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COMMITTEE ON FISHERIES

SUB-COMMITTEE ON AQUACULTURE

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GENETIC RESOURCES AND TECHNOLOGIES IN AQUACULTURE DEVELOPMENT: OPPORTUNITIES AND CHALLENGES

Executive Summary

This document supports the Special Event on the Application of Genetic Technologies in Aquaculture Development and Management and outlines the opportunities and challenges in regard to the use of genetic technologies in aquaculture. The opportunities offered by the application of genetic technologies, both in developing and in developed countries, include increased production, control of reproduction, improved marketability, more accurate and effective traceability in the supply chain, better disease and parasite resistance, more efficient utilization of resources, and better identification and characterization of aquatic genetic resources. Challenges related to the lack of capacity, lack of information on genetic resources and how to apply appropriate technologies, bio-security and risk analysis, consumer awareness and regional collaboration. More detailed information is available in COFI:AQ/VI/2012/inf.9.

The Sub-Committee is invited to:

1) Consider the need for more emphasis on the responsible use and development of aquatic genetic resources;
2) Consider ways and means how information collection and exchange, capacity development and networking at the global and regional levels could be facilitated and policy guidance provided;
3) Consider the establishment of mechanisms, such as an advisory Working Group, a plan of action, or similar mechanisms which would bring together knowledge and expertise on aquatic genetic resources and genetic technologies.

Introduction

1. Aquaculture is perceived as having the potential to meet the growing demand for safe and nutritious aquatic food, but in order for this to become a reality, it will have to increasingly intensify and expand. The application of genetic principles to cultured aquatic species is relatively recent and still has considerable potential. Rapid progress is being made in the field of genetics and the availability of genetic information for application in aquaculture. The opportunities offered by the application of genetic technologies, both in developing and in developed countries, include increased production, control of reproduction, improved marketability, better disease and parasite resistance, a more efficient utilization of resources, and a better identification and characterization of aquatic genetic resources. Also, genetic technologies are increasingly used to facilitate traceability in the supply chain.

2. Technical guidelines on genetic resource management in aquaculture have been produced[1] in support of the FAO Code of Conduct for Responsible Fisheries (CCRF) that provides a framework for stakeholders. Aquaculture development would benefit from the wider application of genetic technologies; however, basic knowledge on the genetic resources in aquaculture is still insufficient. A recent assessment[2] identified that lack of data and information and inadequate standardization has, *inter alia*, resulted in a poor understanding of the potential uses of aquatic genetic resources.

3. Building on the recommendations of the Bangkok Declaration and Strategy, and reaffirming the Phuket Consensus, there is now a growing recognition that genetic information and the application of genetic technologies will be increasingly important to support more efficient, responsible and sustainable aquaculture production.

Application of genetic technologies

4. Genetic technologies can be utilized in aquaculture for a variety of reasons[3] including better growth, improved disease and parasite resistance, change in appearance (body shape, colour), and the conservation of natural resources.

5. The full potential of aquatic genetic resources in aquaculture will only be realized by domestication through long-term breeding programmes. Progress has been made in domesticating several fish and mollusc species; very few improved varieties of crustaceans have been developed due to problems in artificial breeding.

6. Genetic improvement strategies include selective breeding and genetic engineering, hybridization and crossbreeding, chromosome-set manipulation and sex manipulation. In addition, genetic technologies provide a unique tool that is available throughout the supply chain, i.e. traceability, to identify species or to identify samples to geographic origin, to specific stocks, to specific pedigree and even to identify escaped farmed fish and differentiate them from wild relatives.

7. Genetic technologies to characterize fish are finding wide application in fisheries as well. Genetic stock identification has been able to help combat IUU fishing and to define the stock structure of numerous commercially important species. Linking the use of genetic technologies in fishing and aquaculture will increase efficiency and efficacy of the technologies.

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[1] FAO. 2008. Aquaculture development. 3. Genetic resource management. FAO Technical Guidelines for Responsible Fisheries No.5 Suppl. 3. FAO, Rome.

2 FAO 2011. FAO Technical Expert Workshop Improving the Information Base for Aquatic Genetic Resources for The State of the World's Aquatic Genetic Resources, held at OESA, Madrid, 1-4 March 2011. Rome, Italy.

3 For details please refer to Information Document COFI:AQ/VI/2012/Inf.9. Application of genetic technologies in aquaculture development and management.

8. Further, a number of emerging technologies are now beginning to be applied in cultured aquatic species ranging from the sequencing of the genome to the establishment of maps showing the relative positions of genes along a chromosome, and to functional genomics that examine how genes actually function in the organisms. These technologies will eventually be useful to find important genes affecting traits such as disease resistance, growth rate and sex determination, allowing more precisely targeted selection to improve aquaculture performance. Genetic technologies are beginning to find applications in the production of aquaculture feed. Yeast has been genetically engineered to produce important feed ingredients such as fish growth hormone and carotenoid pigments.

Opportunities and limitations

9. Several positive factors favour the increased use of genetic technologies in aquaculture:

- There is an increasing number of aquatic species for which the life cycle has been closed and therefore would be suitable for genetic improvement and domestication;
- The field of genetics and the understanding of how genes work is advancing rapidly, while at the same time the cost of genetic analyses are rapidly decreasing;
- There is a vast range of genetic technologies to meet specific needs in aquaculture production, from traditional breeding to genetic engineering; and
- Genetic technologies have wide application in both fisheries and aquaculture in terms of management, control, marketing and trade issues.

10. However, there are also limitations that must be addressed:

- Limited application of good genetic management of broodstock resulting in genetic degradation of hatchery stocks from inbreeding depression and inadvertent hybridization in some countries/areas;
- Lack of awareness of the usefulness of genetic technologies and principles in fisheries and aquaculture development and management;
- Limited capacity to collect, analyze and interpret genetic data for genetic improvement programmes and characterization in some countries/areas;
- The cost of developing capacity to use genetic technologies may be restrictive;
- The variety of techniques may lead to inappropriate techniques being used to address specific problems;
- Issues of risk analysis, bio-security and protection of native biodiversity;
- Lack of consumer awareness;
- Need to standardize techniques, terminology and analyses.

The way forward

11. There are clear advantages to the responsible use of genetic technologies in aquaculture to supply increased quantity and quality of fish and fish products to an ever growing human population. The ‘supply gap’ could be greatly reduced or eliminated if all the farmed aquatic species were put into selective breeding programmes.

12. Why genetic information and technologies are not more commonly used needs to be investigated in more detail. Several key areas have been identified where coordination and collaboration would make a significant difference in the global agenda of moving sustainable aquaculture development forward.

Information gap

13. Information is needed at a variety of levels. Existing national data collections and a few information sharing systems that target commercially important aquatic species are key sources of information on aquatic genetic resources and their use for food and agriculture. There are major gaps in recording aquatic genetic variation at levels below that of the species, e.g. breeds, strains and hybrids. Small, local databases recording intra-specific variation, fish stocking histories or breeds and

varieties of fish exist, but they are scattered, not easily accessed and the scope is highly limited. There is an increasing body of information on genetic resources for aquaculture, and a recognized need for more information to identify useful resources and to underpin sound management and conduct appropriate risk assessment. Information is also needed on available technologies.

Capacity development

14. Many areas including developing countries often do not have the capacity needed to collect information on genetic diversity, to apply genetic techniques and to conduct appropriate risk analysis. National and regional efforts will be required to understand how to develop such capacity in light of available resources and priorities.

Regional collaboration

15. A framework mechanism for addressing and facilitating information exchange on aquatic genetic resources as well as providing technical and policy guidance on dissemination and use of appropriate genetic technologies is needed. This could be achieved through dedicated aquatic genetic resources focal points in the various regional aquaculture networks. Networks could regularly report to a Secretariat of a Sub-Committee Working Group on their activities, achievements and needs, and the Secretariat could provide the necessary hub for inter-regional collaboration and administration of funding.

Need for a coordinated approach

16. The Sub-Committee is requested to consider the need for more emphasis on the responsible use and development of aquatic genetic resources. It may wish to consider ways and means how information collection and exchange, capacity development and networking at global and regional levels could be facilitated and policy guidance provided. Mechanisms, such as the establishment of an advisory Working Group, a plan of action, or similar arrangements which would bring together knowledge and expertise on aquatic genetic resources and genetic technologies, and which would serve a valuable function in moving the field of aquaculture genetics forward, should be explored and recommended. With a strong mandate, FAO would be well placed to promote work in this area through its technical bodies, decentralized offices, links with aquaculture networks, advanced scientific institutions, NGOs, and other inter-governmental organizations such as the Commission on Genetic Resources for Food and Agriculture.