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COMMITTEE FOR INLAND FISHERIES AND AQUACULTURE OF AFRICA

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PRATICAL REGIONAL CONCERNS INVOLVING THE DEVELOPMENT AND DISTRIBUTION OF IMPROVED AQUACULTURE SEED

SUMMARY

New and improved stocks of fish and other aquatic organisms are essential for aquaculture and are considered to be key for future development of the sector.

Previous sessions of CIFAA have deliberated on the technical options in the field of genetics and use of introduced species (e.g. CIFAA OP29).

CIFAA Members need to be looking for the optimal approach to acquiring for the region the best performing aquaculture stock and ensuring the long term maintenance and improvement of the quality of that stock that can contribute to fish production in a way that is sustainable and without undue risk.

The specific nature of these activities requires intergovernmental and regional cooperation whether it is for recognition of conservation areas for species in the wild, managing the impact of alien species (also known as exotic species) or the development and exchange of improved aquaculture strains.

Environmental, ecological, economic, regulatory and political pressures favour using regional cooperative structures for effective development in this domain.

Programmes for the improvement of fish strains through selective breeding twinned with conservation of native gene pools are expected to be part of African aquaculture development initiatives, an example being the TIVO programme in the Volta Basin in West Africa. The principal components of such a programme are discussed and the advantages of a long term view and regional cooperation are underlined.

INTRODUCTION: WHY APPROPRIATE GENETIC MATERIAL IS IMPORTANT TO AQUACULTURE:

1. The rapidly growing production in aquaculture is based partly on an increasing diversity of species as farmers seek to exploit various new opportunities suited to the various physical conditions they have to deal with: salt or freshwater, warm or cold water etc. This is also driven by the market which seeks multiple species to compete with the variety of wild catch.

2. It is a fact that a major part of the current industry is based on the use of species that are exotic to the country and to the continent of culture. Carps, Tilapia and Salmon have led the way, and are now found throughout the world wherever the physical and economic conditions permit. While many reasons can be advanced for this situation, being "first on the scene" explains a significant part as farmers quickly adopt methods that have been successful elsewhere. Will this situation continue? The composition by species will change, as the rapid penetration of the international market by Pangasius catfish from Viet Nam demonstrates; but this too is a species being spread beyond its natural range as it is adopted by farmers elsewhere.

3. Genetics is having a growing impact on aquaculture. It is important as it provides some of the basic scientific understanding of the organisms we are farming. It is also used to provide "improvements" in the strains and varieties of aquatic organisms being farmed, for example in creating strains with faster growth potential. The techniques used are mostly those which are familiar in classic animal husbandry and agriculture, and which have over the years produced the variety of domesticated crops and breeds we know today. New techniques are being developed and may well have a significant impact on fish in the future.

4. We are only at the beginning of the development of genetics in aquaculture and its influence will be felt more and more, globally and in Africa. Production will continue to diversify and many other species may be adopted for culture in the future. There is reason to expect that Africa, with over 2800 freshwater fish species, will be a source of many of these which may be adopted by farmers on the continent and elsewhere.

5. Improvements to existing strains of fish is an obvious and necessary trend for the future. Such enhancements will justify themselves though their contribution to key national policies to improve food security and economic development. Genetic selection on a cultured species, can offer annual incremental improvements in key characteristics that enhance performance, such as a 5% or more improvement in growth rate. Other characteristics that make up a "better fish" for farming can be selected for – such as appearance, disease resistance, environmental tolerance, sexual maturity, fillet percentage, and feed assimilation. The objective is to provide producers with enhanced economic opportunities.

6. Care is however essential with regards to the impact of such developments on the wild genetic resources of fish or other aquatic organisms. Even in the case of an indigenous species, genetic changes in aquaculture might impact on the

wild population if there was a high level of interaction between the populations. These are important questions to monitor and to research.

7. Although this paper is primarily concerned with genetic improvements to local aquaculture species in Africa, such as tilapias, some of the issues raised are similar to those resulting from the introduction of alien species. It must be remembered that while some alien species come from outside the African continent, others are indigenous in some countries but "exotic" in neighbouring countries.

8. Perception among producers of a "better fish" will bring pressure to move stocks from country to country, basin to basin, region to region, or continent to continent. This inevitably raises questions linked to the impact on the environment, and possible concerns over biodiversity and the risk of opening paths for transmission of diseases.

9. Existing initiatives for improving strains on the continent deal with traditional selective breeding, hybridization and chromosome manipulation. The issues of risk and benefit of these genetic technologies will have to be considered in depth by CIFAA in the future.

10. Farmers are the basis for any aquaculture production of fish. They need and will seek the best seed material for their enterprise. Fashions and fads are often not helpful, but a long term and coordinated approach by the sector is preferable to identify and improve the best possible seed for the local conditions, and make these accessible to African farmers in a sustainable manner.

THERE IS A REGIONAL DIMENSION TO MANAGING AQUACULTURE SPECIES AND STRAINS:

11. While aquaculture is not new to Africa, it has until recently been an activity practiced at a relatively small scale, with little active and effective commitment to management of fish genetic material, whether in nature, in aquaculture. Decision making has been in a local context, driven mainly by individual farmers or development projects. Globalisation of ideas and of commerce has been increasing. This has been interpreted until recently by the continent's farmers as needing to be competitive in 'export markets' (where improved strains of tilapia are used). Now there are new pressures on internal African fish markets from low-cost Asian producers.

12. Fish and other organisms used by farmers have changed over the years and there have been many transfers of organisms and introductions of alien species with minimum documentation and precaution.

13. There is an increasing recognition of the benefits of a regional and coordinated approach, including within CIFAA, which can deal with trans-boundary issues of all kinds – natural ecosystems, promotion of development activities, economic growth, biodiversity conservation, trade etc.

14. A species improvement programme using genetic selection provides a clear example of an initiative with an inevitable regional dimension. This can be seen in diverse ways, realising advantages from sharing both *costs* and *benefits*.

15. *Costs*: the long term and sustained nature of a successful breeding programme makes sharing the material investment costs a sensible option for African countries; this applies to finance but also to sharing the required specialized scientific human capacity rather than trying to duplicate it in every country. This not only avoids duplication, but also brings economies of scale resulting from a larger regional effort.

16. *Benefits*: any progress towards a "better fish" would be likely to be taken up by other surrounding countries in a sub region who then have a stake in the benefits accruing from a breeding programme; this then raises issues of how the fish would be distributed between countries, how diseases are monitored and controlled and how common systems are recognised for certification or use of material transfer agreements. Other benefits would come from sharing goals, technology, and expertise.

17. *Environmental boundaries*: national boundaries rarely coincide with ecological boundaries such as river basins, lake limits, and lagoon systems. The impacts (another potential cost) of an aquaculture initiative in one part of an ecological unit such as a river basin can be felt far beyond the original site of aquaculture activity. Such trans-boundary interaction can only really be dealt with on the basis of consensus among nation states.

18. Regulatory cooperation: if effective management of a resource requires regional input, then regulations need to reflect that. Regional consistency and common measures would go a long way to providing effective tools for regulating relevant activities such as transfers, environmental impact monitoring etc. The Union Economique et Monetaire Ouest Africaine (UEMOA), is an example of a regional organisation (in West Africa) working to achieve harmonised regulations in both fisheries and environment and natural resources.

19. Certification and quality control is one element of sectoral regulation that would benefit from regional coordination/recognition. There are two perspectives - from the point of view of the core breeding programme and also from the point of view of the farmer and consumer.

20. From the breeder's viewpoint, provision should be made for some oversight of the breeding programme itself to ensure transparency in use of genetic material, methodologies and decision making. Breeders will need to have in place some guarantees of the capacity of direct users of their improved broodstock (skill sets, broodstock management know-how, infrastructure, distribution policies). A multiplication centre might undergo an approval/certification process to be included in normal "updating" of broodstock. In some cases distribution might involve formal arrangements such as regionally recognised Material Transfer Agreements in order to strengthen best practice among users.

21. Certification from the farmers' and consumers' viewpoint can provide straightforward guarantees of known origin and general quality. Consumers may have concerns about quality and health issues which can be allayed by simple certification.

22. Development of aquaculture in the region is also increasingly being promoted through regional bodies such as CIFAA. The Aquaculture Network for Africa ANAF is a potential forum for exchange of information on genetic issues, and able to keep all members abreast of developments. Active support to the sector,

including to seed production in aquaculture, is being provided through FAO's Special Programme for Aquaculture Development in Africa (SPADA) both through its focus on developing appropriate strategies for the full value chain and supporting the regional execution of development activities such as breeding programmes.

23. What regional structures are available to support aquaculture? The African Union (AU) and NEPAD have taken a clear interest in aquaculture, as have the large regional groupings - the Regional Economic Communities (RECs), such as ECOWAS etc. A number of smaller sub-regional groupings also function well as they bring together groups of countries with many common characteristics.

24. There are institutions with regional membership which have been created to promote the management of resources within aquatic trans-boundary entities; in some of these aquaculture is, or is likely to become, a significant activity – they unite common interests in: river basins (e.g. Niger, Volta), lakes (e.g. Victoria, Kariba), coastal areas (e.g. lagoon systems). Both environmental and development issues can be discussed within such bodies.

25. Many African countries are members of global/regional inter-governmental organizations which place obligations and guidance on members to regulate and manage or protect species, control movement of fish and control the transmission of disease across frontiers. ACCNNR (African Convention on the Conservation of Nature and Natural Resources), CBD (Convention on Biological Diversity), OIE (International Animal Health Organisation) are examples of these.

26. Regional cooperation is certainly easier said than done, and probably no single regional institution can fulfil the complex role. CIFAA is well placed to explore the best institutional combination to successfully provide the appropriate fora for international cooperation in the region to promote the environmental, technological and regulatory aspects of a dynamic and sustainable aquaculture seed sector capable of acquiring, improving and certifying improved stocks of fish and other species.

27. National strategic approaches increasingly favour the private sector to drive aquaculture, and this should be so in the seed subsector. The nature of a selective breeding programme – the requirement for long term planning and resources, scientific personnel, accompanying research, national and regional biosecurity, conservation concerns – all suggest that the public sector (national and regional) has a partnership role to play. Seed multiplication and seed distribution will be best carried out within the private sector.

28. Considering the above points about costs, benefits and impacts in managing genetic resources in relation to aquaculture, CIFAA countries are encouraged to share the decision making and burden among like minded countries in a geographical sub region. The outcome would likely be a small number of breeding programmes in the African region which would be focussed on providing stock to farmers over quite large (perhaps overlapping) geographical areas;

AN ENVIRONMENTAL DIMENSION

29. Decision making concerning aquatic genetic resources almost always includes the environment dimension alluded to above, and can impact on diverse concerns, including genetic resources and their conservation, biodiversity and in the spread and control of disease. This dimension involves many stakeholders both within and outside aquaculture, and in the public sector alone extends direct involvement to environmental and veterinary agencies.

30. To address these concerns, some precaution is required. Impact assessment and risk assessment are both tools that can be used before undertaking initiatives such as a major breeding programme that involves selection of or moving genetic material. Due to the possible trans-boundary consequences in the aquatic ecosystem, the mitigation of impacts requires a concerted approach by neighbouring countries and when it is appropriate impact or risk assessments need to have international reach even if the particular development initiative is limited within national boundaries.

31. Most countries have recently passed legislation making impact assessment in some form necessary for a major aquaculture enterprise and for significant events such as the introduction of an alien species. There is scope for CIFAA Members to refine the use of impact assessments for aquaculture to ensure common standards across the region, and to include the issues raised by culture of indigenous species as well as the introduction of exotics.

32. There are aspects of environmental impact that are not yet fully understood particularly in relation to genetics. There is need to foster capacity to study and monitor these in the African context in order to formulate advice on best practice, and CIFAA could encourage regional bodies such as ANAF or SPADA to play a part in building and exchanging a body of knowledge in this field. Alien species, which are now generally proscribed or limited by regulation in most African countries, raise issues, some quite clear, of invasiveness, biodiversity, possibly species interbreeding, habitat change. On the other hand genetic selection of local species could have an impact on the genetic resources in the wild as there is no real prospect of isolation between wild and farm stocks and this is clearly an issue of interest to both aquaculturists and conservationists alike.

33. There is a need in Africa to increase monitoring and precautions over disease transmission. Fish diseases have until now not received a great deal of attention on the continent, mainly due the very low level of problems encountered. However, as the recent detection of EUS in Southern Africa has demonstrated, it would be wrong to be complacent. Risk of spreading disease increases with the pressures to move fish seed around in the search of the ‘better fish’.

34. Recent initiatives by the OIE, to which most CIFAA members have signed up, have promoted guidelines for managing the trans-boundary movement of aquatic organisms along similar lines to poultry and other animals. This targets a number of specific notifiable diseases and imposes obligations on both exporting and importing countries for monitoring, testing, and paperwork before a transfer can take place. As the aquaculture sector develops, there will be need for more widespread adoption of OIE measures, entailing reinforcement of

veterinary and quarantine capacity which is currently lacking. This is not just an issue for aquaculture, and it is also a fact that African countries are very active in the aquarium trade with very few controls in place.

INITIATING A NEW GENETIC IMPROVEMENT PROGRAMME

35. The above summarises some elements that CIFAA countries might consider in making decisions about starting similar initiative. The objective should be to achieve a permanent capacity in genetic R&D. This capacity would have multiple elements supported by both national and regional policy, and might include:

    a. Research and Development infrastructure, typically a large area of easily managed ponds with ancillary structures such as a hatchery;

    b. Biosecurity to protect the research stocks and minimise contact with outside aquatic environment;

    c. Quarantine facility if stocks need to be transferred into or out of the region;

    d. A team of trained quantitative and molecular genetics scientists and supporting technicians/breeders; access to the wider global genetics community to stay abreast of a fast moving field;

    e. A collaborative approach with a wider group of stakeholders particularly those concerned with environmental regulation and conservation, and with the private sector producers who are the final target.

    f. A long term view and the capacity to be in this 'for the long haul'. A realistic horizon might be 10 years to establish a capacity of this nature, and to achieve significant progress in selection through incremental progress with each generation. A vibrant aquaculture sector would likely require a permanent capacity of this kind.

    g. A dissemination strategy which encompasses transparent and managed distribution of the strain with various optional tools such as 'Certification' and contractual arrangements such as 'Material transfer protocols', all of which will need to attain regional recognition in their application.

SUGGESTED ACTIONS BY THE COMMITTEE:

The 16th CIFAA Session is invited to review the present document, and discuss and advise on the following:

36. The level of priority to be given to genetic selection activities within the overall aquaculture development strategy in the continent;

37. The institutions that would be appropriate for regional cooperation in different parts of Africa in efforts to develop high quality sustainable seed stock for African aquaculture farmers, and in so doing to avoid unnecessary duplication of development efforts in the field of genetics;

38. The lessons learned from the role of a project activity such as TIVO and its various components;

39. Other priority species for which genetic improvement would be of value to the region;

40. The value and practicalities of designating conservation areas for protecting the genetic characteristics of wild populations of fish and other organisms;

41. The value of the OIE process to ensure control measures and disease notification and the challenges to African countries seeking to meet international standards;

BOX: INTRODUCING TIVO, A NEW PROGRAMME IN WEST AFRICA
Funded by Spain

42. TIVO or Tilapia Volta Project (GCP/RAF/417/SPA) is an example of an initiative to establish a sub regional programme for improving a strain of fish for aquaculture and protecting native gene pools. It is in an initial phase of 3 years financed by the Government of Spain and field operations began in 2009. Field operations began in 2009. Six countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo) are involved, all members of the Volta Basin Authority. This brings together six national fisheries institutions and six national environmental institutions.

43. The programme focuses on Nile Tilapia, one of the two principal species used in West African fish culture. It is native to the Volta River Basin, and is present in the river and Volta Lake fisheries,. As a species, it is already proven that it can be significantly improved by selective breeding.

44. Two fish strains will be included in the preliminary work of identifying the optimum initial genetic material to be used in future development. TIVO provides support to a Ghanaian team working at the Water Research Institute near the Akosombo dam; one Ivoirian researcher has now joined the team. This work began under the International Network for Genetics in Aquaculture e ; the team is presently working on the 6^{th} generation of an "Akosombo strain", which is based uniquely on parent material from Ghana. It is increasingly the preferred choice of local farmers currently with a potential of 25% improvement in growth rate over wild stock. The team will also introduce the GIFT/Worldfish strain from Malaysia which has the potential advantage of being several selected generations in advance over the current strain. However, the GIFT strain was genetically improved in Asia and there are questions over how it will perform in the under Volta Basin conditions. The GIFT strain although includes genetic material from other basins and might raise additional questions of environmental and disease risk which will be assessed. The strain will initially only be introduced to biosecure facilities at the research station, where it will be tested for performance under local conditions. After reviewing the two strains, a decision will be made on the material to be developed further, and this will be submitted to the authorities to be approved before dissemination to farmers.

45. The physical facilities are being upgraded as a first step. i) A Quarantine Unit that will be used for fish being moved in or out of Ghana and/or the sub region, a first for this part of Africa. This will enable the full application of the veterinary procedures included in the guidance from the OIE. ii) A Biosecure Area of ponds and hatchery which will be used for the genetics research and testing activities. This will protect the stock, and prevent mixing with the wider aquatic environment until approval is obtained for wider use.

46. Environmental consultations. TIVO works with a network of environmental institutions in the sub region to ensure compliance with relevant national protocols on environmental assessment. Additional attention is being given to

quarantine, risk assessment and acquiring data on environmental impact. The final objective of the project is to propose a management plan for tilapia genetic resources across the basin.

47. A key background study being carried out in support of environmental decision making, is to establish – using DNA analysis - the genetic characteristics of select populations of *Oreochromis niloticus*, both wild and domestic, in the Volta Basin. A reference collection of populations has been made with the assistance of a specialised institute in Burkina Faso. This will provide baseline information, and permit future monitoring of potential impacts of aquaculture. It may also provide supporting data for decisions about conservation areas.

48. The next step will be to put in place a system of dissemination of an improved strain with accompanying measures of certification to enable farmers to identify sources of quality seed. This will involve farmers in the whole Volta Basin and the participation of all six countries.

49. Parallel efforts are being made to achieve a common regulatory framework for the exchange of genetic material for aquaculture in the sub region. Currently each country has its own law and regulations, and there is a need to avoid complexity and contradiction if there is to be smooth and transparent movement of the strain across the basin. Material Transfer Agreements and a regional recognition of certification could be included in this regional networking.

50. It is not yet possible to provide definitive results or conclude lessons learned. However, experience so far indicates that execution is complex, and the multi-stakeholder aspect is a challenge. Resources, infrastructure and human capacity cannot instantly be mobilised for the technical objectives, and need to be seen in a longer term context. Already there are concerns that developing human capacity for the medium term, beyond the short life of the project, should be a priority.

51. The Volta Basin was chosen as a logical ecological unit. In this way environmental decisions might be considered as essentially contained with the basin area and studies can be focussed within manageable geographical limits. However, from consultations with regional partners, it is clear that there are significant practical difficulties to limiting the use of a strain to ecological boundaries in this way, and these will need to be explored for suitable solutions.