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Access to Genetic Resources and 'Rings of Protection' in Indian Shrimp Aquaculture

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Abstract

This study examines the global and national factors affecting India's policy on access and rights in relation to the shrimp sector. Shrimp aquaculture in India has witnessed recent changes that illustrate the complexities involved in establishing a framework for importing improved breeding material, and ensuring access to aquatic genetic resources. Historically, the shrimp sector in India has been mainly based on public sector led investments along with the private sector involvement for increasing production, and developing and widely disseminating material, rather than creating proprietary products. This structure is undergoing changes with the Government of India's recent steps to acquire improved material and to permit import of an exotic species. In tune with global trends, foreign companies are using biological and technological strategies ('rings of protection') rather than IPRs to protect their materials in India. This study finds that although stakeholders do not currently perceive the implications of such structural and legal shifts, restrictions on access could pose a real challenge to the Indian shrimp sector. Dependence on imported material, monopoly situations, future demands for IPRs, greater privatization and commercialization are outlined as factors that could restrict access to resources for stakeholders. This study points out the implications of international developments with regard to access and rights, and outlines various policy options that India could pursue to balance rights and access to aquatic genetic resources.

Key Words

Genetic resources, intellectual property rights, access, benefit sharing, biodiversity, monodon, vannamei, black tiger shrimp, public, private

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The contents remain the sole responsibility of the author.

Pune, February 2012

Anitha Ramanna Pathak

1 Introduction

The goal of sustainable aquaculture is not likely to be attained if a balance between access and protection of aquaculture genetic resources is not achieved. For developing countries such as India, achieving such a balance means ensuring to access technology/genetic material as well as protecting and promoting innovations. India requires access to foreign improved breeding material and technology, and must also create incentives for companies and institutions to invest in genetic material. Shrimp farmers and breeders also need access to genetic resources for food production and sustainable use of genetic material. These objectives are crucial for India to prevent and deal with disease outbreaks, as well as to become self-reliant through establishing its own breeding programmes. India must also ensure that the goals of both the public and the private sector are promoted. The main challenge arises with respect to the balance between fair and affordable access, and legal or biological protection of innovations. These objectives can create conflicting goals. This becomes further complicated not only by India's own regulatory and structural factors, but also by the lack of clarity in international regimes and the rapidly changing global structures in aquaculture. This study focuses on India's shrimp sector and tries to analyze the legal and structural factors affecting access and protection of aquaculture resources. We link this with the perceptions of actors and their interests in dealing with the dilemma of balancing access with rights. Policy options for India to ensure a balance between access and protection over aquatic genetic resources are also outlined. The main questions raised by this study are:

1. What factors affect access and rights over genetic resources in India's shrimp sector?
2. What are the interests and perceptions of the major stakeholders in the Indian shrimp sector with regard to access and protection of aquaculture genetic resources?
3. What are the policy options for India for ensuring access to resources for farmers and breeders, while simultaneously promoting investment and innovation in the shrimp sector?

India is an important country for a case study, because of its active role in international negotiations dealing with access to genetic resources and Intellectual Property Rights (IPRs). India has played a leadership role in evolving the norms and regulations relating to access and benefit sharing (ABS) in the Convention on Biological Diversity (CBD). India is also among the first developing countries to have established laws on biodiversity and access to genetic resources. India is rich in aquatic biodiversity, has a vast coastline, and has possibly one of the richest multispecies fisheries areas in the world (James, 2000). India's shrimp sector provides an interesting example to focus upon as India's shrimp sector has recently undergone various changes. These changes illustrate the complexities involved in in establishing a framework for importing improved breeding material, and ensuring access to aquatic genetic resources. They also point to shifts in the public-private relationship in India, reflecting global trends towards greater commercialization and privatization of aquatic resources. The Indian case can therefore be utilized to explore the implications of the changing roles of the public and private sector on issues of access and rights over genetic resources.

We focus on three main factors, legal, structural and biological, identified by Rosendal and Olesen as significant in accounting for actor perceptions of needs and interests with regard to access and rights over genetic resources (Rosendal et al. 2006; Olesen et al., 2007). Legal factors include international and national laws and regulations pertaining to access and protection of aquaculture genetic resources. Structural factors outline the different type of ownership (public, private, multinational, cooperative) that exists with regard to genetic resources and breeding programmes. It also focuses on the global and national trends towards greater privatization and commercialization. The biological characteristics focus on the role of biology of fish and aquatic species in shaping interests of actors. The paper is thus divided into the following main sections: International and national laws regulating access and protection of genetic resources; Structural Developments, Technological Factors, Impact of Legal, Structural and Technological Factors on Access and Rights, Policy Options and Interests of Actors; International Developments and Implications for India.

2 Methods

We utilize both literature review and the interview method. Policy briefs, legal documents and publications of the aquaculture industry are consulted to provide relevant data. Interviews are relied upon to understand the perceptions and interests of various stakeholders in the shrimp sector. These are used to document their experiences with legal and policy issues affecting access to resources, and to map their views on needs for balancing access with protection. Key stakeholders from government, industry and other sectors have been interviewed for the study. These include: scientists from the main public sector organization focusing on shrimp in India (Central Institute of Brackishwater Aquaculture), policy makers at the helm of the Coastal Aquaculture Authority and the National Biodiversity Authority, shrimp industry and hatchery operators, and NGOs. India being a large country with several players, the objective was not to interview all the actors but rather focus on the views of key stakeholders. The aim is not provide statistical surveys, but to explore the various arguments and perceived needs and interests among the stakeholders regarding access and protection of material. About twenty detailed interviews and discussions at various meetings with several stakeholders were conducted.[1] This study does not claim to have gathered views from a large sample but only to have conducted a limited review based on a few interviews from important actors. Thus, it can be viewed as preliminary study upon which further more detailed and larger number

[1] The number of detailed interviews include: seven public sector scientists, four industry representatives, four Government officials, three from other sectors including NGOs. In addition to this, discussions with various stakeholders from industry and public sector were held at meetings and conferences.

of interviews could be conducted to gather a wider and more representative sample. The data from detailed interviews, conducted mainly during July 2010, is supplemented with the information and discussions gathered at two conferences and one international seminar: the Aqua India conference hosted by Indian aquaculture industry (Chennai, October 2010), the World Aquaculture Society conference in Kochi (January, 2011) and the seminar on "Stimulating sustainable innovation in aquaculture; access and protection of aquatic genetic resources" at the Fridtjof Nansen Institute, Norway (September 2011).

3 International and national laws regulating access and protection of genetic resources

3.1 International regimes

Internationally, the conflict between access and protection over genetic resources is clearly found between two global agreements, TRIPs (Trade Related Intellectual Property Rights Agreement) of WTO (World Trade Organization) and the CBD (Convention on Biological Diversity). While TRIPs lays down minimum standards for protection of intellectual property rights, the CBD focuses on conservation and regulating access to genetic resources. The controversy between extending IPRs and protecting genetic resources is a North-South issue in agriculture and pharmaceuticals. While the North currently has a predominant position in terms of technology and resources to file and enforce patents, the South houses the greatest store of biodiversity. Industrialized countries require access to genetic resources, and developing countries need access to technology. However, the situation is different in the case of aquaculture as the exchange has not been only from South to North. Exchanges have been from South to South, as in the cases of tilapia and catfish and North to both North and South, particularly in the case of salmon (Bartley et al 2009; Rosendal et al, forthcoming).

The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs), which entered into force in 1995, established global standards for intellectual property. TRIPs deals with various forms of intellectual property rights (IPRs) including patents, trademarks, and copyrights. Patents have been one the most controversial aspects of TRIPs, particularly with regard to plants. TRIPs obliged all parties to make patents available for any invention, whether product or process, in any field of technology (Grain, 2001). However, TRIPS Article 27.3(b) allows WTO members to exclude "plants and animals other than microorganisms and essentially biological processes for the production of plants and animals other than biological and microbiological processes," provided that they offer patents or establish "an effective *sui generis* system" of protection for plant varieties (Grain, 2001).What constitutes "an effective *sui generis* system" is not defined by WTO and has led to enormous debates internationally (Grain, 2001).

The focus of the debate over TRIPs so far has been mostly on plants and not on aquaculture. Currently, though patent protection is available in many countries for fish breeding, there are only a few examples of patents in this sector, such as genetic disease resistance marker in salmon, transgenic salmon, patent on determination of viral disease resistance of salmon and triploid oysters (Olesen et al, 2007). There are more patents on virus and vaccines in aquaculture[2]. Other IPRs such as “Breeder's rights' are not applicable to fish due to the need for much higher genetic heterogeneity in most commercial fish populations (Rosendal et al, 2006; Olesen et al, 2007). However, patents and other forms of IPRs are likely to become more attractive to the aquaculture industry in the future because developments in genetic engineering and genomics will facilitate more patentable findings and innovations (Olesen et al., 2007). According to the FAO, “Although the TRIPs Agreement so far has had only limited implications for trade in fishery products, the importance of TRIPs is expected to increase in line with the projected growth in aquaculture and the possible use of biotechnologies in production.”[3](see section 6.2)

The Convention on Biological Diversity (CBD), signed at the Earth Summit in Rio de Janeiro in 1992, represented the overt shift of developing nations from viewing genetic resources as free and commonly accessible by all (common heritage of mankind) to sovereign control over genetic resources.[4] This shift was considered important as new bio-technological techniques to screen for biochemical substances increased private industry interest in naturally-occurring plants and other organisms (Wijk and Ramanna, 2007). Scientific teams often turn to local farmers or traditional healers to tap their local knowledge, but fail to offer due compensation (Wijk and Ramanna, 2007). The CBD aims to redress this by introducing ‘access and benefit sharing’ (ABS). 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 (CBD, 1992; Rosendal, 2000).The scope of 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. Operationalizing the ABS has however been a controversial issue. A Protocol on Access and Benefit Sharing was recently concluded at the 10th Conference of the Parties to the CBD in Nagoya, October 2010. India was one of the leading developing countries that argued that the Nagoya Protocol should enact measures to ensure that the benefits of natural resources and their commercial derivatives are shared with local communities. India's Minister for Environment, Jairam Ramesh, speaking about the Nagoya Protocol stated, “It is a big victory for India that both derivatives and pathogens are part of the ABS. The new ABS Rules mean that multi-national companies will have to share their profits with local commun-

[2] Personal communication, Senior Scientist, Nofima

[3] http://www.fao.org/fishery/topic/13275/en

[4] The shift had been preceeded by the reinterpretation of the FAO International Undertaking in 1989, where the principle of CHM (common heritage of mankind) was discontinued, much to the dismay of developing countries (Rosendal, 2000).

ities not only for using the original resource, but also any derivative products developed from it"[5].

3.2 Domestic legislation

India's National Biodiversity Act, 2002, enacted to implement the CBD, regulates access and use of genetic resources in India. Prior to this law, India considered such resources as common heritage and no regulatory authority existed to check such access or use. With the establishment of the National Biodiversity Authority (NBA), foreign nationals[6] must now seek permission before accessing any biological resource in India. The NBA also regulates IPRs on biological resources by requiring anyone applying for a patent on a biological resource to first get the permission of the NBA to access the resources. Indian nationals can access biological resources but they must comply with benefit sharing which applies to both citizens and non-citizens of India. Benefit sharing, which essentially entails compensation for use of genetic resources, is to be done on mutually agreed terms. The NBA states that it would provide guidelines regarding benefit sharing on a case-by-case basis (see section 7.5).

The Patent Amendment Acts of 1999, 2002, and 2005, passed to comply with the TRIPs Agreement, essentially paves the way for product patents in pharmaceuticals and agrochemicals, revising India's earlier regime of granting only process patents in these fields. (The Patents Act, 1970; The Patents (Amendment) Act, 2002; The Patents (Amendment) Act, 2005; Ramanna, 2005). Microbiological processes and resulting products are patentable, as well as microorganisms (Bala Ravi, 2006). But India does not provide patents to other life forms including plants and animals or their parts like organs, tissues, cell lines and their genetic material (Bala Ravi, 2006). In addition, transgenic plants and animals, gene sequences of plants or animals and Expressed Sequence tags are not patentable.(Bala Ravi, 2006).However, confusing language in respect of plant improvement processes and on micro-organisms has led to speculations that patent coverage for plants was *de facto* a possibility (Ramakrishna, 2002; Wijk and Ramanna, 2007).

India has also established an act to provide protection for goods (including agricultural goods) that originate in a specific territory or region, known as the Geographical Indications of Goods (Registration and Protection) Act, 1999. The protection is provided for 10 years with renewal possible for another 10 years. There is a separate classification for fish, but nothing has yet been registered in this category. According to Kochar (2008), there are ample opportunities to identify geographically linked process and products in aquaculture for facilitating their registration and protection as geographical indications, and ultimately extending the benefits to farmers/fishermen.

[5] 'Nagoya Protocol, a big victory for India', Priscilla Jebaraj,The Hindu October 31, 2010.
[6]Elaborated in the Act as: 1) a person who is not a citizen of India, a non-resident Indian, any body corporate association or organization not registered in India or which has any non-Indian participation in its share capital or management.

4 Structural developments

A strong public interest in investing in seed production for domestic users has shaped India's shrimp structure. The normative motivation of the Indian public sector historically has been of widely disseminating material rather than creating proprietary products. However, the shifting normative and structural positions within the Indian aquaculture sector would change this scenario, possibly quite rapidly. The public sector has invested largely in aquaculture in order to build a strong domestic aquaculture industry. This complementary public-private relationship is undergoing changes with the globalization of the Indian shrimp sector. Private companies can now acquire more aquatic resources from foreign sources. In the future, it may lead to greater demands for protecting rather than widely sharing material (Indian or foreign).

4.1 The Indian shrimp sector in brief

Shrimps constitute a major sector of India's marine exports. The export value of frozen shrimp in the year 2010-2011 was $ 1261.83 (US million) up from $ 883.03 (US million in the year 2009-2010)[7]. Frozen Shrimp continued to be the major export value item accounting for 44.17% of the total of marine product export earnings (in US $) in the year 2010-2011[8]. Shrimp exports during the year 2010-2011 increased by 16.02%, 36.72% and 42.90% in quantity, rupee value and US$ value respectively[9]. India exports frozen shrimp to 62 countries with the major markets being United States, EU and Japan (www.fis.com). In view of the high potential of shrimp farming to contribute to the Indian economy, it is one of the priority sectors for the Government (Ravichandran and Ponniah, unpublished draft, 2010). Shrimp production in India reached a total of 95,918.89 million tonnes in 2009-2010 and area under cultivation was 1,02,259.98 hectares[10].

The public institutions in India have played a key role in establishing the domestic aquaculture industry. The Marine Products Export Development Authority (MPEDA), under the Ministry of Commerce and Industry, took the major initiative of establishing two large commercial shrimp hatcheries with technical collaboration from French and American companies around 1988-89[11]. Realizing the critical importance of assured supply of seed for the development of shrimp farming in the country, these hatcheries were established for the production and supply of shrimp larvae[12]. This initiative led to the large scale development of shrimp farming in 1988-89. In addition, development schemes for shrimp farming by the Ministry of Agriculture and Ministry of Commerce and Industry paved the way for the establishment of a number of shrimp

[7] http://www.mpeda.com/inner_home.asp?pg=aquaculture/contents.htm
[8] Ibid.
[9] Ibid.
[10] Dr. Paulraj, "Revitalising Indian Aquaculture" Key note address at Progress and Profits in Indian Aquaculture, AquaIndia Conference, October 29-30, 2010.
[11] http://eprints.cmfri.org.in/5621/1/6.pdf
[12] Ibid.

hatcheries and farms in the coastal states during the early 90s. (Ravichandran and Ponniah, unpublished draft 2010).These investments led to a phenomenal increase in farmed shrimp production from 40,000 tonnes in 1991–1992 to 115,000 tonnes in 2002–2003[13].

There are a total of 351 hatcheries producing shrimp and prawn seed in India, out of which 280 hatcheries were dedicated to shrimps with a total annual capacity of producing 12.5 billion post larvae (Ravichandran and Ponniah, unpublished draft, 2010). Shrimp seeds are produced by large private companies or in partnership with government agencies (Gura, 2009). In India, about 95% of the farmed and landed shrimp are exported, but domestic markets for shrimp and other aquaculture species are growing with the advent of retail chains (Gura, 2009). Currently about 91 percent of the shrimp farmers in India own less than 2 hectares, 6 percent between 2 to 5 hectares and the remaining 3 percent have an area of greater than 5 hectares. Out of the total area of 0.152 million hectares presently being utilized for shrimp farming in the country, Andhra Pradesh alone provides 47 percent of the area and contributes 50 percent of the total production. (www.fao.org).

The shrimp industry in India has seen great fluctuations, ranging from high growth and profits to significant loss of market share and revenue. Ravichandran and Ponniah unpublished draft (2010) outline various stages of the shrimp sector's development in India. The first phase (pre 1988-89), was a period of low risk and low profit where shrimp farming was based on traditional methods dependent on wild seed with an absence of commercial hatcheries. In the second phase (1989-95), hatcheries were set up; semi-intensive culture was practiced, which led to a low risk high profit model. The year 1995 marks the beginning of the third phase when the shrimp industry was plagued with disease. The White spot disease (WSSV) played havoc and its repeated occurrence demoralized the shrimp farmers (Yadava, 2002). WSSV is probably the most striking example of spread of disease and consequential major economic loss in aquaculture. This phase can thus be seen as one of high risk. The fourth phase (2006 to 2008) witnessed a drop in global shrimp prices, and the industry faced anti-dumping duties, strict food-safety standards and moved to a period of low profit. After 2009 the global prices have improved and with the production of vannamei in 2010, it has become more profitable.

Shrimp farming in India has historically been one of monoculture, producing mainly black tiger shrimp, *Penaeus mondon,* a species native to India. The giant tiger shrimp inhabits the coasts of Australia, South East Asia, South Asia and East Africa[14]. The major producers of *Penaeus monodon* include Thailand, Viet Nam, Indonesia, India, the Philippines, Malaysia and Myanmar[15]. In general, *Penaeus monodon* is the most prominent farmed crustacean product in international trade and has driven a significant expansion in aquaculture in many developing countries in

[13] http://eprints.cmfri.org.in/5621/1/6.pdf
[14] http://www.fao.org/fishery/culturedspecies/Penaeus_monodon/en
[15] Ibid.

Asia, but since 2002, production of *Penaeus monodon* has been unofficially reported to have declined, particularly in Thailand and Indonesia, because of substitution by *Litopenaeus vannamei* in many farms[16]. One of the main reasons for the switch to SPF vannamei was the disease (WSSV) that affected monodon as well as the potential to achieve higher production in vannamei. India was also one of the countries that suffered heavily due to the onset of viral disease in monodon. Annual economic losses from the impact of the disease have been estimated to be in the range of more than US$ 400 million in China (1993), US$ 17.6 million in India (1994), and over US$ 500 million in Thailand (1996)[17]. The economic losses suffered by the Indian shrimp industry due to disease in monodon, as well as the competition internationally from vannamei led to the demand for introduction of SPF vannamei.

4.2 Response to disease problems—SPF and SPR shrimp

India is not alone in having to deal with the disease in shrimp. The shrimp industry worldwide has faced enormous problems due to the spread of disease. The response to these outbreaks has focused on efforts to develop disease resistance. The terms frequently used in relation to these efforts are SPF (Specific Pathogen Free) and SPR (Specific Pathogen Resistant). According to Briggs et al (2004), "SPF means that the animals have been assured of being free from specific pathogens. This does not, however, guarantee against the animal being infected with unknown pathogens or known pathogens which are not screened against. SPR or Specific Pathogen Resistant describes a genetic trait of a shrimp that confers some resistance against one specific pathogen. SPF and SPR are independent characteristics and not all SPR shrimp are SPF and vice versa" (Briggs et al, 2004).

India's response to the disease in monodon was to try to acquire shrimp that would be better equipped to fight disease. This was done in two ways: 1) to acquire SPF monodon 2) to allow for imports of high health vannamei. The species of shrimp mainly produced in India, monodon, has very limited availability currently from SPF stocks, although some stocks are currently under development (Briggs et al, 2004). The main reason for this is the technical complexity of closing the life cycle of monodon. The Indian government floated enquiries to all the companies that claimed to have SPF monodon. Only a definite proposal was submitted by Moana Biotech and after due diligence, an agreement was entered with this firm for supply of SPF monodon seed to Indian farmers (see section 4.3).

As opposed to monodon, high health vannamei, another species of shrimp, has been available from SPF stocks since the 1990s. The Pacific white shrimp, *Litopenaeus vannamei* (formerly *Penaeus vannamei*), is a marine crustacean (Bridson, 2010). *Penaeus vannamei* is native to the Pacific coast of Mexico and Central and South America as far south as Peru (Briggs, 2004). One factor that enabled the production of SPF vannamei is the fact that it is easier to close the life cycle of vannamei in

[16] http://www.fao.org/fishery/culturedspecies/Penaeus_monodon/en
[17] http://www.agriculture.de/acms1/conf6/ws9fish.htm

comparison with monodon (see section 5). A programme to develop SPF vannamei was started in 1989 in the United States Department of Agriculture (USDA)-funded Oceanic Institute in Hawaii (Wyban, 2007). This programme continues to this day and has been expanded by a number of commercial ventures, mostly located in Hawaii. (Briggs et al, 2004). Domestication and breeding of the Pacific White Shrimp, *P. vannamei,* directly led to worldwide expansion of *P. vannamei* farming resulting in rapid increases in worldwide production (Wyban 2007). There are also suppliers of SPR strains of vannamei, but it is important to note that this resistance is only for some specific strains and no SPR stocks are reportedly available that are resistant to WSSV. (Briggs et al, 2004). The Indian government decided to allow for the introduction of the exotic species, vannamei, to India which was available as SPF for a number of major viral diseases, as a means of preventing the disease occurrence.

4.3 The introduction of exotic species

A major shift in India’s policy on shrimp took place in with the introduction of an exotic species of shrimp. *Litopenaeus vannamei* is a species native to South America that is also cultivated in many Asian countries. The vannamei species constitutes around 90 per cent of the world's shrimp aquaculture production, largely due to its low production costs, that is, half those of the black tiger or indicus species raised in India[18]. India had been hesitant to introduce vannamei due to concerns regarding the introduction of exotic pathogens.

Southeast Asian countries which had also suffered from disease in monodon made the switch to vannemai over a decade ago and were very successful. India lost much of its former market shares in the United States and European Union (EU) to cheap vannamei raised in these and other countries.The continued losses suffered by the domestic shrimp industry, along with demands by the stakeholders, ultimately prompted the Agriculture Ministry to permit the entry of vannamei.

The introduction of vannemai in India occurred under controlled conditions with a clear procedure laid down by the government. Initially, two companies, Sarat Seafood and BMR Hatcheries, were permitted to import brood stock from approved countries and conduct trials in a restricted environment[19]. The Central Institute for Brackishwater Aquaculture and the National Bureau for Fish Genetic Resources conducted the risk analysis for the introduction of vannamei in India[20].Following the risk analysis studies, the government decided for large scale introduction for commercial use of vannamei in 2009. The government consulted with the stakeholders with regard to introduction of vannamei. [21]. Vannamei importation and cultivation guidelines were prepared by the Department of Animal Husbandry, Dairying and Fisheries. A separate notification

[18] Economic Times, October 17, 2008
[19] Business Line Feb 3, 2009.
[20] Interview, policy maker, July 21, 2010
[21] Ibid.

laid out guidelines for hatcheries and cultivation of vannamei, and the Coastal Aquaculture Authority (CAA) was identified as the body that would grant permission to import vannamei brood stock. (Business Standard, October 17, 2008).

The Indian Government decided to establish quarantine specifically for the purpose of importing vannamei. This process was unique as no other country in Asia had such quarantine[22]. The State Government hatchery in Chennai was converted into quarantine, and all vannamei brood stock had to enter the country through Chennai, wherein the Animal Quarantine Officer would inspect the consignment in question and send it to the quarantine facility. Import of vannamei would be allowed only from a pre-approved group of suppliers who would be selected by a high powered committee constituted by the Ministry of Agriculture under the Chairmanship of the Member Secretary CAA from those firms which have expressed their interest in SPF vannamei. The agencies would base their shortlist of suppliers on a genetic basis as well as on the disease status of the facility and the brood stock.

Initially, the CAA shortlisted six companies who were international suppliers of vannamei, and later, two more companies were added to this list. Trial samples from SIS, Florida were acquired and in August 2009 regular commercial brood stock was brought in. The CAA advertised for applications from hatchery operators who wanted to import vannamei. Sixty-two applications were received and 24 were approved for one year, with the possibility of renewal. Restrictions were placed on the amount that companies could import, and guidelines were framed for farmers as well. Hatcheries are permitted only to sell PL to registered farmers.[23]. This was mainly done as a measure to guard against unregulated farming. Regular reports must be sent to the CAA by hatcheries and farmers. There will also be inspections of individual farms carried out by monitoring committees (Business Standard, October 17, 2008).The Indian government does place a restriction on hatchery operators in India that they must not sell or exchange the brood stock of vannamei. It is also assumed by some that hatchery operators would not do so in any case as they would like to retain the brood stock.[24] Perhaps this would be done to avoid illegal breeding/dissemination.

4.4 Policy to acquire SPF Black Tiger Shrimp

The Indian government decided to permit production of SPF (Special Pathogen Free) monodon from Moana Marine Biotech as another measure to cope with the disease plaguing the Indian shrimp industry. The production of SPF monodon is extremely difficult due to the technical complexity of closing the life cycle of monodon (see section 5). SPF essentially refers to animals being free from specific pathogens (Briggs et al, 2004). This should not be confused with SPR or Specific Pathogen Resistant which describes a genetic trait of a shrimp that confers some

[22] Ibid.
[23] Interview, Policy maker, July 21, 2010
[24] Ibid.

resistance against one specific pathogen (Briggs et al, 2004) (see discussion in section 7.4). Moana Marine Biotech Inc., Hawaii, had initiated a SPF *P. monodon* programme by collecting wild brood stock from various areas including Asia and South-east Asia. Moana has its headquarters in Hong Kong and through its bio-secure facility on the Big Island of Hawaii, the Nucleus Breeding Center; it supplies the parent seed to its overseas Multiplication Centers[25]. Currently, MOANA operates Multiplication Centers in Vietnam, Thailand and India through which high quality SPF seed is made available to shrimp farmers[26]. In 1999, MOANA started a project in support of the revitalization of the black tiger shrimp industry. “Moana successfully developed the largest and most diverse gene pool of specific pathogen free parent stock worldwide. Over a period of three years, technologies have been developed on an industrial scale for the domestication of the black tiger shrimp. A family based genetic improvement program was launched for developing ever better breeds. The successful results of these initiatives have enabled MOANA to become the leading aquaculture company in the development and supply of genetically improved and specific pathogen free seed of black tiger. MOANA’s specific pathogen free and traceable seed, guaranteed with a MOANA Certificate, will add value throughout the global supply chain, benefiting farmers, processors, exporters, retailers and consumers. Combined with MOANA’s know-how, services and technology, farmers will have the opportunity to improve quality, quantity and consistency in their production. Resulting benefits such as increased survival and improved growth rates will lead to more stable income and higher profits.”[27]

Moana Marine Biotech, U.S.A put forward a proposal for setting up of a Multiplication Centre for SPF *P.monodon* in December, 2006. “After detailed deliberations with a presentation by M/s Moana Technologies, at New Delhi on 1st December, 2006, steps were taken to carry out due diligence for the project, including a visit of team of officials to the facilities in Hawaii. The team visited the facility during 5-8 February, 2007 and validated the level of technology attained by the Agency[28].” After due approvals, an Agreement in this regard was signed between the NFDB and M/s Moana Technologies, Hong Kong in the presence of India’s Agriculture Minister and in New Delhi on 20th March 2008[29]. Towards establishment of Multiplication Center, the NFDB has acquired land at Mulapolam village of Sompet Mandal, Srikakulam District, Andhra Pradesh.[30] The multiplication centre was envisaged to have a production capacity of three billion post larvae (seed) a year to serve about 150,000 shrimp farmers across the country (quoted in Gura, 2009).

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[25] “Sustainable and safe black tiger shrimp seed will increase profit of farmers” MOANA (Asia) Ltd. Research and Farming Techniques October-December 2007. http://library.enaca.org/AquacultureAsia/Articles/Oct-Dec-2007/aa-oct-dec-07-moana.pdf
[26] Ibid.
[27] “Sustainable and safe black tiger shrimp seed will increase profit of farmers” MOANA (Asia) Ltd. Research and Farming Techniques October-December 2007. http://library.enaca.org/AquacultureAsia/Articles/Oct-Dec-2007/aa-oct-dec-07-moana.pdf
[28] http://nfdb.ap.nic.in/pdf/AnnualReport2007-08-NFDB.pdf
[29] Ibid.
[30] http://nfdb.ap.nic.in/pdf/AnnualReport2007-08-NFDB.pdf

India has a programme to develop its own SPF monodon programme through the Rajiv Gandhi Centre for Aquaculture (RGCA) under MPEDA in the Andamans. MPEDA has taken several steps to develop new technologies for aquaculture through research and development activities which have been initiated by the Rajiv Gandhi Centre for Aquaculture (RGCA) including the project for SPF brood stock of monodon[31]. The Marine Products Export Development Authority (MPEDA) was constituted in 1972 with a comprehensive role covering fisheries of all kinds, increasing exports, specifying standards, processing, marketing, extension and training in various aspects of the industry. (www.mpeda.com).The Rajiv Gandhi Centre for Aquaculture was setup by the Government of India to develop commercial culture technologies for species which commands good market potential particularly marine fin fishes[32]. With respect of SPF monodon it is reported that the RGCA is currently working on field trials[33].

The Central Institute of Brackishwater Aquaculture (CIBA), located in Chennai India, established under the Ministry of Agriculture 1987, serves as the nodal agency for the development of brackishwater aquaculture in the country (www.ciba.res.in). CIBA is one of the main government research institutes in India focusing on shrimp, and has also been working on establishing a breeding programme with monodon. According to CIBA, in an earlier project between CIBA, CIFE and AKVAFORSK genetic parameters for growth and resistance to WSSV were estimated. Growth was found to be heritable whereas resistance to WSSV had very low heritability indicating that conventional selection for disease resistance would not be successful. Based on the results a collaboration project exists between, Nofima (formerly AKVAFORSK) and CIBA in unraveling DNA markers for White Spot disease resistance in *P. monodon,* according to CIBA.

5 Technological developments and the biology of shrimp

Technological and biological factors play a role in determining policy. Tiger shrimp (*P. monodon*) is one of the most economically important cultured species but breeding it in captivity is extremely difficult (Preechaphol et al, 2010). It is very much restricted by the current dependency on wild-caught brood stock, with the consequential over-exploitation of high-quality sources in the wild (Preechaphol et al, 2010).The low degree of reproductive maturation of captive *P. monodon* has also limited the ability to genetically improve this important species

[31] http://goliath.ecnext.com/coms2/gi_0199-7833797/Empowering-farmers-towards-sustainability-and.html accessed on February 15, 2012

[32] Y C Thampi Sam Raj Rajiv Gandhi Centre for Aquaculture, MPEDA, "Brief Overview of Aquaculture in India and Prospects of Marine Fin Fish Culture" http://library.enaca.org/Grouper/HalongWorkshop/India.pdf

[33] Rao, Manuvendra, "Emerging Trends in SPF P. Monodon program—performance and commercialization, General Update on Domestication", presented at the AquaIndia 2010 conference Progress and profits in Indian Aquaculture, Chennai, October 29-30, 2010.

by domestication and selective breeding programs (Preechaphol et al, 2010). Vannamei which is a biologically different species from monodon, can be induced to mate and spawn easily in captivity which enables the culturist to close the life cycle of the shrimp, facilitating genetic selection (i.e. for improved growth rate and disease resistance) and domestication programmes (Briggs et al, 2004). The minimum spawning size for *P. monodon* females is 100 g, which will take at least 10-12 months under commercial pond conditions, whilst *P. vannamei* can be spawned at only 35 g, which can be achieved easily in 7 months (Briggs et al, 2004). This has obvious advantages over *P. monodon* in terms of generation interval and the expense involved in producing captive broodstock (Briggs et al, 2004).

These differences between monodon and vannamei do play a role in the structure and regulation of shrimp in India. The technical complexity of reproduction and hence of closing the life cycle of monodon has restricted actors, including Indian public sector research institutions, from establishing an active breeding program for this species. Actors who have been able to produce SPF monodon can effectively protect against unauthorized breeding by limiting access to the knowledge and technology of reproduction and production of SPF.

6 Impact of structural, legal and technological factors on access and rights

India requires access to resources and technology in order to: 1) prevent or deal with disease in shrimp 2) to promote the growth of the domestic shrimp industry 3) to ensure that public sector institutions can conduct research to improve quality and output of shrimp production in India. India's rich genetic resources have been utilized to a greater extent in the agriculture and medicines than in aquaculture. The issues of access differ in relation to the plant and pharmaceutical industry and the aquaculture sector. Access issues are even more crucial now as India has shifted from a policy of internal reliance to one of dependence on materials from abroad. Until very recently, India's shrimp industry was based on monodon, a species native to India. With the permission to import vannamei and the attempt to acquire SPF monodon, Indian industry is now dependent on access to these materials from abroad as vannamei is not native to India, and domestication and production of SPF monodon is not yet achieved by domestic actors at present. Here we outline the how the structural legal and technological factors affect access and rights.

6.1 'Protection Rings' and dependency

Companies supplying vannamei in India are not relying on IPRs, but on biological and technological strategies to protect their materials. Moana Biotech, the sole supplier of SPF monodon in India, keeps its production technology to itself to restrict transfer of technology and material. Rosendal et al (2006) and Olesen et al (2007) in their study, found that, "The aquaculture industry has preferred continuous upgrading of the material through genetic improvement combined with contracts (between breeding company and multiplier) to protect its material. These strategies have been aptly termed ‘rings of protection’. Hein van der Steen, a shrimp breeder, advocates that the shrimp breeding industry must rely on ‘rings of protection’ as long as the ultimate protection, i.e. high quality sterile Post larvae (PL), is not in place (quoted in Gura, 2009). The ‘protection rings’ that can be used by companies globally include[34]:

- Contracts designed to prevent the use of PLs for the production of broodstock and subsequent breeding.
- Traceability that enables tracing shrimp back to previous generation
- Cross between inbred lines which results in offspring less suitable for further breeding (less heterosis in subsequent generations)
- Selling a narrow genetic base which also results in offspring less suitable for breeding
- Fast progress that ensures the customers return to the company to buy their products.

The contracts between Indian and foreign companies on vannamei imports are negotiated mainly on price and not IPRs[35], but these companies are relying on techniques such as selling a narrow genetic base, cross between inbred lines and continuous improvement to protect their material. According to one source from a global firm based in Indonesia producing vannamei, “When we sell, we give very limited family.”[36] He further elaborated that, “…it is a difficult strategy to keep people from taking your technology. It is better to improve your product so that people will keep coming back to you and your product will be better. We deal with the farmer so it is difficult to enforce IPRs. It is worse if we patent because then the information is open but at the same time we can’t protect the technology”[37]. According to Gura (2009), “Shrimp breeders are recommended to sell brood stock that will accumulate ever-increasing levels of inbreeding in successive generations as a biological mechanism for property protection of shrimp breeding stock. Pirated shrimps will have a very low reproduction rate or even die”. Gura (2009) further points out that the “the aquaculture genetics industry is not at the spearhead of those pushing for animal patents. Broad patents may be an argument to attract shareholders. But patents are valid for a limited time of 20 years, costly to defend in case of infringements, and the knowledge is published. Technical ways to prevent others from breeding are more durable, and the knowledge may be kept as trade secret.”

Moana Marine Biotech is also utilizing protection strategies such as contracts and traceability. Moana does not transfer brood stock but only

[34] Gura, 2009; Dr. Hein Van der Steen, How to deliver real genetic improvement to the shrimp farming industry? http://www.panoramaacuicola.com/noticias/2004/01/21/how_to_deliver_real_genetic_improvement_to_the_shrimp_farming_industry_.html

[35] Interview, Indian shrimp hatchery operator, 20th July 2010

[36] Interview, Multinational Corporation engaged in vannamei, 29th October 2010

[37] Ibid.

Post Larvae to its own multiplication centre in India. For India to establish its own breeding programme, which is scientifically viable, it would require diverse founder population collected from various geographical locations.

These 'protection rings' have implications for India in terms of access to resources. While not preventing domestic companies from producing or selling products, they restrict India's ability to be self-reliant. The protection strategies currently used by foreign companies create a situation of dependency for Indian companies requiring access to materials. This dependent situation essentially arises because Indian companies must continuously return to the foreign companies to access vannamei. However, farmers require genetic material that can meet their specific goals and needs, such as adaptation to their specific environments or farming systems and conditions (Olesen et al, 2000; Gjedrem, 2005a). For example, inclusion of specific disease resistance traits in the breeding goal and selection programme may be crucial for sustainable farming practises (Olesen et al, 2000, Gjedrem, 2005b), and for this national (or cooperative) breeding programmes may be more suitable (Rosendal, Olesen and Tvedt, forthcoming).

6.2 IPRs and the future of access to public materials

Future demands for IPR could have implications for India. For example, if a breakthrough related to breeding, selection or disease resistance occurred and was patented, it could have an impact on India in terms of affordability. For using the patented technology, a license would be required for using that technology. Currently, legal or structural restrictions are not preventing India from gaining access to material required for producing and exporting various shrimp species. The real barriers that India could face in future are those limiting its ability to establish a domestic breeding programme. While several factors includeing costs, research expertise and government support may play a role, access to materials and technology in future could become an important factor with regard to vannamei since it is not a native species.

Access to technology is likely to act as a greater barrier than access to brood stock. Private actors in the aquaculture sector have developed techniques to protect their materials and are finding ways to apply this effectively. Some of these tools include: DNA markers to trace and enforce rights, reproductive sterility, triplodisation techniques, and methods to control and document the origin of brood stock (Rosendal et al, 2006; Gura, 2009). DNA markers can be used to differentiate between different cultured stocks or between wild and cultured stocks. There have been suggestions to establish the tracing by DNA fingerprinting nationally or even internationally, by making pedigree certificates mandatory for all hatcheries and grow-out farmers, for proprietary purposes of the genetics companies (Gura, 2009). The shrimp genetic industry has developed "reproductively sterile, all-female shrimp for commercial culture. As selectively bred shrimp with elite genotypes become available for use to the global shrimp industry, the demand for a genetic protection strategy and method to produce all-female populations has never been so great. Reproductive sterility is of interest as it provides fail-proof genetic protection, whilst all-female populations will substantially improve pond yields when harvested as shrimp females grow larger than males.” (Gura, 2009) Triploids cannot reproduce; however, they are not totally sterile (Gura, 2009). However, the above stated activities are in various stages of experimentation and may not accessible at this point. The Australian CSIRO have been optimising triploidisation technologies developed in the shrimp variety *Penaeus japonicus* to be suitable for commercial-scale triploidy in the two regionally more active important varieties Black tiger prawn *Penaeus monodon* and Pacific White shrimp *Litopennaeus vannamei* (Gura, 2009). The genetics industry is looking for a possibility to control and document the origin of brood stock. Allele frequencies, marker genes and DNA fingerprinting are gene technology and biochemical methods together with databases that have already been applied for such tracing or pedigree control (Gura, 2009).

SPF monodon programmes are currently being undertaken by various private and public actors[38]:

- Moana
- Unima group (Aqualma farming operations) based in Madagascar.
- CP group (Thailand).
- CSIRO, Australia
- France Aquaculture (previously developed but do not hold any stocks now)
- Rajiv Gandhi Centre for Aquaculture, MPEDA, India
- Biotech – Thailand
- CP Indonesia (stocks in Hawaii).
- Highhealth (have SPF stocks but not sure if there is a continued breeding program going on).
- Black Tiger Aquaculture, Malaysia (by Integrated Aquaculture International -IAI - abandoned)
- Department of Fisheries, Brunei Govt. (in collaboration with IAI – on going program into F3)

It is only a matter of time before foreign programmes develop superior materials and reproduction technology which they may protect under various strategies including IPRs. India will have to pay high price for accessing such material if it is required. If disease outbreak or radical climatic change occurs, it will become all the more urgent to access such materials to adjust the stocks to local farming conditions and systems. Taking this into consideration India should strengthen its ongoing selection programme so that it can produce its own superior germplasm which would address the risk of disease and climatic changes. India should also ensure that it protects its technology. At the same time, India must ensure that such protection measures do not restrict access to the

[38] Rao, Manuvendra, “Emerging Trends in SPF P. Monodon program—performance and commercialization, General Update on Domestication”, presented at the AquaIndia 2010 conference Progress and profits in Indian Aquaculture, Chennai, October 29-30, 2010.

poor and must also consider the implications of protection measures on other developing nations.

In addition to the biological and other means of control, the extension of intellectual property rights to aquaculture is a clear possibility in the future. The patenting of living aquatic resources or parts thereof including genetic material may increase in future, given the largely unexplored potential of such resources (Ninan et al, 2004).Olesen et al (2007) point out that increased knowledge about the genome of each fish species will increase the applicability of the patent system for protecting the commercial use of such knowledge. Greater exploration of aquatic genetic resources of potential value for pharmaceutical and other commercial applications will lead to demands for IPR protection. The trend towards greater privatization and commercialization in the aqua-culture industry would also increase the importance of patents in this sector. (See section 8 and Rosendal et al, forthcoming, for a clear case of increasing privatization in salmon).

The demand for applying IPRs to aquaculture is likely to occur in India as well. The structural changes taking shape in India with the introduction of vannamei and the entry of SPF monodon, lead to greater role for foreign private players in India. Greater collaboration between domestic and foreign actors could push the demand for IPRs in aquaculture. Patents have already been granted in India relating to shrimp. The Department of Biotechnology on its website states that the following patents have been granted:[39]

1. PAT/4.4.16.1/20135 for PCR primers for detection of white spot syndrome virus of shrimp – Dr.Karunasagar, Mangalore Fisheries College.

2. PAT/4.4.9.4/01042 for sequence of a portion of the genome of white spot syndrome virus (WSSV) affecting shrimp - Dr.Karunasagar, Mangalore Fisheries College.

3. PAT/4.9.2/06052: Bio-control of luminous bacteria in shrimp hatcheries using bacteriophages - Dr.Karunasagar, Mangalore Fisheries College.

4. PAT/4.9.1.5/06053: Oligonucleotide probe for detection and enumeration of Vibrio spp. in aquaculture systems - Dr.Karunasagar, Mangalore Fisheries College.

5. Process and apparatus for nitrifying water in closed system hatcheries of penaeid and non penaeid prawns for the term of 20 years from the 13th day of September 2000. The patent was granted with no.241648 entitled – Dr. I. Bright Singh, CUSAT, Cochin.

According to the same DBT website, the following patent has been filed:

[39] http://dbtindia.nic.in/uniquepage.asp?Id_Pk=159&ParentID=23 accessed on December 1, 2011

Microsatellite DNA marker used for identifying disease resistant populations of Penaeus monodon (filed in India on November 21, 2005 Application No.1054/kol/2005). International Patent filed on March 22, 2006 (Vietnam, Thailand, Malaysia, Singapore, Philippines and Indonesia) Application No.PCT/IN06/00101, Publication No. WO/2007/057915 and Publication date on May 24, 2007. Dr. N. Mandal, Bose Institute, Kolkata.

6.3 Greater commercialization and privatization affects public-private sector roles

Greater commercialization and privatization of aquatic resources, taking place both globally and in India, affects the nature of public-private roles and relations. Increased foreign investment and imports enable domestic companies to acquire resources from foreign firms, thereby reducing their reliance on public sector institutions. In a reversal of roles, the public sector may also become dependent on the private sector (foreign or domestic) for access to materials and technology. Public sector institutions in India, for example, are currently dependent on private sector for access to SPF monodon material and technology. The focus of public sector institutions also shifts towards monitoring of private sector activities as they must oversee imports, and establish and ensure compliance of both domestic and foreign actors. Public sector institutions take on a more regulatory role, as they must act as checks on the entire process of foreign acquisition of materials. Public sector research institutions would have to provide technical support for the introduction of technology and this may put some pressure on time devoted to research. Regulatory bodies would have to be vested with the manpower and funds to check the introduction of technology.

6.4 Monopoly situations could restrict access

The greater role for foreign companies in India's shrimp sector raises the possibility of certain firms capturing a large share of the market. Moana Marine Biotech currently has a monopoly in India with regard to SPF monodon. The monopolistic situation arising from the fact that one company is the sole supplier of SPF Monodon would have clear implications for the structure and competition in the shrimp sector in India. Moana Technologies is involved in a research project at Vlaams Instituutvoor Biotechnologie (VIB) into develop GMO shrimps (Gura, 2009). GMOs are easily patentable, and this strategy may be important for the company to protect the genetic material (personal communication, senior scientist, Nofima).

In vannamei, although several companies are permitted to export to India, there is scope for large players such as CP Thai to dominate the market. Charoen Pokphand or C.P. Aquaculture (India) is engaged in shrimp feed production, distribution and shrimp farming. (http://www.mycpindia.com/.) In Asia, the CP group is a major food processing and trading company. CP has three main shrimp aquaculture companies with businesses in China, India, Indonesia, Thailand and Viet Nam (Gura, 2009). CP controls approximately 18% of Thai shrimp exports and 60% of Thai shrimp feed market (Gura, 2009). CP is 31% owner of the single largest shrimp company in Indonesia (Gura, 2009). Companies such as CP can integrate their shrimp farming with feed production so that firms must buy both seed and feed.

Access to resources, both with vannamei and monodon, is restricted for small companies and small farmers due to affordability. Access to vannamei is available only for those companies and farmers that meet the Coastal Aquaculture Authority guidelines and have adequate facilities.

6.5 Demands for access and benefit sharing from other countries could affect access

Developing countries perceive the implementation of access and benefit sharing through the Convention on Biological Diversity as a positive step. While this is certainly the case, it must also be recognized that restrictions on access can also act as barriers for developing countries themselves. Although ABS (access and benefit sharing) measures are not intended to create barriers between poor countries, without proper coordination among nations, such situations may arise. In the case of aquaculture, where developing countries are also dependent on access aquatic genetic resources from other nations, this becomes all the more important. If India intends to establish its own breeding programme for vannamei, it will certainly require access to brood stock from other countries. In the case of monodon, although India can access brood stock domestically, it would need to collect brood stock from different geographic locations to produce SPF monodon in order to have a wider genetic base. The CBD principles have not yet been implemented to a large extent and therefore there may be no legal barriers at present to accessing foreign brood stock. However, with the implementation of the CBD, restrictions on access to wild populations of vannamei could create barriers for India to start a selective breeding programme for vannamei.

7 Policy options and interests of actors

7.1 Short term gains should not reduce focus on long term needs for access

The Indian shrimp industry is currently more optimistic about its future. After years of facing challenges from disease in monodon and competition from vannamei in other countries, the Industry now sees itself in a much better position. The main reason for the optimism is the success that the industry is achieving with vannamei. A prominent Indian entrepreneur outlining the cyclical movement witnessed in India's shrimp industry, termed 1995-99 the golden period, 2002-2008 the troubled period, 2009 year of survival and 2010 the *return of the golden period* for the shrimp industry[40]. The managing director of one company, points to

[40] S. Santhana Krishnan, "Status of Shrimp Aquaculture in India—Future Strategies (BT & Vannamei)" presented at Aqua India 2010 Progress and Profits in Indian Aquaculture, 29-30 October, 2010.

clear evidence of the higher yield from vannamei as compared to monodon. He stated that the best yield they achieved with black tiger shrimp was 5 *to* 6 tonnes per hectare, whereas with vannamei they are getting 20 tonnes and 16 tonnes per hectare from the best farms and from second level farms respectively[41]**.** Exports have also witnessed a rise recently and the Seafood Exporters Association of India (SEAI) attributes this to the introduction of vannamei. According to Marine Exports Product Development Authority (MPEDA), exports during the four-month period of April-July 2010 were 23 per cent higher as compared to the same period last year. Seafood Exports in 2009-10 aggregated to 663,603 tonne valued at Rs 9,921.46 crore ($2,105.60 million).According to SEAI sources, the cost of production of vannamei is $2.29 per kg—which is just half the cost of producing other Indian shrimp species. SEAI pointed out that, “Buying in the US and EU market has improved and a global shortage of shrimps is helping us get better value. Rising production and export of vannamei or white shrimps is likely to help Indian seafood exports record an impressive performance in the current financial year[42]

However, these short term gains/profits in sector must not reduce focus on the long term need for ensuring access to improved materials and technology. Indian private sector actors do perceive the need for investing in breeding According to one industry head; one of the main needs for the Indian shrimp industry is to set up a multiplication centre for black tiger shrimp and vannamei. Olesen (2011) points out that, “In spite of the tremendous benefit cost ratios and value creation for the society in terms of more efficient fish production and lower fish prices, only a small percentage (ca 10%) of the current world aquaculture production is based on genetically improved material from modern breeding programs. The last two decades, R&D funds have tended to be prioritized for research in molecular genetics and genomics with less funding for further development and establishment of selective breeding that has proved to give long term genetic gains. However, also for applying genomic information efficiently, well organized selective breeding program is a prerequisite”.[43]

The decision to invest in a multiplication centre for vannamei must be taken before access and IPR issues arise. IPR and access issues are not very prominent in the minds of the private sector at present due to the

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[41] Sanandakumar S, “Fish-eaters, growers greet fresh-looking vannamei”, The Economic Times, Kochi http://lite.epaper.timesofindia.com/getpage.aspx?articles=yes&pageid=28&max=true&articleid=Ar02803&sectid=23edid=&edlabel=ETD&mydateHid=29-10-2010&pubname=Economic+Times+-+Delhi+-+Commodities&title=Fish-eaters%2C+growers+greet+%E2%80%98fresh-looking%E2%80%99+vannamei&edname=&publabel=ET

[42]http://qualasa.wordpress.com/2010/11/19/india-rising-production-and-export-of vannamei-or-white-shrimps-is-likely-to-help-indian-seafood-exports-record-an impressive-performance-in-the-current-financial-year-officials-of-the-seafood-expo/)

[43] Ingrid Olesen, “'Successes, Challenges and Future Prospects of Fish Breeding”. Abstract, World Aquaculture Society Conference, Natal, Brazil 2011. https://www.was.org/WasMeetings/meetings/SessionAbstracts.aspx?Code=WA2011&Session=10

gains now being made with vannamei. However, they do acknowledge that IPRs could be a problem in the future. One hatchery operator pointed out that no IPR issues have been involved so far but that in future maybe it would come. A shrimp industry leader in India stated that if IPR for shrimp is captured by large producers it would have an impact on Indian industry.

India has to consider various policy options for investing in a breeding programme: initiating a new public sector programme; developing the programmes that have already been started with monodon; or establishing programmes with joint investments from the public and private sectors. Each option has its own set of advantages and disadvantages; however it is clear that some level of public sector involvement is required. Indian private sector still expects the public sector to establish infrastructure for the shrimp industry. According to one prominent industry leader, "Government should get the technology from abroad and distribute it in India. We should have public-private partnership module to get a nucleus breeding facility"[44].According to one industry head, "The stakeholders and government should work on SPF monodon. We should start vannamei breeding programs and/or multiplication centers[45]. The process for partnerships between the public and private sector needs to be worked out. The differing priorities of the public-private partnerships would first need to be resolved for forging such collaborations. In addition, clear roles for the public and private sectors must be defined.

7.2 Public Sector Role

The public sector is faced with a serious dilemma in evolving a balance between IPRs and access. On the one hand, there is the mandate to widely distribute material in order to ensure access for all stakeholders, particularly the poor. On the other hand, there is the question of how to protect its own material from being copied and misused. The pressure to generate revenue and increasing trend of privatization of public resources complicates the issues further. It also raises the question of whether the public sector should patent its innovations.

Public sector scientists still exhibit a strong normative position of working for the public good. The issue of whether it would be fair to file for IPRs that may raise the cost for small farmers or to seek IPRs for protecting innovations could be decided by the Public sector research organizations taking due considerations of their mandate.

Indian Council for Agricultural Research (ICAR) has laid down guidelines on how public sector agriculture research institutions should handle IPRs. There is now an IPR cell to screen application in all public sector institutions, according to scientists. The ICAR has given the IPR guidelines. The ICAR guidelines state, "IP management can prove to be a potent instrument for technology transfer to end users through public and

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[44] Interview, Industry head, , July 24, 2010
[45] Yellanki, Ravikumar, "Role of Hatchery Operators in the Changing Environment" presented at AquaIndia 2010 conference on Progress and Profits in Indian Aquaculture, October 29-30, 2010.

private agencies, and cooperative sector. While not the major factor, IP management is also expected to bring in revenues to the ICAR through commercialization of technologies. After IP protection is secured as per law, case-specific decisions will be taken -- based upon expediency of public need/ food and nutritional security -- on whether a particular ICAR IP/ technology would be transferred for public access through commercial route or just dedicated for public use through open access.”

While this case by case approach may be required, it is also important to lay down some criteria for deciding whether a product should be commercialized or not. In the shrimp sector, public sector institutions must devote attention to such issues. If Indian public sector institutions invest and produce disease free/resistant shrimp, should they file for IPRs or distribute the technology to through open access? If public research institutions create such products in collaboration with the private sector how can a balance be achieved between rights and access?

These questions point to the fact that the role of public sector is itself undergoing various changes. Public sector is shifting from a position of providing resources for the public good towards commercialization of at least some of its technologies. Exactly what role the public sector will play in relation to the shrimp industry is a crucial issue that must be addressed. It is clear that a balance must be achieved between providing access to resources and protection of innovations.

7.3 Lessons from experiences with SPF monodon and vannamei

In defining the role of the public sector, and laying down procedures for acquiring technology from abroad, India can certainly draw some lessons from its experience with SPF monodon and vannamei. The process for importing vannamei appears to have been much more streamlined than with SPF monodon. The private sector also expresses that it was happier with the process followed for vannamei than monodon.

The vannamei process could serve as a model. Lessons from the process used for vannamei introduction in India could be used for establishment of monodon multiplication centre also. It should also be kept in mind that SPF broodstock of vannamei is available commercially from a number of overseas producers whereas the SPF brood stock of monodon has a very limited supply from a few SPF facilities.

7.4 Strategies for promoting different species and coping with disease

In addition to the existing focus on vannamei and monodon, India could also promote different strains/breeds within the shrimp sector. This policy option could provide India with a safety net in case of disease outbreaks. Various stakeholders interviewed expressed the view that India should promote the Indicus species of shrimp. *P. indicus*, also known as the Indian white shrimp inhabits the coasts of East Africa, South Africa, Madagascar, the Gulf, Pakistan, the Southwest and East coast of India, Bangladesh, Thailand, Malaysia, Philippines, Indonesia, Southern China and the Northern coast of Australia[46].In 2004 FAO had pointed out that *P. indicus* was cultured in Saudi Arabia, Vietnam, Islamic Republic of Iran and India[47].India has done lot of work on indicus and could explore the possibility of establishing a selective breeding programme. According to one industry head, "After monodon, now it is vannamei. Crop rotation is an age old, successful practice being followed. Researchers should gear up for the next species, preferably native, immediately.[48]"

According to Briggs et al (2004), "There is significant confusion in Asia regarding the exact meaning of SPF. For example, a widely held belief is that SPF animals are resistant to and cannot become infected by any viral pathogens that they encounter during cultivation. This is most certainly not the case." Briggs et al (2004) also note that once shrimp are removed from the SPF facility, they should not be called SPF but High Health (HH). In addition, if they are placed in a non-biosecure environment, they can no longer be called SPF or HH as they are now exposed to a high risk of infection (Briggs et al, 2004).

Latin America is now almost exclusively using pond-grown and (often) disease checked and quarantined SPR *P. vannamei* due to their better performance in maturation, hatcheries and grow-out ponds (Briggs et al, 2004). Some experts even claim that perhaps SPF could be even more susceptible and sensitive (and hence less tolerant or robust) to the pathogens, because they have never been exposed to it, and hence have not got a chance to develop any resistance mechanisms (personal communication, Ingrid Olesen).

7.5 Domestic regulations on rights and access

Stakeholders in the aquaculture sector must actively participate in the framing of laws and regulations relating to access and rights over genetic resources. The implementation of the Biodiversity Act in India requires co-ordination from various government bodies and research institutes. The NBA requires information such as a list of species that are in the wild in order to be able to distinguish which cases require permission and which ones would qualify for benefit sharing.

Access and benefit sharing issues are extremely relevant for the aquaculture sector. Regulations need to be laid down for collecting species from Indian waters. There is also a need to frame benefit sharing mechanisms when such resources are commercialized. Although the NBA has outlined general principles for access and benefit sharing, the technical details would have to be developed in relation to specific cases. According to the Biodiversity Act, the following methods of benefit sharing can be proposed: Grant of joint ownership of Intellectual Property Rights to NBA, or where benefit claimers are identified, to such benefit

[46] http://www.fao.org/fishery/culturedspecies/Penaeus_indicus/en
[47] Ibid.
[48]Yellanki, Ravikumar, "Role of Hatchery Operators in the Changing Environment" presented at AquaIndia 2010 conference on Progress and Profits in Indian Aquaculture, October 29-30, 2010.

claimers; Transfer of technology; Location of production, research and development units in such areas which will facilitate better living standards to the benefit claimers; Association of Indian scientists, benefit claimers and the local people with research and development in biological resources and bio-survey and bio-utilization; Setting up of venture capital fund for aiding the cause of benefit claimers; Payment of monetary compensation and non-monetary benefits to the benefit claimers as the National Biodiversity Authority may deem fit[49]. However, the exact method of benefit sharing could be determined on a case by case basis.

A few cases of benefit sharing have been administered by the NBA. In such cases, the NBA has collected fees from the company and deposited it into a Fund. This money is to be distributed to the communities. One example of benefit sharing that has some relevance to aquaculture is on access to sea weed dating back to 2007. PepsiCo, a multinational company applied to the NBA for access to sea weed from Tamil Nadu for export[50]. As the seaweed is collected from Self Help Groups (SHGs) with the knowledge and skills of seaweed cultivation, the NBA determined that PepsiCo must pay a royalty to the NBA in this case[51]. According to some critics, the company paid INR 37.26 lakhs to the NBA, but the Authority is yet to transfer the money to the community (Bhutani and Kohli, 2011).

In the case of shrimp, Moana Marine Biotech has collected brood stock from several countries. It could be argued that the principles of the Convention on Biological Diversity would apply in this case as the collections occurred post the CBD. The case could be taken up to push for benefit sharing in the form of technology transfer. However, the practical difficulties and consequences of such actions would have to be carefully weighed. There is no mechanism in the CBD such as in the WTO for dispute settlement and the precedence for such cases is not clear. Establishing the exact jurisdiction of the source of aquatic species is not easy. In addition, India would have to be prepared to reciprocate in cases where India itself requires biological resources like vannamei from other countries

7.6 Ensuring access to all stakeholders and providing space for policy input

India must evolve strategies for ensuring access for public sector, small scale sector and poor farmers in the face of greater technological and other forms of protection by companies. In the case of both vannamei and SPF monodon, it is the large players who can gain access. The approval for vannamei is given only to those hatchery operators and farmers that meet the criteria laid down by the Coastal Aquaculture Authority. In addition, in order to produce vannamei, expensive, power-intensive

[49] National Biodiversity Act, 2002: http://www.nbaindia.org/act/pdf/Biological_Diversity_Act_2002.pdf
[50] www.cbd.int/doc/meetings/abs/...01/.../emabschm-01-india-en.pdf
[51] www.cbd.int/doc/meetings/abs/...01/.../emabschm-01-india-en.pdf

equipment is needed and only 20 per cent of aquaculture farms in India currently are equipped to raise vannamei. (Economic Times, October 17, 2008). One of the stakeholders has indicated that it is also doubtful if small scale farmers who have not upgraded their facilities will be able to reap the eventual benefits from Moana's SPF monodon.[52]

Policy space for stakeholders to provide input must also be created. Consultations with stakeholders can provide important policy inputs. For example, wide ranging consultations were held in India with regard to rights and access under Farmer's Rights. India's legislation on Protection of Plant Varieties and Farmers Rights Act could not be passed in Parliament (several drafts were rejected) until a series of consultations were held across the country and incorporated into the policy (Ramanna, 2006). This process of consultation led to the inclusion of various innovative aspects in India's policy (Ramanna, 2006). However, a lesson learned from this process is also that a situation should not arise where the law aims to satisfy all actors, but does not fully take into account the implications for its target group, namely, the farmers themselves (see Ramanna, 2006).

7.7 International negotiations

The domestic structures and regulations cannot function smoothly unless India strategically positions itself in international negotiations. The issue of access and rights involves a range of factors determined at the global level and is shaped by the interests of international actors. In addition, the trends towards privatization and commercialization of public materials occurring in several countries and within international organizations have enormous implications for India's access to resources. India's current strategy is based largely on demanding access and benefit sharing, particularly within the CBD. While the issue of access and benefit sharing is extremely important for India, it should be part of a coherent multi-pronged strategy working within various international organizations. India must also pay adequate attention to IPRs and other protection mechanisms that keep knowledge out of the public domain. The trend of companies to use biological or other forms of protection such as keeping technology secret, keeps knowledge out of the public domain which may ultimately have negative implications for aquaculture as a whole. Among the various types of protection strategies, patents represent the strictest barrier to access, while biological strategies (continuous upgrading) do not restrict others from using improved breeding material. The International Treaty for Plant Genetic Resources and Agriculture under the FAO, in a sense, attempts to redefine the principle of common heritage by proposing a list of crops on which there would be some free exchange. The lessons learned from this treaty should also be taken into account when deciding to frame a strategy for access and protection in aquaculture. Such lessons should be utilized to negotiate effectively on agreements such as the Nagoya Protocol.

[52] Personal communication, Indian Industry head, November 26, 2008.

8 Implications of international developments for India

The Indian shrimp sector is currently entering a phase marked by globalization and internationalization. A greater focus on the global stage is evident with the introduction of new species, new technologies, and the greater role for foreign companies in India. The shift away from domestic reliance on one species, the black tiger shrimp, towards an exotic species, vannamei paves the way for increasing collaborations between domestic and global companies. The steps for acquiring SPF black tiger shrimp also lead to a greater role for multinational players in India. Dealing with this new wave of integration requires a carefully planned strategy. One of the main tasks for the industry and public sector institutions focusing on shrimp is to recognize and evolve strategies to deal with the issue of access and rights over resources. Currently, stakeholders in India do not have a clear perception regarding the implications of restrictions on access. Yet it is evident that limitations on access to wild populations of exotic species could pose a serious challenge to the growth of the Indian shrimp sector.

Three international examples illustrate how greater privatization and market consolidations in the aquaculture industry can affect rights and access to resources. Rosendal et al (forthcoming) clearly illustrate this with the case of salmon in Norway where salmon breeding was initiated with public financing in 1971, but the breeding material ultimately came under the control of a German company. Rosendal et al (forthcoming) point out that, "… the Ministry of Fisheries and Coastal Affairs gradually lost control over the material from the public breeding programme for salmon. This breeding material can now in theory be patented and removed from the public domain. Norwegian salmon farmers may end up in a situation with limited access to breeding material from Norwegian rivers." This occurred in spite of the fact that mechanisms were established to ensure the public interest by trying to divide ownership between public and private shareholders (see Rosendal et al, forthcoming).

Tilapia, a freshwater fish indigenous to Africa but introduced in many countries, provides an important example of the complexities of access issues. The GIFT (Genetic Improvement of Farmed Tilapias), project illustrates that it is difficult to ensure material remains in the public domain, even when it is created with the objective of dissemination to poor countries. Ponzoni et al (2010), describe GIFT (Genetic Improvement of Farmed Tilapias), "as a collective research and development initiative by the WorldFish Center (formerly, International Center for Living Aquatic Resources Management, ICLARM) and its partners from the Philippines and Norway aimed at developing methodologies for the genetic improvement of tropical finfish of aquaculture importance." GIFT fish were originally developed as a public good funded by various institutions and countries including the UNDP, FAO, and the Asian Development Bank (Rosendal et al, forthcoming). Ultimately, due to financial constraints, a Norwegian private company, Genomar ASA, acquired the commercial rights to the GIFT strain and representatives from all the latest GIFT families (Ponzoni et al, 2010; Rosendal et al, forthcoming). GenoMar's profit motive is very different from the original mandate of disseminating GIFT to poor countries free of charge (Rosendal et al, forthcoming). GenoMar has continued with the breeding program and has been very active marketing the fish, and has entered into commercial ventures using their trademark name, GenoMar Supreme Tilapia, in the Philippines, Brazil and China (Ponzoni et al, 2010). GIFT fish were originally developed as a public good funded by various institutions and countries including the UNDP, FAO, and the Asian Development Bank (Greer and Harvey, 2004). Ultimately, due to financial constraints, a Norwegian private company, Genomar ASA, acquired the commercial rights to the GIFT strain and representatives from all the latest GIFT families (Ponzoni et al, 2010). GenoMar's profit motive is very different from the original mandate of disseminating GIFT to poor countries free of charge (Ponzoni et al, 2010; Rosendal et al, forthcoming). GenoMar has continued with the breeding program and has been very active marketing the fish, and has entered into commercial ventures using their trademark name, GenoMar Supreme Tilapia, in the Philippines, Brazil and China (Ponzoni et al, 2010). Although Worldfish could also acquire GIFT families and has been distributing it as a public good at no cost, the dissemination of GIFT fish (through WorldFish) is currently much smaller in scope than was originally intended and envisaged by the donors, and much too low to meet the demand (Greer and Harvey 2004; Ponzoni et al., 2010). The reason why poor farmers have had reduced access to GIFT fish after GenoMar took over, is that GenoMar is selling at market price and does not help with training and technology transfer like WorldFish used to do (Rosendal et al., forthcoming). WorldFish still owns part of the breeding program of GIFT and is still trying to disseminate to poor farmers, but they have very limited means to do so, since the public funding stopped (Rosendal et al., forthcoming).

The third case of cod in Norway demonstrates that legal and structural frameworks are yet to be designed to ensure a balance between public good and private interests. Rosendal et al (forthcoming) document the national project on cod that was initiated in Norway in 2001 with both public and private breeding programmes. Norway's official goal, according to Rosendal et al, is to retain the cod breeding material as a public good asset. However, cod, like salmon, is also intended to become profitable and be commercialized in future (Rosendal et al, forthcoming). The exact nature of the legal and other structures required to simultaneously promote both goals are still being worked out (Rosendal et al, forthcoming).

These cases should serve as a wake-up call to stakeholders in the Indian shrimp sector for several reasons. Firstly, these global developments indicate that publicly funded breeding programmes and breeder's lines are increasingly becoming privatized. This could reduce access to global materials and resources for various actors in India including industry, public sector institutions and farmers. Secondly, to ensure that scientific efforts aimed at creating products for dissemination to the poor remain in the public domain, India must also establish political, legal and structural regimes in ways that ensure access for the poor. Thirdly, developed and developed countries alike are yet to tackle this important but difficult goal of simultaneously promoting both public and private interests. No easy solutions exist and India must work along with other countries to address this issue. The Indian shrimp sector is at a crucial juncture, moving towards greater globalization and integration with international markets. India cannot afford to ignore global and national developments with regard to ownership of aquatic resources. The implications of ‘rings of protection’ currently applied by companies to protect their material must be evaluated. Policy measures to ensure affordable access to resources and protection of aquatic material should be designed to effectively promote shrimp aquaculture in India.

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