

The strength of the Asia-Pacific region, its rich and diverse biological wealth, is a potential pathway to transform the bioeconomy leading to regional growth supporting the livelihoods and income of farmers, producing safe and certified food, increased revenues through new products and opportunities of trade and social equitability. This transformation will need investments in capacity development of nations, mutual understanding on policy frameworks for sharing knowledge and resources, responsive institutional frameworks, research, and new technologies and opportunities for effective linkages between researchers and industry within the region and to global planning and development processes.

Cast nets: The dominant active fishing gear in the Kashmir Valley

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The State of Jammu and Kashmir falls in the great north-western, complex of the Himalayan ranges with marked relief variation, snow- capped summits, antecedent drainage, complex geological structures and rich temperate flora and fauna. Kashmir or the Jhelum Valley is situated between the Pir Panjal range and the Zanskar range. The average height of the valley is 1,850 metres above sea level but the surrounding mountains, which are always snow-clad, rise from three to four thousand metres above sea level. The surface of the valley is plains and abounds with springs, lakes and health resorts.

Kashmir Valley is bestowed with abundant water resources in the form of high altitude lakes, wetlands, rivers and springs and the geophysical conditions offer a great scope for fish to thrive. There are about 1,248 water bodies in the valley, of which lakes cover about 32,765 hectares (Raina, 2002; Sodhi et al., 2013). These harbour diverse species of fish both endemic and exotic in nature of which the predominant ones are snow trout, Chinese carps, and introduced trout. Although the fisheries sector in the Kashmir valley has enormous potential, which could ineluctably contribute to the GDP of the valley, it is yet to gain the required pace. While fishing is limited to harvesting and selling, aquaculture is in its infancy stage (Malik et al., 2018).

The huge water resources of the area play a compelling role in the socio-economic and cultural development of a large section of the population in the valley (Malik et al., 2018). At the national level fisheries form an important instrument of livelihood for a large section of the economically disadvantaged population of the country. More than seven million fishers in the country depend on capture fisheries and aquaculture for their livelihood. The story of Kashmir valley is no different as around 70% of the total population has adopted agriculture as a primary source of occupation, of

which 15% substantially has fisheries as a principal source of income (Qureshi et al., 2013). The existing fish production from Jammu and Kashmir is around 20.7 thousand metric tonnes, and the volume of fish production over a decade has varied between 19-20 thousand metric tonnes (Statista, 2019). The fisheries sector contributes around 0.48% of India's total freshwater fish production and 31% of total cold-water fishes produced in the country (Qureshi et al. 2016). The major share is from capture fishery wherein fishes are harvested from natural or open water bodies employing different types of harvesting crafts and gears. The different types of fishing gears employed in Kashmiri waters are gill net, long line, cast net, pole and line, scoop net, spears, and bag nets. The major and most commonly used is the cast net.