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Access to, equity and protection of genetic resources in Ghana: The case of tilapia (*O. niloticus*)

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Access and Benefit Sharing
The ABS Capacity Development Initiative

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Abstract

Ghana is a latecomer to ABS legislation although the principle of benefit sharing has long traditions in Ghanaian society, also in the aquaculture sector. Experiences from bioprospecting deals have often been negative, similar to many other cases in Africa. This underscores the need for ABS legislation and institutions also in Ghana. For aquaculture and tilapia, access issues have most relevance in a regional sense and hence it is important to retain open access to tilapia genetic material between the countries of the greater Volta region, probably more important than ensuring benefits from others' use. Still, in the case of future interest in tilapia from multinational corporations, Ghana could benefit from a solid ABS framework, which includes aquatic genetic resources. The GIFT programme has already provided benefit sharing in terms of technology transfer – which may be equally or even more important than sharing and dissemination of breeding material or monetary payments. There may also be future interest in exchange of improved breeding material between GIFT breeding programmes and the Akosombo strain – a possible avenue for Ghana to profit from improved high-quality breeding material from the Akosombo breeding programme.

Key Words

aquaculture, access & benefit sharing, Ghana, CBD, legislation, patent protection

Contents

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1 Introduction

The natural distribution of tilapia genetic resources is primarily restricted to Africa, and in Ghana tilapia is the major species of farmed fish. Until recently, tilapia breeding and farming have been most successful in South-East Asia through the Genetic Improvement of Farmed Tilapia (GIFT) programme. Only about one per cent of this type of aquaculture production takes place in sub-Sahara Africa (Tran et al, 2012). The African countries of origin, including Ghana, have so far been excluded from using GIFT fish due to environmental concerns (Eknath & Hulata, 2009; Ponzoni et al., 2010). Ghana has recently succeeded in producing fast-growing quality tilapia through a publicly funded breeding programme, using fish from the Volta basin region. This may give rise to ownership issues as well as conflicts over access and benefit sharing (ABS) and legal protection over tilapia genetic material in the region.

This study examines factors assumed to affect the establishment and implementation of access and benefit sharing (ABS) legislation in Ghana. The main focus is on appropriate institutional designs and effective capacity building for handling ABS issues. The regulatory and institutional framework is evaluated in terms of the overall obligations under the Convention on Biological Diversity (CBD): conservation of biodiversity, sustainable use of its components, and equitable sharing of benefits from use of genetic resources. In 2010, CBD members agreed to supplement the Convention with the Nagoya Protocol, intended to make ABS more functional. The main dimensions of factors studied here are international and national regulations and institutions, structural developments, and biological traits. We investigate how these factors affect strategies pertaining to access to and legal protection of tilapia genetic resources.

The study focuses on tilapia in Ghana, but we also draw on insights from similar case studies on cod and salmon in Norway (Rosendal et al., 2006), shrimp and carp farming in India (Ramanna Pathak, 2012), as well as the case of Genetic Improvement of Farmed Tilapia (GIFT) in South East Asia (Ponzoni et al., 2010). The rationale for this comparison is to search for broader tendencies in the aquaculture sector among several countries and among species of bred and farmed fish. We also draw comparative lessons from African case studies of ABS in Cameroon and Ethiopia, in order to explore similarities and differences between African countries as provider countries in ABS and among sectors. Asian countries dominate aquaculture, with 88 per cent of total world production, and the salmon industry is dominated by Norway, Chile, Canada and Scotland, but African aquaculture is currently on the rise, with tilapia as the major choice.

1.1 Background and framework for the study

The study investigates how international and national regulations and institutions, structural developments, and biological traits affect strategies pertaining to access to and legal protection of aquatic genetic resources. Earlier studies of access issues in aquaculture have indicated that these three categories of factors are significant in accounting for actor perceptions of needs and interests (Rosendal et al. 2006; Olesen et al., 2007). As this calls for a multidisciplinary approach, we combine biological competence on the characteristics of genetic resources with legal and political science competence on property rights, international law and resource management.

First, our legal focus is the situation in Ghana. We examine how international regulations on access and benefit sharing (ABS) from the use of genetic resources as embedded in the Convention on Biological Diversity (CBD) and the more detailed rules specified in the Nagoya Protocol on ABS and the related work of the FAO Commission on genetic resources for food and agriculture (CGRFA) are transferred to the national level. International transactions with genetic resources are also affected by national patent systems becoming more harmonized globally through several agreements – notably, the Trade Related Aspects of Intellectual Property Rights (TRIPS) under the World Trade Organization, and the Patent Co-operation Treaty under the World Intellectual Property Rights Organization (WIPO). Whereas access and intellectual property rights (IPR) issues in the pharmaceutical and agriculture sectors have long been discussed, the exchange of aquatic genetic resources and legal protection of innovations and research in aquaculture have received attention only very recently (Greer and Harvey, 2005: 5; Rosendal et al., 2006; Olesen et al., 2007; FAO, 2009). This set of international regulatory contexts provides the backdrop for the domestic level, and the institutions and legislation aimed at ABS and aquaculture in Ghana, presented in section 3.1.

Second, we investigate the evolving ownership structure by looking at various forms of ownership to genetic resources and breeding programmes. In the agricultural sector it is recognized that diverging interests in access, benefit sharing and legal protection are based on differences in technological and economical capacity to utilize genetic resources and on differences in holding biological diversity (Rosendal, 2000, 2006; Raustiala & Victor, 2004). Section 3.2 describes the use of Ghana's tilapia genetic resources by foreign and domestic breeders and farmers, including an examination of the GIFT programme. The literature here is not very extensive, so in addition to drawing on reports and articles written about aquaculture in Ghana, we supplement with stakeholder interviews. This provides a basis for discussing the potential implications for access and protection when wild and improved aquatic genetic material comes from more than one country, as is the case with the GIFT population.

Section 3.3 explores the biology of fish and technological developments pertaining to fish farming, which may imply different perceptions of needs and interests in ABS for aquaculture compared to the plant and

pharmaceutical sectors. Biological and technological traits are also believed to affect the potential for controlling aquatic genetic resources (Olesen et al., 2007; Rosendal et al., 2006). This point is also relevant for whether there is a need for a differentiated approach to ABS for various types of genetic resources (FAO, 2009).[1]

2 Method and analytical approach

In terms of methodology, we follow an analytical framework set out for examining case studies of ABS legislation (Rosendal, 2010a). The data material is drawn from written material such as reports from the aquaculture sector and legal and policy documents of relevance to the sector. Moreover, through interviews with key actors in the aquaculture sector, we map different stakeholders' perceptions of the need for access and legal protection of breeding material, and document their experiences with policies and regulations affecting access and legal protection. We interviewed persons directly involved in fish breeding and farming, key actors in aquaculture management at various levels of administration, foreign breeders and representatives for international organizations central in fish breeding. A high degree of confidentiality was granted to respondents, which is why we provide no accompanying list of interviewees. Finally, we build on discussions spurred by our presentations at the Fish Breeders Round Table organized by the Norwegian Institute of Aquaculture Research AS in June 2004 and similar discussions during three sessions of World Aquaculture Society Conferences – in Hanoi 2007, Kuala Lumpur 2010 and Kochi 2011.

The benefit-sharing part of ABS as a concept has implications at both international and domestic levels. Most ABS studies and actors have focused on the international level and the effects on the international distribution of benefits from the use of genetic resources. However, proposals and formulations for the ABS negotiations with direct consequences for domestic distribution may affect overall problem solving as well. On the other hand, we need to draw the line somewhere, and one implication of our delimitation is that we will not deal with the issues of tenure and land rights here (Mahop, 2004). A second aspect that needs comment in terms of delimitations is the very concept of 'genetic resources'. The current ABS debate is riddled with problems on how to distinguish between genetic and biological resources, coupled with the fear that common activities like import and export of biological material in bulk (e.g. trade in fruits and grain for consumption) will inadvertently come under the definition and scope of an ABS regime under the CBD (Schei & Tvedt, 2010). One important element in making ABS functional is to examine regulations and policies at both the point of access and the point of utilization of genetic resources (Tvedt & Young, 2007; Tvedt & Fauchald, 2011).

[1] This was also discussed at the thirteenth regular session of the Commission on Genetic Resources for Food and Agriculture (CGRFA), held 18–22 July 2011 at the headquarters of the UN Food and Agricultural Organization (FAO) in Rome.

3 Legal, structural and biological developments in aquaculture

3.1 The legal framework

3.1.1 International obligations: Access, equitable sharing, conservation, and innovation

Access to genetic resources, conservation, equitable sharing of benefits, and IPR systems to boost innovation: these are all internationally agreed objectives, but they are not necessarily mutually compatible (Rosendal, 2006). How they are reflected in specific, domestic legislation is important for how well the system will function. The CBD has three interrelated objectives: conservation and sustainable use of biodiversity, and access and equitable sharing of benefits from use of genetic resources. Conservation is a basic prerequisite for access, innovation and benefit sharing, as acknowledged in the three objectives of the CBD. From an African perspective, the essence of the CBD is to link the balance between ABS and IPR to that of conservation (Rosendal 2000): Without access to genetic resources, there can be little innovation. The CBD attempts to establish a system for innovation based on biodiversity, so as to contribute in a fair manner to the conservation of the diversity. IPR legislation is justified in terms of creating incentives for innovation. However, there are indications that broad patent claims may also obstruct innovation by stifling access to technology and increasing the transaction costs (EU, 2008). Without innovation, there may be fewer benefits created and less to share. Without benefit sharing from utilization of genetic resources, there may be less will and ability to conserve biodiversity in developing countries – although this particular dimension has less immediate relevance in aquaculture compared to the agricultural and pharmaceutical sectors.

The CBD covers conservation and sustainable use of wild species and improved breeding stocks, as well as equitable sharing of benefits derived from the use of the world's genetic resources. How to make benefit sharing contribute to conservation has been subject to controversial negotiations ever since the adoption of the CBD in 1992. In October 2010, the negotiations mandated at the Conference of the Parties (COP) in Kuala Lumpur in 2004 resulted in a Protocol on Access and Benefit Sharing at the 10th Conference of the Parties to the CBD in Nagoya.[2] After the signing of the Nagoya Protocol (NP), much attention has been devoted to its implementation; however, we must bear in mind that the CBD still establishes rules legally binding on all its members regardless of whether the member eventually decides to join the Protocol or not.

[2] The Nagoya Protocol recognizes the interdependence between countries with regard to 'genetic resources for food and agriculture as well as their special nature and importance for achieving food security worldwide … and acknowledging the fundamental role of the International Treaty on Plant Genetic Resources for Food and Agriculture and the FAO Commission on Genetic Resources for Food and Agriculture'. UNEP/CBD/COP/10/L.43/Rev.1: p. 6.

There is currently a discussion in FAO's Commission on Genetic Resources of whether to establish special rules for ABS regarding, *inter alia*, aquatic genetic resources.[3] The Nagoya Protocol opens for establishing such sector-based systems under other organizations than the CBD. This leads to the question of whether this will have relevance also in those countries that are party to the CBD but not the NP.

The World Trade Organization (WTO) establishes global standards for harmonization of various aspects of intellectual property rights, and the World Intellectual Property Organization has as its mandate to strive towards cooperation and harmonization of IPR in all member countries. Harmonized IPR regulations target all technological fields similarly, including biotechnology and cases where biological material forms part of the invention. Two changes in patent law have made the patent system controversial. The first change dates back to the 1980 Diamond v. Chakrabarty case,[4] where the United States Supreme Court held that patents may be granted on living organisms, *in casu* a genetically modified bacterium. Since that case in 1980, patents in biotechnology have become increasingly wide and the patent criterion of inventive step has been lowered (Safrin, 2004). It has also been pointed out that filings of patent applications are increasingly replacing journal articles as places for public disclosure, hence reducing the body of knowledge in the literature.[5] These tendencies bring up questions on the extent to which patents serve to spur or hamper innovation. Also the CBD-inspired link between exclusive rights and access rules seems to have provided only limited amounts of benefits arising from the utilization of genetic resources that have been shared with providers. The ABS in the CBD seeks to balance expanding patent regimes by establishing a compromise between access to technology and access to the input factors in biotechnology – genetic resources (Koester, 1997; Rosendal, 2000). This interaction between different international objectives has led to North–South conflicts over access to seeds and medicinal plants versus patented technology in the agriculture and medicinal sectors, respectively. The situation is different for aquaculture and animal husbandry, where there has been little South to North movement of breeding material (FAO, 2009).

In contrast to the crop sector, where seeds have a long history of international exchange, there have been few cases of conflicts over ABS in the aquaculture sector. A central explanation, as stated by FAO, is that 'exchange of aquatic genetic resources has generally not been from South to North as appears to have been the case in the crop sector' (FAO, 2009:33). A related part of the explanation may be the much lower incidence of traditional knowledge in aquaculture compared to agriculture and medicine; there are few 'farmers' breeds' or landraces of fish, as the bulk of the world's fish farming is based on wild catches. This is not to refute the potential for knowledge about what fish are more suited

[3] The thirteenth regular session of the Commission on Genetic Resources for Food and Agriculture (CGRFA) was held 18–22 July 2011 at FAO headquarters in Rome.
[4] *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).
[5] http://www.ornl.gov/sci/techresources/Human_Genome/elsi/patents.shtml Accessed 29th October 2011.

to catch and breed. Moreover, breeding programmes for aquaculture species are more common in Western countries, especially as regards salmonid species. Following the GIFT programme of the 1990s, there have also been several breeding programmes for tilapia. This trend is substantiated by another conclusion in the FAO report (2009), that 'concern for compensation for providing aquatic genetic resources used in other countries has not yet been widely expressed' (p. 33). The exchange has taken other avenues, most importantly from South to South, as in the cases of tilapia and catfish. There is also a significant channel from North to both North and South, particularly in the case of salmon (FAO, 2009:38; Liabø et al., 2007).

3.1.2 Ghana: Domestic legislation and institutions for aquaculture and ABS

Turning to domestic norms and regulations in Ghana, we focus on legislation directly pertaining to aquaculture and aquatic genetic resources and also add the more general framework for ABS institutions. Ghana has a British-based common-law system, with elements of customary (traditional) law and a relatively new Constitution from 1992.

The Fisheries Act of 2002 (Act 625) is the main legislative instrument that governs the practice of aquaculture in Ghana. Section 60 stipulates that a licence is required for an aquaculture farm. Applications must be made to the Fisheries Commission and accompanied by an environmental impact assessment. Section 93 makes it compulsory for anyone undertaking any activity other than fishing that is likely to have a substantial impact on the fishery resources or other aquatic resources of Ghana to inform the Fisheries Commission prior to commencing the planned activity (subsection 1). Subsection 2 empowers the Commission to prepare or to commission reports and make recommendations that must be taken into account in the planning of the activity and in the development of means of preventing or minimizing any adverse impacts. Subsection 3 adds that this requirement is additional to any other requirements of the Environmental Protection Agency. The Act is not explicit on legal rights, protection against other resource users, or ownership and tenure. Nor does it contain any provisions pertaining to fish health, quality assurance or product safety. There is little to suggest that the CBD principles on ABS have in any way been integrated into this legal framework yet.

According to a 2008 UNEP report, due to lack of incentives and legal expertise, there is as yet in Ghana no overarching institutional and legislative framework for genetic resources management; hence institutions do not deal with all aspects of ABS (UNEP, 2008). The situation could change with the entry into force of the Nagoya Protocol, which may enhance Ghana's incentives to provide for such a framework. Ghana ratified the CBD on 29 August 1994.

The African Model Legislation for the Protection of Rights of Local Communities, Farmers and Breeders and for Regulated Access to Bio-

logical Resources, produced by the Organization of African Unity in 2000, may have relevance to aquatic genetic resources.[6] The Model Legislation aims to protect biodiversity as well as the livelihoods depending on it, including farming and fishing communities, and can be seen as a reaction to more conventional developments within IPR legislation. It further seeks to promote the customary community practice of sharing biodiversity and innovations, and to safeguard African interests against potential negative consequences of globalization. As the Model Legislation complies with the CBD obligations concerning prior informed consent and fair and equitable benefit sharing on access to biological resources, it could provide a basis for ABS legislation in Ghana (UNEP, 2008). A review process of the African Model Law is currently underway, aimed at enhancing and examining the potential for implementing the Nagoya Protocol.

3.1.3 Domestic ABS legislation in the aftermath of the Nagoya Protocol[7]

Ghana is trying to formalize ABS legislation now, to get proper legislation and institutions in place. With the Nagoya Protocol has come global interest in enacting ABS legislation, also among the Ghanaian government. A memo is being prepared by the Ministry of Environment, Science and Technology for submission to the Cabinet for discussion and then transmission to the Parliament for all aspects of ABS, beginning in the first instance with ratification of the Nagoya Protocol. The draft memo builds partly on a set of guidelines that were almost ready for Cabinet approval by Cabinet under the previous government, written by a team of experts and officials from the universities, research institutes and the Ministries of Lands and Natural Resources, Health, the Environment and Local Government and Rural Development. Now the draft guidelines will have to be revised in light of the provisions of the Nagoya Protocol, to reflect some of the aspirations of the present government in the new Cabinet memo currently in preparation. A central actor in this process is Professor Alfred Oteng-Yeboah of the Department of Botany at the University of Ghana, and also Chair of the National Biodiversity Council and SBSTTA National Focal Point.

According to Professor Alfred Oteng-Yeboah, the Memo for the Cabinet and its eventual transmission to the Parliament is expected to go through a two-step decision-making process. First, it will involve ratification of the Nagoya Protocol. Second, that will lead to domestic obligations that must be enforced, such as the need to develop guidelines for operational implementation. These guidelines will involve describing the cases and the particular access situations and describing various types of benefit sharing. Material Transfer Agreements have already been noted as minimum standards.

Moreover, there will be a need for an institutional focal point to be in charge for negotiating ABS contracts, monitoring compliance with such

[6] http://www.farmersrights.org/pdf/africa/AU/AU-model%20law00.pdf Accessed 13 March 2012.
[7] This section is based on an interview with Professor Alfred Oteng-Yeboah, 21 October 2011.

ABS contracts and monitoring the benefit-sharing process. This will involve some kind of institution that will have overall responsibility for coordination and monitoring of bioprospecting deals in Ghana. This is acknowledged and specified in the Memo. The Council for Scientific and Industrial Research (CSIR) might be chosen to perform that role, and this was also suggested as a good solution by Professor Oteng-Yeboah. The CSIR has the necessary expertise and competence (with many PhDs among its members), the autonomy vis-à-vis competing ministries, and also adequate funding as it is gets direct support from the national budget. A similar type of institution would seem to be InBio in Costa Rica, which is in charge of monitoring bioprospecting. On the other hand, it is not obvious that a research institute will necessarily function best as focal point. Other case studies have noted problematic turf-wars that persist among ministries if the hierarchy is not clearly determined (Rosendal, 2010b). Thus, it may prove necessary to place the focal point above the ministries, with direct responsibility to the presidency.

Why has ABS legislation been delayed in Ghana? Prior to Nagoya, benefit sharing as an issue was discussed mainly at the local level, in terms of traditional knowledge and exchange between people. A major obstacle to discussing international ABS issues has been lack of awareness. Now, however, the Nagoya Protocol has opened a political window for new possibilities. Another important driving force stems from disappointing experiences from earlier bioprospecting deals. There has been a lack of control and monitoring mechanisms, and that leads to discussions of how to enhance the administrative capacity for monitoring bioprospecting deals. Today there is asymmetry between the parties in bioprospecting deals, with Ghanaian researchers on one side and Western multinational corporations on the other.

Prior to the Nagoya Protocol, it was mostly Ghanaian scientists who entered into bioprospecting deals with external actors; most often universities with an interest in medicinal plants. This has usually been conducted through Memorandums of Understanding and Memorandums of Cooperation, with paragraphs stipulating that in the event of commercialization, benefit sharing would take place. According to Professor Oteng-Yeboah, the scientific conditions for entering into bioprospecting deals can be said to be good in Ghana, as the level of biological knowledge in Ghana is high.

Professor Oteng-Yeboah concedes, however, that in his experience the benefit-sharing impact of the bioprospecting deals has been very small. Ultimately, the deals have built on trust, which may have been falsely based. There has been some success on the small scale, but some partners fail to disclose results from this type of collaboration, especially when filing for patents. One alternative explanation could be that there are not yet significant results; or there might have been a change of partner through, for example, reorganization on the other end. On the other hand, examples of the first interpretation have been widely found also in other case studies: the experience of bioprospecting coming to nothing for the providers is not unique to Ghana. Our research team found similar stories in case studies in Cameroon and Ethiopia (Rosendal, 2010b; Andresen et

al., forthcoming), and there have been many other instances (Robinson, 2010).

One Ghanaian bioprospecting case concerns the serendipity berry (*Synsepalum dulcificum*), which is a berry that coats the mouth with a protein, monellin, that makes everything taste sweet. Clearly, there is great commercial potential here, not least for treating diabetes and for fighting obesity. The Biochemistry Department of the University of Ghana entered into collaboration with a US university to develop a process of freeze-drying the berry to retain its desirable features. During the time of our studies in Ghana, researchers in the Biochemistry Department could not say what had become of this bioprospecting process. This may be due to the time-consuming aspects of this type of research, but it could also mean that there is now secrecy about the research process. In any case, as the USA is not party to either the CBD or its Nagoya Protocol, the case would not have given rise to ABS legal issues under the international regime. On the other hand, there might be moral obligations, as there are also several US bioprospectors striving to appear as legitimate users in transactions with genetic material (Laird, 2000).

The Wests 'discovery' of this fruit with 'miraculous' properties can be traced back to the 18th century in Ghana and Cameroon. Later the serendipity berry was brought to Europe. It is only recently that it has been commercialized as a flavour-tripping additive taken in the form of 'miracle' fruit tablets or freeze-dried granules.[8] Natural monellin has not been mass marketed to the food industry, primarily due to the challenges involved in large-scale purification of the protein, which is relatively sensitive to heat or acid treatment.[9] The serendipity berry is also a threatened plant species, at least in Nigeria, because of massive habitat loss and fragmentation (Obioh & Isichei, 2007). The berry has been described in scientific journals; one of the first such articles appeared in the *Ghana Journal of Agricultural Science* in 1976 (Ata, 1976). The article was submitted by the Council for Scientific and Industrial Research, Institute for Scientific and Technological Information (CSIR-INSTI) in Ghana and could hence bolster the claim for ABS on the serendipity berry for Ghana, even though the berry is found in many countries in sub-Saharan Africa. The fact that the freeze-dry technology seems to have been successful could also indicate a link to the original bioprospecting deal with Ghanaian academics.

Another case of bioprospecting concerns a tannin-based constituent from a plant (*Griffonia simplicifolia*) originating in Ghana, believed to have commercial potential. It was the Ghanaian system itself that failed this time, as the bioprospecting coincided with governmental efforts to promote export of non-traditional crops. This meant that organic material could be shipped out of the country without permits. The change occurred about 25 years ago, when a Government Directive was passed to allow exports of non-traditional crops. The policy was a central element in and

[8] http://titanarum.uconn.edu/200202492.html Accessed 2 November 2011.
[9] http://www.uniprot.org/uniprot/P02882 Accessed 2 November 2011.

part of the trade liberalization policies invoked also before Ghana joined the World Trade Organization and much plant material was shipped out as a consequence of this policy. Previously a range of permits were required for export of organic material, both from the University of Ghana (Department of Herbarium) and from the Forestry Department, which was previously under the Ministry of Lands and Natural Resources. Today this gives rise to Nagoya Protocol questions relating to 'point of access' versus 'point of utilization of genetic material'. The question now is how to come to grips with this in the legislation (Tvedt & Rukundo 2010). This issue is problematic both as regards formulating domestic legislation and in the legal interpretations of the Nagoya Protocol.

Professor Oteng-Yeboah points out that, as a result of these failed bioprospecting deals there is now widespread agreement among politicians, ministry officials and scientists alike that there is a need for strengthened control through ABS legislation. There is also agreement on the need for better documentation of the biological/genetic material along the way, as the purpose of the activities and uses linked to the resource may change. This ties in with more general discussions in the CBD/ABS negotiations over 'point of access' versus 'point of utilization', as some of the cases go back in time and some may have changed focus (from pure academic to commercial). The need for documentation is also evident as regards 'derivatives from genetic material', which remains a contested and unclear legal issue also after adoption of the Nagoya Protocol.

This section provides a background for understanding the concern for establishing a legal framework for controlling genetic resources in Ghana. The stories are anecdotal and difficult to document, but they have a strong impact on perceptions among central actors regarding the need for improved ABS legislation.

3.2 Ghana's aquaculture sector: Foreign and domestic tilapia breeding

3.2.1 Foreign acquisition of wild tilapia

The natural distribution of tilapia genetic resources is primarily restricted to Africa, whereas most utilization in aquaculture now takes place in Asia. Tilapia has become the world's second most popular group of farmed fish, after carp (Eknat & Hulata, 2009).

The example of the GIFT programme is relevant as regards access to and dissemination of improved fish stocks. There are potential benefits for both breeders and farmers. GIFT fish was originally a public good, as the project was funded by the UNDP, FAO, the Asian Development Bank, and a few donor countries, among them Norway. To develop GIFT, wild Nile tilapia populations were brought from Ghana, Egypt, Kenya and Senegal in 1988/1989. Four strains of tilapia used by commercial farmers in Asia (from Israel, Singapore, Taiwan and Thailand – all originating in Africa) were also used in the genetic improvement programme, bringing the total number of strains in the programme to eight (Eknath et al., 1993;

Dey & Gupta, 2000). In all participating countries, the GIFT strain performed much better than the best non-GIFT local strain. Moreover, GIFT represented a neutral technology with respect to feed and fertilizer use, which means that small farmers who use less feed and fertilizers and big farmers who use more feed and fertilizers will benefit equally (ICLARM, 1998; Dey et al., 2000; Dey & Gupta, 2000).

During the 1990s, GIFT provided fast growing tilapia for small-scale Asian fish farmers, applying traditional selection methods and low-input technology. Then, due to financial drought, the major part of the material of the breeding programme was sold to a private company, GenoMar in the late 1990s. As a commercial company, GenoMar has objectives different from those under the original mandate of disseminating GIFT to poor countries free of charge, and a main criticism of the GenoMar deal was that donors had invested to produce GIFT for dissemination in poor countries. The immediate effect of shutting down public funding of the GIFT programme was to make the breeding material far less accessible to poor farmers (Ponzoni et al., 2010). After the transition to GenoMar, GIFT fingerlings were still provided, but no follow-up advice was provided with the transfer of fish. Training and information about farming (along with maintenance and running of the breeding programme) were central to the original GIFT objectives, but resources are now lacking for this (Ponzoni et al., 2010). Today, the dissemination of GIFT fish (through the WorldFish Center) is much smaller in scope than originally intended and envisaged by the donors, and much too low to meet actual demand (Ponzoni et al., 2010). On the other hand, it has also been pointed out that, given dwindling public funding, without the funding supplied by GenoMar, more of 'the GIFT legacy' might have been lost (Eknath & Hulata, 2009:209).

The dissemination of GIFT fish did not go to African countries. This was based on the fear that introducing GIFT fish to areas where tilapia are endemic (as in several parts of Africa) might pose environmental risks, endangering native tilapia genetic resources (Bentsen et al., 1992). Consequently, it was the policy of WorldFish Center not to introduce the GIFT strain into Africa (Pullin, 1994; WorldFish Center 2007). However, African interest in accessing GIFT material has increased, and WorldFish and the FAO are now engaged in developing a project in Ghana, aimed at testing the possible consequences of reintroduction. The rational is that if WorldFish fails to do this, it is very likely that African countries will soon see irresponsible introductions of farmed tilapia through other channels.[10] Hence, the WorldFish Center decided to make the GIFT fish available to African governments, on condition that such requests come from relevant government authorities and involve a well-defined strategy to maintain and disseminate GIFT, as well as clear plan for the management of environmental and biodiversity risks (WorldFish Center, 2007).

[10] Interview with Dr. Raul Ponzoni, WorldFish, November 2009.

3.2.2 Domestic tilapia breeding

Aquaculture has seen increased interest as a means of meeting Ghana's fish requirements. In 2003, Ghana produced only 51.7 per cent of its fish requirements from domestic sources. Tilapia is the major species of farmed fish, constituting over 80 per cent of aquaculture production, with catfish types (*Clarias* sp., *Heterobranchus* sp. and *Heterotis niloticus)* accounting for the remaining 20 per cent (Acosta et al., 2009).

Ghana has several laws regulating the aquaculture sector, and the government has set up institutions responsible for developing fisheries and aquaculture policy and directing and establishing research priorities. The Directorate of Fisheries (DoF) is the lead government agency for aquaculture development, and the Water Research Institute of the Council for Scientific and Industrial Research (CSIR) is mandated to carry out aquaculture research. In the interest of promoting domestic-level fish farming, imports of farmed fish are not allowed (Acosta et al., 2009).

Suitable aquaculture sites are dispersed throughout the southern and middle belts of the country. Most of them depend on underground seepage of water to fill the ponds. The endemic *O. niloticus* is the only species of tilapia supplied by hatcheries in Ghana.

To establish the public tilapia breeding programme of what is known as the Akosombo strain, wild fish were collected from three ecological zones, starting in 1994. Between 50 and 100 fish families have been tested annually during recent years in the programme. So far, inbreeding has not been a problem, although some increase has been documented and has given reason to certain longer-term concerns. One possible way of controlling this and avoiding inbreeding is by expanding the programme through increasing the number of families and/or crossing with external stocks. More wild material from Ghana was brought in around 2010. For long-term survival, it may be desirable to bring in material also from the northern part of the Volta Basin system, as the fish here is expected to have important characteristics of hardiness and fast growth. This addition of new material contributes to the development of the Akosombo strain and is also part of a project known as the Tilapia Volta Project (TIVO),[11] in full: 'Aquaculture Investment for Poverty Reduction in the Volta Basin: Creating Opportunities for Low-Income African Fish Farmers through Improved Management of Tilapia Genetic Resources'. TIVO is funded by the Spanish government and implemented by FAO in cooperation with the WorldFish Centre, CSIR-Water Research Institute, focal point representatives and other stakeholders. The aim of TIVO is to disseminate the Akosombo improved tilapia strain to West African fish farmers, aiming at reducing hunger and poverty in rural communities and more than 540 fish farmers in the Volta Basin, Western Africa currently use the Akosombo strain in monoculture or polyculture with catfish (Tran et al., 2012).

[11]Interview with Felix Attipoe, Director of Aquaculture Research and Development Centre (ARDEC) under the Water Research Institute (WRI), 21 October 2011.

The Akosombo tilapia strain, developed by the Aquaculture Research and Development Centre (ARDEC), has now achieved growth rates from 30% to 50% higher than those of other tilapia in the region (Lind et al., 2012).[12] The first step of the Akosombo breeding programme at ARDEC was performance studies, comparing performance of strains in the base populations in different environments. These studies were conducted in 1999/2000. At this stage WorldFish came in, supporting the selection procedure with 80 per cent funding from several donors (most important EU and Japanese Aid). Procedures and techniques developed by the GIFT programme in South East Asia were applied to the Akosombo breeding programme to achieve improvement.[13] The ARDEC Akosombo programme has also had contributions from the World Bank and some national funding (mainly for salaries). Finally, there is some income from selling fry and broodstock from the programme; this increasingly serves to cover the costs of hapa nets, tags, etc. Fish are disseminated to hatcheries and multipliers at 5 Ghana cedis (USD 3) for each broodfish.

The ARDEC Akosombo programme covers about 50 per cent of the market in Ghana. A Danish company, West African Fish Ltd. (WAF), stands for some 30 per cent of tilapia production (grown in cages in the Volta Basin). In addition, there are several smaller companies. Tropo Farms Ltd. buys improved broodstock from ARDEC and has also started some breeding and multiplying based on the Akosombo strain. Crystal Lake Ltd. produces fingerlings and fry, also based on the Akosombo material from ARDEC. In 2005, Tropo Farm Ltd. contravened the ban on import of farmed tilapia and acquired GIFT fish from South East Asia. As a penalty Tropo Farm was required to destroy all their fish, not only the imported GIFT fish. They had to start from scratch and turned to ARDEC for new broodfish and fry. Tropo Farm also tried to integrate its production by developing feed, but gave up and went back to more specialized production.[14] There are not many big farmers and hatcheries, and a main challenge is to train managers of hatcheries properly, so that, for instance, material does not become 'contaminated' (i.e. crossbred with inferior stocks) and inbred.[15] Ownership structure is dominated by foreign companies: very few of the owners are Ghanaian, due to the relatively high cost of buying land and establishing cage cultivation.

Tilapia farming keeps increasing (80 per cent in 2009 to perhaps 90 per cent in 2010), with catfish farming at 20 to 10 per cent. Most domestic dissemination of the genetically improved tilapia goes to the farmers near or by Lake Volta, the world's largest man-made dam. Here the infrastructure and electricity supplies are good, and farmers can produce four times more than those who farm in rivers and ponds, which are shallow and also lack infrastructure. The difference is 400–800 gr per fish cultivated in cages after five months, compared to a mean weight of about 250 gr after six to nine months in ponds. So far, there have not been major problems with disease in the fish, but this could change as the

[12] Interview with Felix Attipoe, Director of ARDEC, 21 October 2011 and with Madam Hannah, Minister of Local Fisheries, 26 October 2011.
[13] See footnote 11.
[14] See footnote 11.
[15] See footnote 11.

sector intensifies. The lack of infrastructure obstructs much-needed efforts to spread out the farms geographically, increasing the distance between them, and to avoid disease problems from intensification in the lake.[16] Tilapia and aquaculture production seems set to increase many times over in the next decades, with most of the increase expected in cage cultivation in the Volta Basin (McCarthy & Seddoh, 2010).

3.3 Technological developments and the biology of tilapia

There are a few important differences between salmon and tilapia breeding. One has to do with technological and structural developments over time, as work with salmon has progressed much further as regards breeding, market consolidation and marketing. Additionally, the salmon-farming sector in Norway as a whole has a long history of rapid market fluctuations.

A central environmental concern with all fish farming is biological. Whereas wild salmon and farmed salmon escapees spawn only in rivers, cod, for example, tend to mature and spawn in the sea cages, with the added risk – and added cost – this represents to the local environment. Unlike salmon, cod spawns in the sea rather than in the rivers. It is argued that escaped salmon may affect wild populations through problems related to competition, gene flow and disease transmission (Ferguson et al., 2007). Escaped cod may represent a more immediate problem for wild fish relatives, in terms of possible competition and gene flow, and as a source of pests and diseases (Svåsand et al., 2007). In India, carp and some types of shrimp farming (monodon) pose similar challenges to wild species (Ramanna Pathak, 2012).

Although exotic species may also represent a threat to ecosystems, farmed tilapia seems to be regarded as less problematic in South-East Asia. GIFT tilapia originates from three African locations – Ghana, Egypt and Senegal – and has, as noted, been subject to very successful breeding in Asia through the GIFT programme (Ponzoni et al., 2010; Eknath and Hulata, 2009; Greer and Harvey, 2004). However, the GIFT breeding material has been inaccessible to African breeders. African countries were excluded from benefitting from the GIFT programme out of fear of genetic contamination (Ponzoni et al., 2010). As far as we can ascertain, it is only in the case of the African tilapia that this type of concerns has had implications for access issues in aquaculture. Most documented cases of potential genetic impact of farm escapees on native wild populations that have been published concern Atlantic salmon. Little is as yet known about such effects between wild and farmed tilapia and other farmed species (CIFA, 2006).

Salmon is a carnivore and relatively few in numbers compared to tilapia, which feed low in the food chain and tend to reach large population sizes, even in small bodies of water. It is argued that salmon generally has a narrow genetic base, highly adapted to specific systems, compared to the broader genetic base of tilapia, which is less specifically adapted to local

[16] See footnote 11.

habitats (CIFA, 2006). The main concerns regarding domesticated tilapia in Africa pertain to the danger of genetic introgression with wild tilapia, which are likely to contain genetic diversity of important adaptive significance lacking in captive stocks. The risk may be less than feared because tilapia are generalists and the wild populations are generally huge compared to any possible escapees. The major remaining risk concerns the considerable difference in growth performance between captive and wild populations (CIFA, 2006).

An important general biological aspect is the relatively long time interval (two to three years) between acquisition of roe and marketing of most farmed fish. This makes salmon in particular and fish farming in general more vulnerable to market fluctuations compared to most agriculture crops, but also tilapia production, where seeds will yield a harvest the same or following year. Some terrestrial animal husbandry is similar to fish farming in this respect, but livestock production is less vulnerable. For instance, Norwegian agricultural farmers primarily produce for and cooperate within domestic markets. Farmed salmon is to a much larger extent produced for international markets and this tends to complicate cooperation strategies for the farmers involved.

Another central biological difference concerns distribution. Salmon is mostly spread through stem fish, roe or smolt, whereas cod is only sold in 'bulk' by litres of roe. Due to the tremendous fertility and small egg size of cod, such bucket loads of cod roe produce enormous quantities of harvest fish. Tilapia also differs substantially from salmon in this respect: salmon reproduce once and then expire, whereas tilapia can spawn many times per year and in the course of a lifetime (CIFA, 2006). Moreover, salmon spawning is primarily limited to rivers, while tilapia can spawn also in farming environments – a characteristic important with a view to interaction between biological and legal control over genetic material.

As the report from a workshop in Ghana in 2006 concluded:

> *Although there are currently no documented cases of negative environmental impacts, Oreochromis niloticus is a weedy species that can survive in harsh conditions and could theoretically disrupt aquatic ecosystems were it to be introduced into pristine habitats, such as the rainforest rivers of West and Central Africa. The introduction of any strain of O. niloticus to places where it currently is not should therefore be undertaken with the utmost caution. As most captive populations eventually find their way into the wild, the transfer and culture of O. niloticus into new watersheds would be wisely avoided (CIFA, 2006).*

This could indicate a need for a system for genetic impact assessments when importing genetic material to a country, as proposed by Drucker for farm animals (see Hiemstra et al., 2006; Drucker et al., 2007). Such a study will from 2012 onwards be carried out in connection with the TIVO project when comparing and assessing environmental effects of introducing GIFT tilapia from Asia.

4 Results and discussion: Balancing access to and protection of tilapia genetic resources

Following up on our research question, here we discuss how the above factors may strengthen or weaken Ghana's possibilities for controlling aquatic genetic material, especially that of tilapia. Moreover, how can they be expected to affect the country's opportunities for accessing improved breeding material of tilapia? The discussion draws on lessons from other case studies as well as interviews with key actors in Ghana.

4.1 Access to and protection of breeding material in the Volta region

According to one of our interviewees, intellectual property rights (IPR) first entered the political agenda in Ghana in response to a new awareness of the need to protect own aquatic breeding material. This awareness was prompted as personnel sent out to study returned, saying that Ghana was losing out on benefits.[17] This brought the realization that aquaculture in Ghana was weak with regard to intellectual property rights.

The practice of the Water Research Institute is to publish, but publishing disqualifies for patenting; hence the authorities now recommend greater caution.[18] This may also have implications for how Ghana will deal with tilapia from the Akosombo breeding programme: fish used to be provided for free in the region, but the concept of gaining benefits is now being heard. As we shall see, however, most researchers involved argue that patenting is not suitable for the purposes of fish breeding, as the genetic resources should be shared in order to enable increased food production. This might also involve exchanges with the GIFT programme, which could benefit both sides on an equal basis, as both might bring in useful gene variants – for instance, genes for disease resistance.[19]

A second argument made in favour of seeking patent rights or using other protection mechanisms is to maintain some control over the breeding material from the Akosombo programme. The Akosombo strain of ARDEC is now in its eighth generation, after the fifth generation of selection for growth rate. The continually faster-growing fish from the Akosombo strain ensure that farmers will return to this breeding programme to purchase more fry/fingerlings. This strategy of continuous upgrading to maintain a high-quality product is widely used in aqua-culture; it is also the most commonly applied strategy in Norwegian salmon breeding (Rosendal et al., 2006).

However, some buyers have been known to try to cut corners: They buy from the Akosombo strain breeding programme and go on to reproduce the fish illegally – and then claim that this is still the high-quality fish, even after they have mixed it with inferior strains, without paying royalties, and without making any genetic improvements. According to

[17] Interview with NN3 at WRI, 24 October 2011.
[18] See footnote 17.
[19] See footnote 17.

Felix Attipoe of ARDEC, this could ruin their reputation and they hence try to avoid the situation, as people will not chose to pay more for a bad product. A similar situation has been troubling the Jayanti rohu carp of Central Institute of Freshwater Aquaculture (CIFA) in India (Ramanna Pathak, 2012). Dr Attipoe explains that one solution could be to try to counter this through some type of tagging/DNA marking for tracing the material, but such tagging is expensive.[20] It is partly in response to this situation that the Ghanaian government has raised the issue of patenting. However, at present it is not possible to patent a diverse breeding population or strain, but indirect control of a fish population may be gained by process patents on, for example, marker genes for resistance against diseases (Rosendal et al., 2006).

Researchers in general do not, however, agree on patenting as the preferred strategy. There are several arguments against it. First, Dr Attipoe maintains that patenting is both difficult and costly, and there have been no such attempts, nor have researchers at ARDEC tried to do gene technology (GM). In the Fisheries Division of the Water Research Institute (WRI), the situation concerning ABS and IPR is also regarded as very complicated; and the management realizes that it is not at all clear who will benefit, or how to determine ownership and acknowledge input. Here also, it is noted that IPR of biological material and genetic resources are now increasingly coming into focus for the government.[21]

The question of legal protection or patents is closely connected to the underlying issue of how to maintain and further improve the quality of the breeding programme, in this case the Akosombo tilapia strain. According to ARDEC's Felix Attipoe, funding is the greatest challenge, as income from the programme is not sufficient to sustain research and further development, e.g. for tagging. This basically means that the breeding programme is still largely dependent on foreign funding components.[22] From the WRI, it is maintained that national funding will only cover salaries, so there it is important to raise production and sales of fish to cover expenses.[23] Still, researchers in the aquaculture sector expect that future developments are likely to involve greater intensification and larger farming units in the sector. According to Dr Attipoe, this should involve more training and education among the farmers; however, government funding is declining, with the government expecting the private sector to take on more development work in the sector.[24] At this point in our interviews, the issue of Norwegian experiences with salmon farming also came up. We discussed the incident of the majority share of the state Norwegian salmon breeding programme having been purchased by a multinational corporation. The sale could pose future challenges with regard to securing access to high quality breeding material for domestic actors in salmon farming and breeding (Rosendal et al, forthcoming). A general lesson could be the importance of maintaining the quality of the national breeding

[20] Interview with Felix Attipoe, 21 October 2011.
[21] Interview with NN4, Fisheries Department at WRI, 24 October 2011.
[22] Interview with Felix Attipoe, 21 October 2011.
[23] Interview with NN3 at WRI, 24 October 2011.
[24] See footnote 22.

programme, the nucleus, as a national capital and public good. As a minimum, there should be conscious decision-making process regarding the maintenance and improvement of breeding material.[25]

Access is an essential element in the debate on patenting aquatic genetic material. Here we should note that the ARDEC breeding programme has been carried out in cooperation with actors in the larger region of the Volta Basin. This means that it involves not only the Volta Lake in Ghana, but the catchment area for tilapia in this region, where there are important traits that need to be further identified.[26] Hence, breeding activities at ARDEC, including the TIVO project, involve international transactions with aquatic genetic material. In general, access is not seen to be a problem, as the ABS issue will be resolved by the providers getting fish back from the breeding programme as well as benefitting through training. ARDEC has disseminated fish to Burkina Faso and Togo, and Dr Attipoe spoke of plans to disseminate also to Ivory Coast (where an earlier breeding programme was lost during the recent civil war). Some of this dissemination has been sponsored by the FAO through the TIVO project.[27] Accordingly, the results will be shared with all the countries involved who have contributed, even though Ghana has contributed most. Again, it is clear that the situation makes it difficult to determine who should get what from benefit sharing, or how ownership will eventually work out. Our interviewees at the Water Resource Institute were all but unanimous in agreeing to share and retain open access among the countries of the Volta Basin.[28] A steering committee is working on this and a protocol has been made on how to disseminate the fish to the various countries. Our interviewees mention a dilemma: successful Ghanaian achievements could either speak in favour of Ghana serving as a kind of role model for other countries in the region, or might be used as an argument against free sharing in the region.[29] This is an inherent dilemma for South–South movement of genetic material – should the same type of ABS principles apply here as when the genetic resources move from South to North? The predominance of South–South movement of aquatic genetic resources represents an important difference between aquaculture and the sectors of agriculture and pharmacy.

Eddie Kofi Abban is a pioneer in aquaculture in Ghana, now retired from the Water Resources Institute, but still active in aquaculture and fish management. One of his concerns has been how to deal with the Akosombo breeding programme in legal terms, when it concerns the whole Volta basin. The fish has been collected from the Volta Basin – does that make it a transboundary issue? and how should the material be controlled? It is important to set up procedures for dissemination in order to retain benefits for farmers and consumers and to have a focal person that will monitor and control this. According to Mr Abban, one problem is that the farmers and the hatcheries (although they agreed to it) do not appear willing to pay the extra price for the improved fish, even though it

[25] See footnote 21
[26] See footnote 21.
[27] Interview with Felix Attipoe, 21 October 2011.
[28] See footnote 21.
[29] See footnote 21

saves them a lot of money, due to lower input costs and higher growth in the fish from the Akosombo breeding programme: 'The fry still just looks like a very small fish to them, so why should they pay more…'[30] But the market is not able to regulate this situation, and certainly not able to provide long-term planning for prevention and to be in the forefront in the event of disease. Hence, there is still a need for public or external funding. [31] However, this seems to have changed recently and there has been more demand for the Akosombo strain; hence, the time may be ripe for a small levy on the sale of the superior broodstock.[32] Moreover, the government had decided in 2011 to restrict tilapia farming to using the Akosombo strain only.

Given the mutual dependency among the countries sharing tilapia within in the Volta Basin, the issues of access and benefit sharing are important. ABS in a regional perspective is central to aquaculture in all African countries, as aquaculture is dominated by tilapia and catfish, which are found in many locations in the region. Hence, for the purposes of food security and production, it is necessary to share and access technology and breeding material across the continent. Mr Abban explained that some politicians believe patenting to be a good idea, whereas the technicians have realized that patenting is much too costly and that there is very little chance of success for this strategy within the aquaculture sector in Ghana.[33] It takes too much time and energy to achieve and then enforce a patent, so Ghana should not spend resources on securing IPR. One alternative might be to look into establishing trademarks or some type of branding (or geographical origin labelling), but here one would have to clarify how cumbersome such a system would be and how Ghana could go about enforcing it. According to our interviewees at the Water Research Institute, the current strategy is still to publish in order to prevent other external actors from patenting the results from the Akosombo strain.

There is some limited awareness that the Ministry of Food and Agriculture is working on ABS legislation and that lawyers are looking into how to secure benefits, to be based on cooperation involving all sectors – crops, forestry, medicine, soils and fisheries.[34] Basically, however, there seemed little awareness about the new ABS legislative initiative within the administrative levels of the fisheries sector.[35]

4.2 Access issues in light of GIFT

The biological knowledge base on tilapia is considered to be very sound. As early as in 1988, an inventory of Ghanaian tilapia was conducted. Some of that material was made available to the Philippines, and the GIFT breeding programme was developed. There has been widespread agreement at the international and domestic levels for caution in bringing

[30] Interview with E.K. Abban, Fisheries Department at WRI, 24 October 2011.
[31] Interview with Abban / NN5, Fisheries Department at WRI, 24 October 2011.
[32] See footnote 30.
[33] Interview with NN5, Fisheries Department at WRI, 24 October 2011.
[34] Interview with NN3 at WRI, 24 October 2011.
[35] Interview with NN5, Fisheries Department at WRI, 24 October 2011.

GIFT tilapia back to Ghana, due to fear of contamination of the native fish stocks. According to our interviewees at the Water Resource Institute, this view has recently changed: There is now agreement that GIFT tilapia should go back to Ghana to benefit the source countries, including Kenya, Senegal and other countries in the Volta region.[36]

Although Ghana has not yet received GIFT fish, GIFT technology has been used to develop the Akosombo strain.[37] When GIFT fish was banned from Africa, WorldFish wanted to contribute to ABS through funding the technological elements of the domestic breeding programme and through training programmes conducted *inter alia* in Egypt, India and the Philippines.[38] Since 1999 WorldFish has worked with national partners in West Africa to genetically improve locally farmed tilapia strains and the Akosombo tilapia is a result of this type of collaboration (Tran et al., 2012).

Hence, the GIFT programme has already provided benefits to Ghana through the use of GIFT technology and training – a central aspect of the programme.[39] After two years and several rounds of environmental impact assessments, the Ghanaian Environmental Protection Agency on 7th November 2011 granted the final permit to start importing GIFT fish to ARDEC, Akosombo for trial purposes. The project work will be carried out in collaboration with the WorldFish Center and the FAO. The objective is to compare GIFT fish with the Akosombo strain, after first doing an environmental study on introducing GIFT fish in Ghana. The decision as to whether to release the GIFT fish to farmers in Ghana will depend on the outcome of the experimental study.[40]

Access to foreign breeding material has mainly been hampered by domestic environmental regulations set up to prevent import of diseases to Ghana, similar to the concerns linked to the GIFT fish. The GIFT/WFC/FAO project was delayed for the same reason. It will be located in Akosombo and then possibly, depending on the impact assessment results, be disseminated to the other countries involved in the project – Burkina Faso, Ivory Coast, Mali, Togo and Benin – but will not be set up in any of the other countries. The Ghana breeding programme is much more advanced, so activity will stay here.[41]

So far, GIFT actors from WorldFish have not seen a need to access more or recent African tilapia seed. It is believed to be inferior to GIFT fish in growth performance, such that GIFT fish would (at least in the short term and at least with a view to growth) suffer from such genetic infusions.[42] However, as African tilapia breeding programmes take off there may be renewed interest in this material. Both sides might benefit from exchange of genetic material, and Africa could become more interesting as a source

[36] Interview with NN4, Fisheries Department at WRI, 24 October 2011.
[37] See preceding footnote
[38] Interview with Felix Attipoe, 21 October 2011.
[39] Interview with NN3 at WRI, 24 October 2011.
[40] Interview with Felix Attipoe, 21 October 2011.
[41] Interview with NN3 at WRI, 24 October 2011.
[42] Interview with Raul Ponzoni, World Fish, November 2009.

of tilapia.[43] While there might still not be much to offer in terms of growth, there could be other desirable characteristics, such as disease resistance traits. Genetic diversity of genetically improved and domesticated stocks in the global tilapia farming is important and currently not particularly large, so any new strains developed should be highly valued.[44]

There might also conceivably be future interest from external companies such as GenoMar, the multinational corporation that bought large parts of GIFT, in accessing tilapia from African sources like the Akosombo breeding programme. In order to maintain control over their genetic material also in such situations, Ghana and other African countries might consider a combination of two strategies: First, to keep publishing the results from tilapia breeding in order to restraint patenting by external actors. Second, to establish an ABS system along the lines of the Nagoya Protocol, including the principles of prior informed consent (PIC) and mutually agreed terms (MAT) for cases of external access to tilapia breeding material.

4.3 Access issues in light of environmental legislation

The Environmental Protection Agency has a strong position and conservation concerns are central to the government in Ghana. For aquaculture, the policy is to use zones to identify the areas that will not be used for farming in order to ensure conservation. This also necessitates cooperation between the various ministries.[45] The environmental problems envisaged by intensification of farming may to some extent be countered by Ghana's stringent environmental regulations. Every six months an environmental impact assessment (EIA) must be performed by the fish farmers; this is now also being required from the smaller farmers, who must acquire permits and who are being asked to form associations. In this way, the government is strengthening policies to regulate the aquaculture sector.[46]

As to the GIFT/WFC/FAO project, this is still a trial and it is not certain that the outcome will be that GIFT fish is actually needed in Ghana. Tilapia from GIFT will be accepted only if the fish display significantly higher growth or other favourable characteristics without any negative side effects compared to the Akosombo strain. In any case, the control mechanisms are now being put in place and will be very strict.[47] The

[43] Interview with NN3 at WRI, 24 October 2011.
[44] Interview with Felix Attipoe, 21 October 2011.
[45] Interview with NN4, Fisheries Department at WRI, 24 October 2011.
[46] Interview with Felix Attipoe, 21 October 2011. Corroborated in interview with NN6, Veterinary division, Fisheries Commission, 24 October 2011.
[47] NN at the Fisheries Commission does not see any problem in letting GIFT into the country, however. That material is much needed to improve Ghana's own stocks and it will bring profits. He himself had issued the permit for Tropo Farm to import GIFT fish and thought the farm did well in importing the GIFT fish. This is the installation that later had to destroy all its material as a consequence of bringing in GIFT fish. Interview with NN6, Veterinary division, Fisheries Commission, 24 October 2011.

Fisheries Commission is a central actor here and will issue the permits accordingly.[48]

The role of the Veterinary Division of the Fisheries Commission is to support aquaculture with policies and legislation, often based on Norwegian and European models (standards of the World Animal Health Organization, OIE in Paris). New results in breeding or new farming facilities or research projects require permits from the Fisheries Commission.[49] This constitutes part of the environmental and health legislation in Ghana, of high importance because the Ghanaian borders are viewed as being very loose. The stringent regulations could be part of the reason why there is still so little disease in fish farming in Ghana. Some diseases are present, but they are not very serious. However, this situation may change along with the expected increase in intensification.

According to the Veterinary Division of the Fisheries Commission, the Ghanaian authorities enforce strict import bans on tilapia from abroad in order to counter the possibility of increased diseases. The ban includes not only GIFT tilapia and breeding material, but also fresh and frozen fish for consumption. Even transfers within the country are now strictly monitored and regulated through various zones. Since the regulations entered into force in 2011, all tilapia material used must come from the Akosombo strain, so as to control the health of the tilapia seed as far as possible. In other words, all the broodstock must come from ARDEC. This decision was made through a stakeholder meeting and process. Later on, however, most of the farmers and hatcheries complained that it was too cumbersome. In any case, some 16 or 17 hatcheries will be selected and approved for multiplying and disseminating the Akosombo strain.[50]

Fish farming in Ghana is still very expensive, especially the intensive cage culturing in Lake Volta, partly due to the high cost of imported extruded floating tilapia feed, which is the main diet administered by cage farmers.[51] Domestically farmed tilapia is not sufficient to provide for the domestic market and the fish produced is still very expensive. Some importers try to dodge the ban by labelling the fish something else, as tilapia from China is available at half the price. However, the Ghanaian government believes that as soon as domestic production catches up, prices will come down and production will increase. This is seen as important to the government in order to reach the goals of self-sufficiency and food security.[52] On the other hand, most aquaculture in Ghana seems to be run by foreigners; there are very few Ghanaian owners.[53] This situation brings us to the bottlenecks characterizing the aquaculture sector.

[48] Interview with NN4, Fisheries Department at WRI, 24 October 2011.
[49] See Fisheries Regulations (2010) of L.I. 1968: Para 64–67 on permits in aquaculture. Interview with NN6, Veterinary division, Fisheries Commission, 24 October 2011.
[50] Interview with NN6, Veterinary division, Fisheries Commission, 24 October 2011.
[51] Interview with Felix Attipoe, 21 October 2011.
[52] See preceding footnote.
[53] Interview with Halvor Kittelsen, Head of West African Fish Ltd, 26 October 2011. Corroborated in interview with Felix Attipoe, Director of Aquaculture Research and Development Centre (ARDEC) under the Water Research Institute, 21 October 2011 and also by Madam Hannah, Minister of Local Fisheries r, 26 October 2011.

4.4 Major constraints in aquaculture

All along, the major constraint for genetic improvement and dissemination of farmed tilapia has been funding. With regard to human capacity, the situation is much better: there is a high level of competence in Ghana, likely to improve further with the cooperation with WorldFish on training and technology. Besides tilapia, also catfish will be considered as a farmed species entailing a breeding programme.[54] A major bottleneck for Ghanaian aquaculture has been the lack of the laboratories and veterinary experts essential in order to stay at the forefront and be prepared if new disease outbreaks should occur. Interviewees also emphasized the need to develop and produce feed domestically. Today Ghana imports most of the feed, and little is known about the quality of the feeds entering the country. This is recognized as a serious health issue that will also require more laboratories and veterinary experts.[55]

Many key actors in the aquaculture sector pointed out that the most pertinent challenge for aquaculture in Ghana today, asides developing better feed, with cheaper and easier access to feed (through domestic production of floating pellets), is to start breeding for disease resistance.[56] Ghanaian aquaculture has been largely free of diseases so far, but it is important to be forewarned and take precautions. West African Fish Ltd. has the necessary equipment to get started and there are plans for a breeding programme that may include disease resistance in the future. However, the company owners (headquartered in Denmark) have not agreed.[57] The same hesitance to invest in disease resistance seems to be found among public and private potential funders alike.

In a wider perspective, external observers maintain that corruption and lack of effectiveness in production are also major stumbling blocks to enhanced production in Ghana's primary sector. This is also why domestic prices are so high; production is not very efficient in agriculture at least, perhaps also in aquaculture. Basically, Ghana cannot compete with external competition.[58] In the mining sector and the forestry sector at least, corporate social responsibility has been lacking. The rules and the policies are in place, stipulating that revenues should go back to local communities. In practice, however, this does not happen, because there is a lack of control mechanisms to enforce policy. Investments are also lacking for the same reasons: lack of enforcement of rules, and lack of effectiveness. On the same note, the Environment Protection Agency has a strong position, but that does not automatically translate into a high level of implementation of environmental legislation.[59] This view is corroborated at the farm level: environmental standards are very high, but not always enforced. The strict reaction that forced Tropo Farm to

[54] Interview with NN4, Fisheries Department at WRI, 24 October 2011.
[55] Interview with NN6, Veterinary division, Fisheries Commission, 24 October 2011.
[56] Interview with NN6, Veterinary division, Fisheries Commission, 24 October 2011. Corroborated by Felix Attipoe and Halvor Kittelsen.
[57] Interview with Halvor Kittelsen, Head of West African Fish Ltd, 26 October 2011.
[58] Interview with Paul Schuetz, Programme Manager, Market Oriented Agriculture Programme, German International Cooperation (GIZ), 25 October 2011.
[59] See preceding footnote.

destroy all its fish after importing GIFT tilapia in contravention of the ban was perhaps more of a one-off case. Lack of enforcement of environmental legislation is said to be not uncommon, indicating that there is yet another effort to forestall diseases that has not been very effective.[60]

5 Summary and concluding remarks

The major insights from this study can be summed up in the following six points:

- Ghana is a latecomer to ABS legislation in Africa, and this is still not a widely recognized issue among parts of officialdom and academe. Still, the principle of benefit sharing has long traditions in Ghanaian society, also in the aquaculture sector.
- Experiences from bioprospecting deals have often been negative, and show great similarities with other case studies in Africa. This underscores the need for ABS legislation and institutions (focal point) also in Ghana. Albeit often anecdotal, such stories provide a background for understanding the perceptions among key actors concerning the need for ABS legislation and/or controlling own genetic material through IPR.
- For aquaculture and tilapia, access issues have most relevance in a regional sense, so the CBD's principles for improved benefit sharing between rich and poor countries are not quite on target. On the contrary, it is important to retain open access to tilapia genetic material between the countries of the greater Volta region, probably more important than ensuring benefits from others' use. Moreover, the scope for patent protection is probably much less than desired by the authorities.
- A corollary to the previous point is that in the case of future interest in tilapia from multinational corporations such as GenoMar, Ghana could benefit from a solid ABS framework based on the principles of prior informed consent and mutually agreed terms, which include aquatic genetic resources.
- The GIFT programme has already provided benefit sharing in terms of technology transfer – which may be equally or even more important than sharing and dissemination of breeding material or monetary payments.
- There may be future interest in exchange of improved breeding material between GIFT breeding programmes and the Akosombo strain – a possible avenue for Ghana to profit from improved high-quality breeding material from the Akosombo breeding programme.

[60] Interview with Halvor Kittelsen, 26 October 2011. Corroborated in interview with Felix Attipoe, 21 October 2011, and also by Madam Hannah, Minister of Local Fisheries, 26 October 2011.

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