Rijksdienst voor Ondernemend Nederland

Aquaculture in India

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India offers a huge potential for aquaculture development. The country has a coastline of 7,517 km and an extensive river and canal system of about 195.210 km, consisting of 14 major rivers, 44 medium rivers and numerous small rivers and streams. In addition, pond and tank resources are estimated at 2.36 million ha.[1] India experienced an eleven fold increase of fish production in the past six decades. This growth continues as is demonstrated by figure 1. In the freshwater, brackish water and the marine aquaculture sector there exist challenges and opportunities to which Dutch companies can respond.

Facts and Figures

In India, the annual fisheries and aquaculture production increased from 0.75 million tonnes in 1950-51 to 9.6 million tonnes in 2013-2014. Globally the country now takes the second position, after China, with regard to annual fisheries and aquaculture production.[2] According to the FAO, as shown in table 1, the total aquaculture production in 2012-2013 was 4.21 million tonnes. This constituted over a third of the country's total fish production. This quantity is almost fully consumed on the domestic market, except for shrimps and freshwater prawns, which are mainly exported.[3] India is the largest exporter of shrimps to the Netherlands.[4] Specifically freshwater aquaculture experienced over a tenfold growth in the past three decades, 0.37 million tonnes in 1980 to 4.03 million tonnes in 2010.[5] Over ten percent of the global fish diversity can be found on or near the Indian subcontinent and more than 14.5 million people depend on fisheries activities. Nevertheless, the national average annual consumption of fish and fish products in 2010 was 2.85 kg/capita. In the coastal state of Kerala, fish is consumed the most, with 22.7 kg/per capita and in the mountainous state of Himachal Pradesh consumption is with 0.03 kg/capita relatively low.[6] About 40% of the Indian population does not eat fish since they are vegetarian and the remaining 60% only occasionally consumes fish.[7] Lower income and rural families consume less fish than higher incomes or urban families.

[1] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 1; FAO. 2014 *National Aquaculture Sector Overview India,* p. 11.
[2] FAO. 2014 *National Aquaculture Sector Overview India,* p. 1; Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries. 2014. *Handbook on Fisheries Statistics 2014,* p. 5.
[3] FAO. 2014 *National Aquaculture Sector Overview India,* p. 13.
[4] Interview Mr. Willem van der Pijl. Director Seafood Trade Intelligence Portal, 17 November 2016.
[5] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 6.
[6] FAO, 2014. *The State of World Fisheries and Aquaculture. Opportunities and challenges.* Rome: Food and Agriculture Organization of the United Nations, p. 153.
[7] M. Sakthivel. Email 17 November 2015.

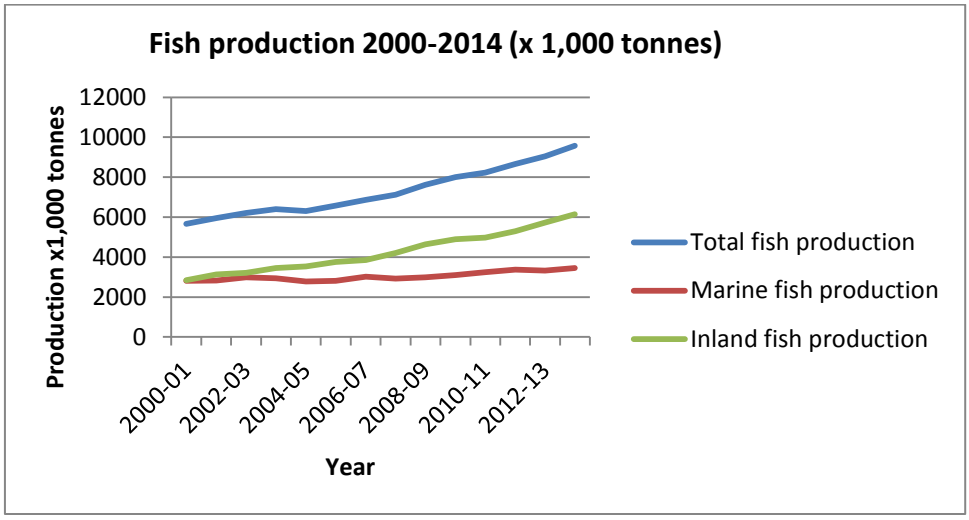

Figure 1: Fish production 2000-2014 (x1,000 tonnes) based on Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries. 2014. *Handbook on Fisheries Statistics 2014.*

Producer	Finfish		Crustaceans	Molluscs	Other species	National total	Share in world total
	Inland aquaculture	Mariculture					
	(Tonnes)			(Tonnes)			(Percentage)
China	23 341 134	1 028 399	3 592 588	12 343 169	803 016	41 108 306	61.7
India	3 812 420	84 164	299 926	12 905	...	4 209 415	6.3
Viet Nam	2 091 200	51 000	513 100	400 000	30 200	3 085 500	4.6
Indonesia	2 097 407	582 077	387 698	...	477	3 067 660	4.6
Bangladesh	1 525 672	63 220	137 174	...	...	1 726 066	2.6
Norway	85	1 319 033	...	2 001	...	1 321 119	2.0
Thailand	380 986	19 994	623 660	205 192	4 045	1 233 877	1.9
Chile	59 527	758 587	...	253 307	...	1 071 421	1.6
Egypt	1 016 629	...	1 109	...	...	1 017 738	1.5
Myanmar	822 589	1 868	58 981	...	1 731	885 169	1.3
Philippines	310 042	361 722	72 822	46 308	...	790 894	1.2
Brazil	611 343	...	74 415	20 699	1 005	707 461	1.1
Japan	33 957	250 472	1 596	345 914	1 108	633 047	1.0
Republic of Korea	14 099	76 307	2 838	373 488	17 672	484 404	0.7
United States of America	185 598	21 169	44 928	168 329	...	420 024	0.6
Top 15 subtotal	**36 302 688**	**4 618 012**	**5 810 835**	**14 171 312**	**859 254**	**61 762 101**	**92.7**
Rest of world	2 296 562	933 893	635 983	999 426	5 288	4 871 152	7.3
World	**38 599 250**	**5 551 905**	**6 446 818**	**15 170 738**	**864 542**	**66 633 253**	**100**

Note: The symbol "..." means the production data are not available or the production volume is regarded as negligibly low.

Table 1: Farmed fish production by top 15 producers and main groups of farmed species in 2012.[8]

[8] FAO, 2014. *The State of World Fisheries and Aquaculture. Opportunities and challenges.* Rome: Food and Agriculture Organization of the United Nations, p. 22.

Sector specific developments, challenges and opportunities

As demonstrated in figure 2, the total aquaculture production is annually increasing. Consumers are mainly from the upper middle class.[9] However, India, with its 1.3 billion inhabitants, is a large country and large regional differences in the aquaculture sector exist. There is a huge development opportunity in aquaculture to improve food security and nutrition for Indians. The growing middle class is only contributing to these opportunities. The aquaculture production can be divided in three sectors: fresh water aquaculture, brackish water aquaculture and marine aquaculture, which are present in different states.

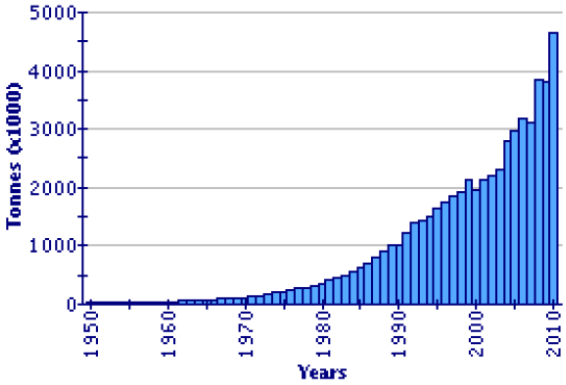

Figure 2: Reported aquaculture production in India (from 1950) – FAO[10]

Freshwater aquaculture

The freshwater aquaculture production in India comprises about 2.36 million ha of ponds and tanks and accounts for nearly 55% of the total fish production in India. Currently, only an estimated 40% of the available area is in use because of technical and market access issues.[11] Additionally, freshwater aquaculture is undertaken in lakes, irrigation canals, reservoirs and paddy fields. It is often combined with the production of shrimps in traditional low-brackish water ponds. Aquaculture production is mainly of a low quality which requires low levels of inputs. More intensive high-quality aquaculture has received more attention in recent years however.[12] Freshwater aquaculture in Eastern India mainly consists of ponds and tanks of less than 1 ha. In Western India aquaculture is operated on a larger scale, with watersheds of 15-25 ha. In Northern India more use is made of open waters for aquaculture and in the South, ponds for crop irrigation are used in aquaculture. Different species of Indian carps (catla (*catla catla)*, roho (*labeo* rohita) and mrigal (*cirrhinus mrigala)*) contribute between 70% and 75% of the total freshwater fish production, while silver carp, grass carp, common carp and catfish make up 25% to 30% of the production. Production is mainly destined for the domestic market and processing of freshwater aquaculture produce is rare. This is caused by the high demand (West-Bengal, a large fish producing state imports for instance 30% of its consumption form neighbouring states). Cold chain is non-existent for similar reasons. In addition, the giant river prawn (scampi) is produced in freshwater ponds.

Catfish offers a huge potential and the diversification of cultivation practices has been identified as a national priority by the government of India.[13] Currently production reaches 10 ton per ha, but the government aims for, through diversification, 40 to 50 ton per ha.[14] Average yields have already increased in the past decades.[15] Catfish in the aquaculture sector is mainly produced in Eastern and North-Eastern

[9] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 4.
[10] FAO. 2014 *National Aquaculture Sector Overview India,* pp. 14.
[11] FAO. 2014 *National Aquaculture Sector Overview India,* p. 2.
[12] Hans Boon. Dutch Aquaculture Experts. Email 15 November 2016.
[13] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 5.
[14] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[15] Ayyappan. Indian Fisheries and Aquaculture: Present Status and Future Prospects.

India. Of later some value addition in fresh water produce (for instance the preparation of filets) takes place, which could entail opportunities for Dutch companies.[16]

Production techniques
Also Tilapia and Pangasius offer opportunities, especially since the development of cage freshwater aquaculture in lakes. These cages have been developed by the Central Institute of Freshwater Aquaculture (CIFA) and involve Pangasius or Tilapia fish. Instead of 10 ton per ha, now a production of 3 ton on a surface of 6 by 4 by 4 can be achieved. A focus on the production of tilapia can be a potential new grow market of cheap source of proteins. India requires here a development of production techniques. Although one should take into account environmental sustainability issues with this technique, Dutch expertise with regard to the production enhancement of Tilapia and Catfish can be deployed here.

In addition, the introduction of Recirculation Aquaculture Systems (RAS) is fairly new to India. This system can be beneficial in reducing soil and water related environmental problems.[17] These systems can also be installed closer to consumer centres and thus avoiding transportation costs and difficulties. Moreover, RAS may become more attractive due to increasing land prices. Several Dutch companies have expertise in this high-tech production technique. The development of RAS in India is nevertheless very slow. The lack of practical demonstration opportunities to farmers is a hindrance and also government agencies have not yet taken up the development of RAS. Aside from this innovation, West Bengal is active on the use of wastewater in aquaculture production. Almost 80% of existing primary-treated wastewater fertilizer aquaculture units are located within this state and about 5700 ha is currently used to produce over 7000 tonnes of fish (primarily carp) per year.[18]

Inputs
Feed is provided through farm produced oil cake, rice bran, snail, clam or mussel meat and buffalo meat. When looking at specific states, Andhra Pradesh, followed by West Bengal and Uttar Pradesh are the main producers of freshwater aquaculture.[19] For feed however, producers depend on these agricultural by-products.[20] The production of feed specifically for freshwater aquaculture experienced a growth in the 2010s.[21] Additional feed is imported from Thailand, Chile, Peru, Myanmar and Taiwan. In West-Bengal a large untapped market for freshwater aquaculture feed exists. Anmol Feeds is currently constructing its first feed company in the state to cater to the existing demand. Freshwater aquaculture production is however scattered and awareness of farmers is low. In order to overcome these hurdles, foreign companies might need to tie up with local actors.

As in the other aquaculture sectors, there exists a need for high-quality feed to increase production. Indian feed plants are available to take this opportunity.[22] Dutch companies may nevertheless become involved through initiating production or supporting the production of higher quality feed by existing producers. Moreover, the aquaculture industry requires quality fish seed, preferably from disease resistant species that grow fast, and quality hatcheries. The feed consists 60 to 70 percent of the production costs. Enabling a reduction in feed costs, for instance through high-quality feed, while stimulating a good growth will increase margins for farmers. Companies such as De Heus and Skretting can contribute here. For hatcheries, the Dutch high-quality industry in the field of starting material can explore business opportunities. Til-Aqua, for instance, has developed a technology which enables the production of male tilapia (which grow faster than females) without the use of hormones.[23] Sustainability issues are furthermore a concern with farmers that lack expertise and stock too much fish in a tank to achieve a high

[16] NBSO Hyderabad, 16 March 2017.
[17] M. Sakthivel. Email 17 November 2015.
[18] FAO. 2014 *National Aquaculture Sector Overview India,* p. 5 and 13.
[19] Food & Agribusiness Strategic Advisory & Research and Yes Bank. 2015. Indian Sea Food Industry: The Cold Chain Perspective, p. 12.
[20] FAO. 2010. *Regional review on status and trends in aquaculture development in Asia-Pacific.* Fisheries and Aquaculture Circular No. 1061/5.
[21] Email Suyash Vardhan Bhal. Trouw Nutrition. 7 December 2016.
[22] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[23] Leeuwerik, Roald. 2016. Een inventarisatie naar internationale kansen voor de Nederlandse aquacultuursector en de mogelijke rol voor het Ministerie van Economische Zaken: Een studie binnen het Programma Intensivering Voedselzekerheid.

output. Farmers are therefore in need of better management practices aimed to reduce diseases.[24] Dutch companies such as Sustainable Aquaculture Solutions and Q-point are focussing on research on disease prevention for pangasius and tilapia. In this regard it is also interesting to note that Dutch companies have expertise in the domain of fish welfare.[25]

The development of the aquaculture sector requires however a complete chain approach, since inputs such as seed, feed, technology, finance and market access are insufficiently available. Also a required need for improved aeration systems, water filters, feed quality management and tailored to the Indian situation RAS systems are mentioned.[26] The Seafood Trade Intelligence Portal indicates that Andhra Pradesh is big on freshwater aquaculture, but the production has been developed here. New development opportunities exist in West Bengal and Odisha for freshwater aquaculture.[27] However, practises in this sector are still traditional or semi intensive. Currently, except for feed manufactures and providers of training, better business perspectives in these states exist in the shrimp sector. In Gujarat, private companies lease areas for a period of time to grow fish for the domestic market. No opportunities for Dutch companies exist in this domain in this state.[28]

Brackish water aquaculture

In the domain of brackish water aquaculture it is worth mentioning that a scientific approach to the traditional practice of trapping naturally bred fish and shrimps in coastal wetlands or manmade impounds was carried out. Initiatives of the Indian government, demonstration projects of the Marine Products Export Development Authority (MPEDA) in combination with credit facilities provided by commercial banks enabled the establishment of several shrimp hatcheries. Between 1989 and 2007, the shrimp farming experienced a fivefold increase to 144.346 tonnes per year. Production is decreasing again however and 90% of the shrimp farmers in India are small scale farmers which own less than 2 ha of land.[29] Some species of shrimps are more sensitive to production relate risks and diseases than others. The whiteleg shrimp (litopenaeus vannamei) is produced inland and is mainly destined for export. This species rapidly replaces the black tiger shrimp (penaeus monodon). In addition to the production of shrimps, also seabass, milkfish and other freshwater species are produced in (low) brackish water aquaculture.

The production of shrimps takes place in different ways. Either after the harvest of rice (polyculture), such as in central Kerala, Odisha, Karnataka, Goa and parts of West Bengal, combined with the growing of rice, which is mainly practiced in Goa and West Bengal, or in dedicated ponds using scientific methods, such as in Andhra Pradesh and parts of West-Bengal. As for freshwater aquaculture, the Seafood Trade Intelligence Portal indicates that Andhra Pradesh is a major player. Production has been developed here however and new development opportunities for shrimp production exist in West Bengal, Odisha and Gujarat.[30]

[24] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[25] Leeuwerik, Roald. 2016. Een inventarisatie naar internationale kansen voor de Nederlandse aquacultuursector en de mogelijke rol voor het Ministerie van Economische Zaken: Een studie binnen het Programma Intensivering Voedselzekerheid.
[26] Interview Mr. Anil Kumar, Deputy Director Aquaculture MPEDA, 8 November 2016.
[27] Interview Mr. Willem van der Pijl. Director Seafood Trade Intelligence Portal, 17 November 2016.
[28] NBSO Ahmedabad, 17 March 2017.
[29] FAO. 2014 *National Aquaculture Sector Overview India,* p. 8.
[30] Interview Mr. Willem van der Pijl. Director Seafood Trade Intelligence Portal, 17 November 2016.

Sl. No.	State/Union Territory	Estimated Potential (Ha)	Area Developed (Ha)	Area under (Ha)	Production (MT)	Productivity (MT/Ha)
1	Andhra Pradesh	150000	84951	36123	159083	4.40
2	Goa	18500	340	31	63	2.03
3	Gujarat	376000	2371	2359	9393	3.98
4	Kerala	65000	14875	12917	5175	0.40
5	Karnataka	8000	1945	394	664	1.69
6	Maharashtra	80000	1330	1486	3513	2.36
7	Odisha	31600	13400	6302	14532	2.31
8	Tamil Nadu & Puducherry	56800	6248	7804	25815	3.31
9	West Bengal	405000	50405	48410	52581	1.09
	Total	1190900	175865	115826	270819	2.34

Table 2: Details of Brackish water area, area developed for aquaculture, area under culture and production as on 31 March 2013.[31]

The majority of production takes place in specific ponds throughout the year. This is done in a traditional way (extensive) with ponds of 1.5 ha and bigger, such as in Kerala and West Bengal or a semi-intensive way with ponds below 0.5 ha, as in Andhra Pradesh, West Bengal and Odisha.[32] The latter production technique entails technical modifications and investment in fertilizers, pumps and construction. In traditional ponds different species (brackish and freshwater) are produced simultaneously and their growth rate is higher than in semi-intensive ponds. Often, farmers produce other products as well. 90% of the farmers in marine and brackish aquaculture own less than 2 ha and have difficulties obtaining finances for investments.[33] The shrimp production is however highly profitable. In West-Bengal a clear regional division exits. In the Kontai area dedicated semi-intensive ponds take care of the majority of the state's production, whereas the majority of the ponds, located in other coastal districts, are part of traditional farms. Farmers usually sell their produce to the same exporter or processor and can deliver on demand.[34] Andhra Pradesh, followed by West Bengal, is the main producer of brackish water aquaculture, while, as table 2 shows, West Bengal and Gujarat have the largest production potential available.[35] The main regions for shrimp production in Andhra Pradesh are Bhimavaram and Visakhapatnam. It is expected that in Odisha, West Bengal and Gujarat, the production will increase and land conversion for the production of shrimps is currently underway.[36]

In Gujarat, shrimp farming is a fast growing activity. Currently approximately 15,000 ha are used for brackish water shrimp production and the land available for this industry could be up to 376,000 ha. The main districts are Valsad, Navsari, Surat and Bharuch, of which Surat is the foremost brackish aquaculture district. Further opportunities exist in Bhavnagar and Jamnagar region. Since the entire coastal land belongs to the government, actors need to obtain a lease to initiate production. This is a lengthy process. For a farmer only five hectares of land is allowed. Companies need 50 ha however to make the production economically viable however.[37] Companies are therefore engaged in contracting farmers. Leases are given

[31] Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries. 2014. *Handbook on Fisheries Statistics 2014,* p. 140.
[32] Seafood TIP. http://www.seafood-tip.com/sourcing-intelligence/countries/india/shrimp/.
[33] Interview Mr. Anil Kumar, Deputy Director Aquaculture MPEDA, 8 November 2016.
[34] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[35] Food & Agribusiness Strategic Advisory & Research and Yes Bank. 2015. Indian Sea Food Industry: The Cold Chain Perspective, p. 14; Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries. 2014. *Handbook on Fisheries Statistics 2014,* p. 140.
[36] Seafood TIP. http://www.seafood-tip.com/sourcing-intelligence/countries/india/shrimp/.
[37] NBSO Ahmedabad, 17 March 2017.

for a period of 20 years after which the lease agreement can be extended for another 20 years. There are four main processors in Gujarat.[38]

In West-Bengal, the lack of landownership and the inland access to sufficient water are major impediments to the conversion of extensive to semi-intensive aquaculture. The low costs of land and labour offer opportunities however. In Gujarat, an expansion entails the further construction of a processing industry as well. It should be noted however that land conversion may be combined with substantial environmental risks and that converting agricultural lands is hindered by state regulations. In Kerala and Tamil Nadu, the aquaculture sector is smaller, but economically more important. Hence the states heavily support the sector, which makes it interesting for investors to look for foreign expertise and technology.[39] They also aim to make the process inclusive and the products exportable (see also the Tamil Nadu government programmes: http://www.tnfdcltd.co.in/).

Export

A large export potential exists in this sector. As in fisheries and marine aquaculture, a sustainable initial demand for brackish water aquaculture can be created through production for the export market.[40] Therefore, when investing in aquaculture, a safe first step may be focussing on the export market to supply to an initial sustainable demand, after which domestic demand may be targeted. Although the vast majority of the aquaculture production is consumed by the domestic market, products such as shrimps are almost exclusively produced for the export market (80%). A large export potential still exist, since the total available area for fisheries remains largely unutilized.[41] There are about 1032 export companies already active in this sector.[42] Specifically in Andhra Pradesh however, it has been noted that large areas of abandoned shrimp ponds exist because of a lack of market access.[43] This can be a serious challenge. Contrary to Andhra Pradesh, the shrimp production in West-Bengal is less organized and consequently the market is more diffuse. This hampers traceability. Processors and exporters have very little insight in the whole production chain. Although farmers are not well organised in Andhra Pradesh either, processing plants generally maintain good traceability. The sector is therefore less diffuse than in West-Bengal. For instance, individual packages indicate the processing plant, producer and individual pond where the catch came from. In Gujarat the organisation of farmers is taking place. Moreover, in Andhra Pradesh, the processors collect samples from the farmers 24-48 prior to the harvest. These samples are tested for various parameters, amongst others for the use of antibiotics. Following awareness creation and education, the percentage of samples testing positive for the use of antibiotics reduced from 50% to 10%. Although a significant reduction, this is still a large percentage taking into account the large size of the market.[44] In West-Bengal no figures have been obtained, but parties involved assured no antibiotics are used due to the more traditional farm management practices. This claim could not be verified.

Since brackish water aquaculture mainly encompassed the production of shrimps for EU and US markets, traceability of the production chain is important. Currently more emphasis is being placed on this traceability and this creates opportunities for experienced foreign companies. Solidaridad, using lessons learned from Bangladesh, in cooperation with the shrimp production company IFB Agro (which provides inputs and processes and exports the production), is involved in a project in West-Bengal that aims to bring farmers (1 – 1.5 ha) up to EU standards for production. IFB Agro hopes to achieve more traceability and to obtain the ASC certificate through this project. The farmers are organised in a collective and are linked through the Solidaridad project to a larger market.[45] Solidaridad provides on the ground technical expertise.

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[38] Shree Datt Aquaculture Farms pvt. Ltd., HN Indigos Pvt. Ltd., WestCoast Frozen Foods Pvt. Ltd., Zeal Aquaculture Pvt. Ltd.
[39] NBSO Chennai. Email 21 March 2017.
[40] M. Sakthivel. Email 16 December 2015.
[41] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 4.
[42] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[43] FAO. 2010. *Regional review on status and trends in aquaculture development in Asia-Pacific.* Fisheries and Aquaculture Circular No. 1061/5.
[44] NBSO Hyderabad, 16 March 2017.
[45] Interview Terence Pradhan, Solidaridad. 16 December 2016.

Inputs
Like in the freshwater aquaculture sector, a shortage of hatcheries and cost-efficient feed exist exists and the brackish water aquaculture industry requires the introduction of better techniques and management practices.[46] However, techniques should be adapted to the Indian situation and financial circumstances. Dutch parties could play a role here by sharing expertise in management practices and adapting existing technologies to local circumstances. Demand for life material will most likely grow in the future as well. Seed is mainly produced in the Chennai region (Tamil Nadu). In West-Bengal the environmental circumstances are not favourable for shrimp hatcheries.[47] In the Bhimavaram and Visakhapatnam area in Andhra Pradesh hatcheries breed mainly Vannamei shrimp, but also produce small quantities of rohu, tilapia, bas and catla.

Important local producers of feed for shrimp farming are CP, Avanti and BMR.[48] Fingerling food is however still imported. Dutch companies can take up the opportunities in feed, feed formulation and feed additives (pre-mixes). Some Dutch companies are already exploring market opportunities in the feed sector. One Dutch feed company is initiating a pilot project for which it imports feed to explore market opportunities. Depending on the market situation, future plans may include taking over an Indian feed factory.

In brackish water aquaculture, as in the other aquaculture sectors, there is a need for high-quality feed to increase production. Indian feed plants are available to take this opportunity.[49] They are however mainly located in Andhra Pradesh. Opportunities for shrimp feed producers may exist in Orissa and West-Bengal, states where the shrimp sector is developing.[50] Different actors in the West-Bengal aquaculture sector indicate that the feed market has been divided amongst the major companies, but that foreign companies with high-quality feed can attempt to conquer a market share. They do need to tie up however with a local partner to obtain essential market insights. Anmol Feeds, IFB Agro and Elque Group all have indicated their interest in possible cooperation to exchange knowledge and technical expertise. Anmol Feeds will initiate its own production in West-Bengal in 2018. Dutch companies may also become involved through initiating production or supporting the production of higher quality feed by existing producers. The West-Bengal Secretary of Fisheries expressed his interest in starting feed production in his state. It is important to realise however that the majority of farms in West-Bengal are of a traditional nature and do not use feed because of the size of the ponds and the feed prices. Some farms however combine the use of probiotics with rice bran. This is for instance the case for farms tied to S.A. Exports in West-Bengal. In Andhra Pradesh the sector is more advanced and shrimp farmers use feed specific for the cultivated species instead of generic feed.[51]

Moreover, the industry requires quality fish seed, preferably from disease resistant species that grow fast, and quality hatcheries. The feed makes up 60 to 70 percent of the production costs. Enabling a reduction in feed costs, for instance through high-quality feed, while stimulating a good growth will increase margins for farmers. Farmers are furthermore in need of better management practices aimed to reduce diseases.[52] Currently, a lack of quality and non-sustainable production methods enable the outbreak of diseases. Diseases such as White Spot, Running Mortality Syndrome (RMS) and Enterocytozoon Hepatopenaei can seriously hamper production. Outbreaks of diseases in 2015 and 2016 reduced the output of shrimps in Andhra Pradesh, Kerala and Tamil Nadu. Better farm management practices could reduce the outbreak of diseases. West-Bengal suffered from diseases in the 1990s. Diseases are however more likely to happen in the semi-intensive farms. The traditional extensive farms have a low density and therefore a low probability of outbreaks. The outbreaks of diseases have increased awareness amongst farmers about reducing risks to prevent future outbreaks and the exposure. Another preventive measure has been taken by the government in the form of a cap on the farming density (this cap may be an impediment to further growth through the use innovative techniques by farms). Nevertheless the risk of a major disease outbreak still remains. The Dutch companies Sustainable Aquaculture Solutions and Q-point have the necessary

[46] Interview Mr Mohandas, CP Aquaculture. 6 December 2016.
[47] See also report aquaculture visit West-Bengal 22-24 February 2017.
[48] Interview Mr Mohandas, CP Aquaculture. 6 December 2016.
[49] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[50] Email Dr. Amit Padhy. Biostadt India Limited. 10 February 2017.
[51] NBSO Hyderabad, 16 March 2017.
[52] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.

expertise in disease prevention in shrimps and can be of assistance to semi-intensive farms. They have been active in Asia before.

Dutch expertise on water quality measurement, traceability, international standards and health management of shrimp production can contribute to existing challenges in the Indian shrimp sector. In Andhra Pradesh and on a smaller scale in West-Bengal; the water quality is periodically monitored. Farmers lack however the knowledge to act on testing results. Appliances for continuous testing can also prove to be beneficial.[53] Royal Eijkelkamp for example has a broad experience on measuring and controlling water quality. For brackish water aquaculture, foremost shrimp production, more potential exist in the processing chain.[54] A possible cooperation with the different fishery research institutes based in Kochi, Kerala, may be another opportunity. The West-Bengal Secretary of Fisheries hopes to introduce solar aeration pumps in the states aquaculture sector and looks to the Netherlands for expertise. Opportunities of these systems may also exist in Andhra Pradesh.

Salination
Coastal aquaculture causes the salination of drinking water wells and farm fields and resistance exists against the conversion of farmland for aquaculture.[55] This is the reason why in 1996, the Indian Supreme Court prohibited the construction of shrimp culture ponds within the Coastal Regulation Zone and within a kilometer of Chilka Lake and Pulicat Lake (state of Odisha and Andhra Pradesh). This prohibition is not for traditional or improved traditional ponds. Additionally, the court ruled that an authority for protecting the environment of the coastal area had to be established. This Aquaculture Authority has been founded and resorts under the Ministry of Agriculture. The organization issues licenses to eligible farms, feed and hatchery companies only.

Although the use of farmland for aquaculture is not allowed everywhere, possibilities may exist with the combined use of agriculture and aquaculture through rice cultivation during the rainy months and shrimp cultivation during the rest of the year, as is done in Kerala and West Bengal. Moreover, in line with the Indian priorities, existing swamps and derelict waters offer a huge potential for the production of catfish.[56]

Marine aquaculture

Thirdly, marine aquaculture, focussing on the production of mussels, oysters and seaweeds has experienced a recent increase in production. Nevertheless the production, which mainly takes place in the states of Maharashtra, Gujarat, Kerala, Andhra Pradesh, West Bengal and Tamil Nadu, is still very modest and is often based on traditional practices. For example in 2007 an estimated 10.044 tonnes of oysters and mussels was produced.[57] Additionally, the great existing potential for sea-farming of fin fishes is not utilized, mainly because of technical and marketing issues. There is attention for the development of circular cages and the production of Seabass and Cobia species. Although marine aquaculture at sea is fairly limited, inland and coastal production of saltwater shrimps is more common, as underlined in the paragraph about brackish water aquaculture.

With regard to marine aquaculture, opportunities exist in the cultivation of finfish and shellfish on a commercial scale. For this a cage based aquaculture has to be introduced into the country. To cope with the Indian weather circumstance, appliances such as wave resistant floating cages can be introduced.[58] According to the MPEDA, there does currently not exist any cage-based production.[59] This could be developed, taking into account the Indian situation. The Indian coast offers several suitable sites for such

[53] NBSO Hyderabad, 16 March 2017.
[54] Interview Mr. Willem van der Pijl. Director Seafood Trade Intelligence Portal, 17 November 2016; Interview Mr. Anil Kumar, Deputy Director Aquaculture MPEDA, 8 November 2016.
[55] M. Sakthivel. Email 17 November 2016.
[56] FAO. 2014 *National Aquaculture Sector Overview India,* p. 12.
[57] FAO. 2014 *National Aquaculture Sector Overview India,* p. 10.
[58] M. Sakthivel. Email 17 November 2015.
[59] Interview Mr. Anil Kumar, Deputy Director Aquaculture MPEDA, 8 November 2016.

developments.[60] Cage culture only takes place in a few experimental trails and training in mariculture is limited to the Central Marine Fisheries Research Institute in Cochin. The West-Bengal government hopes to develop its cage based marine aquaculture, but requires major investments and knowledge exchanges for this. Small scale research is undertaken in the state. The current Indian marine aquaculture production for export is modest, but can be increased.

The total export value of marine aquaculture products in 2015-2016 was over 4.7 billion euros.[61] The products exported are mainly shrimps and the export markets (2012-2013) are primarily in South-East Asia (46.34%), followed by the European Union (17.76%) and the United States (11.27%).[62] Vietnam is a major importer of Indian aquaculture products, but re-exports these products again.[63]

Simultaneously, seaweed farming is slowly gaining ground in Palk Bay and the Gulf of Mannar in the state of Tamil Nadu.[64] Seaweed farming assures a high profit margin since inputs, such as sunlight and seawater, are free of cost.[65] Banks seem willing to finance large scale production. Production is however very modest as well and the huge potential is currently not exploited. This is also caused because of a low domestic demand. Currently, the seaweed produced is only used for bio-fertiliser and is not yet produced on a large commercial scale. Research into product development is however undertaken by the Central Salt Marine Chemical Research Institute.[66]

Participating in the establishment of a sea farming centre that encompasses the whole chain from hatchery, nursery, post-harvest, storage and training could be an interesting opportunity. A suitable location for such an initiative is the area between Palk Bay and the Gulf of Mannar, where stable environmental conditions are present.[67] Such cooperation could focus on aquaculture diversification.

Research

India is focussing on gaining knowledge in the field of aquaculture and several research institutes have been founded. For instance, the Indian Council of Agricultural Research (ICAR) has eight fisheries research institutes of which three focus on aquaculture: The Central Institute of Freshwater Aquaculture (CIFA) in Bhubaneswar focuses on freshwater aquaculture, the Central Institute of Brackish Water Aquaculture (CIBA) in Chennai deals with brackish water aquaculture and the Central Marine Fisheries Research Institute (CMFRI) in Kochi researches marine fisheries. Additionally, the National Research Center for Coldwater Fisheries in Bhimtal focusses on cold water fisheries and aquaculture, Mumbai has a Central Institute of Fisheries Education (CIFE) and several other universities have separate fisheries colleges[68] that undertake aquaculture research. In Hyderabad, the National Fisheries Development Board (NFDB), part of the Ministry of Agriculture, is active on providing training, production, storage and transport in the field of aquaculture and fisheries. Additionally, the Aquaculture Foundation of India is a non-governmental organization promoting fisheries and aquaculture. Opportunities for knowledge sharing may exist here. Specifically Wageningen University indicates that it can contribute to improvement of genetics and has a large expertise on the production of catfish, a priority of the Indian government.[69]

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[60] Potential suitable locations include: bays in Ratnagiri, Goa, Karwar, Palk Bay, Larsons Bay, Gulf of Mannar, Lakshadweep islands and Andaman and Nicobar Islands (Mohan Joseph Modayil, R. Sathiadhas & G.Gopakumar. Marine farming: Country Analysis – India. Central Marine Fisheries Research Institute, Indian Council of Agriculture research (Ministry of Agriculture, Govt. of India), p. 49.
[61] M. Sakthivel. Email 3 November 2015.
[62] Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries. 2014. Handbook on Fisheries Statistics 2014, p. 78.
[63] Seafood TIP. http://www.seafood-tip.com/sourcing-intelligence/countries/india/shrimp/.
[64] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 6.
[65] M. Sakthivel. Email 17 November 2015.
[66] M. Sakthivel. Email 3 November 2016.
[67] P. Chaudhry. Email 17 November 2015.
[68] Andhra Pradesh(1), Assam(1), Bihar(2), Chhattisgarh(1), Gujarat(1), Jammu & Kashmir(1) Karnataka(1), Kerala(1), Maharashtra(3), Odisha(1), Rajasthan (1), Tamil Nadu(1), Tripura(1), Uttaranchal(1), Uttar Pradesh(1) and West Bengal(1)
[69] Interview Mr. Arjo Rothuis, Account manager Asia - Wageningen University and Research, 8 November 2016.

For knowledge and research institutes, it is worthwhile to mention that different Indian research organisations are examining the development of sustainable aquaculture. Opportunities for international knowledge institutions can therefore be found in cooperation with Indian counterparts. France and Australia have cooperated with the Central Institute of Brackish Water Aquaculture (CIBA) and Norway (AKVAFORSK) cooperated with CIFA on a breeding programme for a carp species in fresh water aquaculture. Additionally, the introduction of Recirculation Aquaculture Systems and the necessary institutional reforms can offer opportunities for foreign involvement.

Sector-wide challenges and opportunities

Environment and sustainability
Aside from the challenges and opportunities mentioned above, there are other multidimensional challenges which can hamper the development of the aquaculture sector. The Indian climate can interfere with production, also as a consequence of climate change. Monsoon rains reduce the salinity of coastal waters every year, which requires shrimp species that can handle salinity changes. Additionally, poaching and cyclones causing destruction through high waves constitute other impediments. Simultaneously the production costs for aquaculture are increasing worldwide due to increasing feed prices.[70]

Moreover, in India there is a lack of awareness about long-term sustainability with regard to fisheries and aquaculture. In certain areas fish catches already decline.[71] Other areas suffer from an inadequate water supply due to depleting water sources, mainly caused by irrigation for agriculture and the contamination of water resources used.[72] New cage based aquaculture may involve major environmental sustainability risks. The expansion of fresh- and brackish water aquaculture production can have major environmental consequences. The location of new aquaculture production can have consequences for water quality through the use of antibiotics, quality and quantity of feed, but also long-term consequences with regard to water flows or reduction of forests or agriculture land. Antibiotics are a concern, mainly because of a lack of awareness amongst farmers. In the extensive aquaculture antibiotics are not regularly used, because of the size of the ponds and the price of antibiotics. MPEDA is issuing pre-harvest certificates and tests for antibiotics. Feed companies assure as well that they do not use antibiotics. In Andhra Pradesh, the processing companies test for antibiotics, but its use is still a concern.

Administration
Furthermore, the inefficient administrative system in India can constitute another obstacle to foreign investors and aquaculture development. When engaging in the Indian market, foreign investors have to pay attention to risks with regard to political interference or political non-action, lack of trust between government and fishermen, weak law enforcement, overfishing, labour related issues, such as forced labour or below minimum-wage payment and inadequate qualified manpower.[73] Government-based hurdles with regard to product registration and customs requirement do also constitute challenges. Fisheries and aquaculture are a state matter and therefore mainly addressed at the state level. Certain individual states, like Gujarat, Odisha and Tamil Nadu, currently engage in policy and legal revision processes. Andhra Pradesh aims to make itself a hub of Fisheries and introduced a five year plan, including fiscal benefits for the aquaculture sector, to develop its policy in 2015.[74] The West-Bengal Secretary of Fisheries also stressed his interest in the development of the aquaculture sector.[75] The West-Bengal policy with regard to aquaculture is less crystalized, but the Secretary sees awareness creation (feed use, farm management, sustainability) amongst farmers as a priority. The government currently tries to stimulate the sector through providing feed free of costs to farmers. This consumes 60% of the Fisheries budget and farmers do not use the feed in the most efficient way. Another sector to which the government attaches importance is the development of cage structures in the marine aquaculture and sees itself as a potential

[70] IMARES Wageningen UR. 2014*. Analyse Bouwstenen Nationaal Strategisch Plan Aquacultuur.* DG Agro: Den Haag, p10.
[71] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 1.
[72] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 8.
[73] Kumar, Sujit. 2016. *Fisheries India.* Commissioned by the Netherlands Embassy to India, p. 5.
[74] Commissioner of Fisheries, Andhra Pradesh. Letter No. 1860/B1/2015. 2 May 2015.
[75] See also report aquaculture visit West-Bengal 22-24 February 2017.

investor. Also the enhancement of the fisheries sector using Dutch expertise was mentioned. The Secretary also mentioned the ornamental fish sector as potential interest to Dutch companies. There exists a demand for high quality feed, which is currently not available. The market for ornamental fish is big however in the state.

Nevertheless, in general the inefficient Indian state administrative systems suffer from a lack of capacity and equipment to properly support the management of aquaculture. Additionally, the absence of a federal Ministry of Fisheries weakens the position of the aquaculture sector in the government policy making process. The central and state government should support the aquaculture production sector with an adequate policy framework. Preliminary steps have been made with the establishment of a National Fisheries Development Board (NFDB), a Marine Products Exports Development Authority (MPEDA), a National cooperative Development Corporation (NCDC) and a National Federation of Fishermen's Cooperatives Ltd. (FISHCOPFED). The 2017 national budget allocated however relatively few funds to the fisheries and aquaculture sector and does not foresee in necessary legislative revisions.

Investments
According to the MPEDA, the lack of available finance is, specifically regarding the development of marine aquaculture, the main challenge. Since the average farmer operates small-scale, they do not have the access to finances to invest in high-tech aquaculture production techniques such as RAS or cage-based aquaculture. Introducing such techniques to India requires an adaption to the Indian situation, taking into account the little financial strength of individual small-scale aquaculture farmers. Focussing on the semi-intensive farmers who do invest will be more beneficial. Dutch companies are already doing research on adapting RAS to the climatological circumstances in Africa. The formation of clusters of cooperating aquaculture farmers may be beneficial. Additionally, famers are in need of insurance schemes. Diseases or weather conditions cause large scale crops loss, which cannot be dealt with by small scale farmers. Introducing an insurance scheme covering the loss of income during a period of for instance two months may be helpful.[76] IFB Agro indicated they already provide insurance schemes to their suppliers.

Potential for investments exist in different separate states. Fisheries are for instance the main economic activity in Goa and the increase in production leads to an increase of economic activities in fish-related industries as well. Kerala's government prioritised the development of the fisheries sector, since the sector provides a large share of the state's revenue and brings in foreign exchange. Contrary to Goa and Kerala, who have a higher purchasing power, Andhra Pradesh, though being the largest producer, is mainly exporting its production to West Bengal due to poor local consumption of fish.[77] For export potential, the states Andhra Pradesh, Tamil Nadu, Maharashtra and Gujarat are mentioned by the MPEDA. This organisation is willing to organise, in cooperation with the Embassy, a mission which enable foreign companies to find market and investment opportunities. MPEDA is willing to provide matchmaking for Dutch companies when requested by the Embassy. This could lead to a pilot project facilitated by the MPEDA.[78]

Post-harvest infrastructure
Another important bottleneck in the Indian aquaculture industry is the production and processing chain. Processing has not kept up the increase in production.[79] Processing plants obtain their machinery from abroad (US, China, Vietnam).[80] For the domestic market (fresh water aquaculture) in coastal states, processing is currently not very relevant, due to the high demand and barely matching supply. Only 30% of the total fish production is processed and there are currently 435 EU-certified processing plants.[81] Poor infrastructure (ports and roads) and storage facilities limit access to consumer market for producers. This, in combination with the climatological circumstances, leads to food waste. For domestic supply, the aquaculture production is transported as live catch or with ice.[82] Enabling an improved access to domestic

[76] Interview Mr. Anil Kumar, Deputy Director Aquaculture MPEDA, 8 November 2016.
[77] M. Sakthivel. Email 3 November 2015.
[78] Interview Mr. Anil Kumar, Deputy Director Aquaculture MPEDA, 8 November 2016.
[79] Interview Mr. Willem van der Pijl, Director Seafood Trading Portal, 17 November 2016.
[80] NBSO Hyderabad, 16 March 2017.
[81] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.
[82] Interview Dr. Pandian, Fisheries Development Commissioner, 2 December 2016.

and international markets will create incentives for producers. Possible opportunities with regard to the development of (cold) chain management exist here. When looking at the fishery sector in a broad sense, cold chain components, as shown in table 3, are limited. Cold chain systems mainly exist for the export market and are insufficiently developed for the domestic market. For the domestic market this is however not a major issue, since demand outdoes supply, which leads to a fast turnover. They currently consist of block ice plants, which provide ice for transport (although tube ice, flake ice and slurry ice are more and more available as well) and few available cold storages. These storages have few freezers available that store at -40 degree Celsius, because of energy costs. The majority of storages stores at -18 to -29 degrees Celsius, which results in a variable shell life. Additionally, in the shrimp production for export markets a technique called Individually Quick Frozen Products has been introduced. A controlled cold chain usually only begins when the products have reached the processing facility. Export is done by third party transportation enterprises. Refer trucks are mainly used after processing, since the design of the crates used for transport from the farm to the processing facility prevent the airflow and thus the cooling of the middle of the freight. This is less of an issue after processing (and freezing) when the temperature only has to be maintained within a certain range. A redesign of the crates (e.g. copying the design of flower crates) is a clear possibility for Dutch companies.[83] Again, the transport from the farms to the processing facilities takes place in a more organized fashion in Andhra Pradesh then in West-Bengal.

Processing Facilities		Storage Facilities		Handling Facilities		Ice Plant		Pre-processing facilities	
No	Capacity (in '000 MT)	No	Capacity (in '000 MT)	No	Capacity (in '000 MT)	No	Capacity (in '000 MT)	No	Capacity (in '000 MT)
465	20.2	597	224	148	4.4	78	2.2	620	11.7

Table 3: Processing and Storage Infrastructure in India.[84]

With regard to infrastructure it is important to note that almost no markets exclusively focusing on fish exist. This, because of involvement of intermediary agents, reduces the market efficiency. Retail suppliers do not have the capacity to invest in cold chain storage. Secondly, existing unorganized markets are unhygienic, which leads to health and safety concerns. Additionally, cold chain systems suffer from a low awareness, especially in more remote areas. Finally, climate issues hinder market access. During the monsoon season, up to 30% of the catch is lost post-harvest.[85] MPEDA already undertakes training and awareness creation on different domains, such as post-harvest and capacity building, but the appointed employees indicate that they do not always speak the language of the farmers, which reduces the efficiency of the trainings.

This lack of (cold) chain management does however also create opportunities for foreign investors. Reducing the steps in the supply chain and increase cold chain capacity will decrease transport costs, decrease food losses and increase food safety and market access. For cold chain development, finance and even subsidy opportunities exist. There is a demand however for knowledge techniques which have to be adapted to the Indian situation. As the Netherlands has an international reputation with regard to effective agro logistic solutions, there are opportunities in this sector.

With a specific focus on (cold) chain management in aquaculture and fisheries in a broad sense, the following priorities have been identified by the MPEDA Quality Control Section: the Monitoring of seafood quality in landing and pre-processing centres, providing infrastructural facilities and a mini lab to assure quality, evolving standards for export, based on standards prescribed by such countries and the upgrading of fishing harbours.[86] Additionally, there is a need for an increase in production of ice, cold storage facilities

[83] NBSO Hyderabad, 16 March 2017.
[84] Food & Agribusiness Strategic Advisory & Research and Yes Bank. 2015. Indian Sea Food Industry: The Cold Chain Perspective, p. 19.
[85] Food & Agribusiness Strategic Advisory & Research and Yes Bank. 2015. Indian Sea Food Industry: The Cold Chain Perspective, p. 25.
[86] Food & Agribusiness Strategic Advisory & Research and Yes Bank. 2015. Indian Sea Food Industry: The Cold Chain Perspective, p. 22.

at landing centres, more distribution centres, and an improvement of refrigerated transportation methods and facilities at retail markets. For export markets, a clear traceability and certain sustainability standards are important. International companies have to look for reliable local partners. The MPEDA could identify potential local business partners.

What the Netherlands has to offer India

The Netherlands has a small, but extremely knowledge intensive aquaculture sector. This offers opportunities for the export of specific knowledge, which enables a more efficient production. Previous projects, involving a range of Dutch companies and knowledge institutions, have been undertaken in Africa. Dutch companies that possibly can contribute to the aquaculture sector in India have been identified by the Netherlands Business Support Office in Hyderabad and are partly associated in the Dutch Aquaculture Experts organisation. They can be found below. Specifically, Dutch companies and institutions can cooperate with Indian counterparts in the field of Hatchery and production technologies,[87] health,[88] chain approaches[89] and the implementation and development of RAS systems and other engineering services.[90] Additionally, Dutch experts work on feed formulation and production[91] and on research and education.[92] The introduction of RAS systems requires an adaptation to the Indian situation, especially with regard to the level of investments, as is currently being undertaken in Africa. In West-Bengal there is a demand for solar powered aeration pumps. These innovative systems will not find demand amongst the majority of the (extensive) farms, but a growing group of semi-intensive farms constitute a market.

There exists limited knowledge in the Netherlands on carp production, a growing sector of the Indian freshwater aquaculture. Dutch knowledge about diseases with regard to this species is extensive however, as a result of a large population of ornamental carps maintained by private owners. This knowledge in ornamental fisheries sector can possibly be exported to West-Bengal. Knowhow on freshwater species hatcheries, such as catfish and tilapia, both produced in India is largely available in the Netherlands.[93] Clear opportunities exist in Andhra Pradesh with regard to water quality measurement techniques and storage and transportation.

Dutch aquaculture companies are hesitant however to undertake large-scale investments in the Indian aquaculture sector. Moreover, India is unknown territory for the majority of Dutch aquaculture companies and they are under the impression that Dutch consultants are considered as being too expensive. Dutch companies mention that in India price is considered before quality.[94] This is a major hurdle for the high-quality, but more expensive, techniques available from the Dutch sector. A preliminary focus should therefore aim at identifying market opportunities for the export of knowledge and production techniques.[95] Nevertheless in the long run, as happened in other agriculture sectors, large Indian investors might understand the long term gains from high-quality European products and expertise. It is recommended to look at lessons learned from Dutch companies that are of have been active in India.

Conclusion

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[87] Examples of Dutch companies active on hatchery and production technologies include: Holland Aqua, Aquadect, Sustainable Aquaculture Solutions, Aquaculture farming technology, Fishion, Hendrix Genetics, Til-Aqua International, Fleuren & Nooijen, Catvis, Hesy Aquaculture b.v., Viqon Water Solutions, ACE Aquaculture Consultancy & Engineering.
[88] Examples of Dutch companies active on health include: Blue Leg Monitor, Sustainable Aquaculture Solutions, EuroProxima, Qpoint, Eijkelkamp Agrisearch Equipment, COSTA and Aquaculture Stewardship Council.
[89] Examples of Dutch companies active on chain approaches include: Fishion, Promatec Food Ventures, Innotec Systems, Mutte Techniek b.v., Marel, Qpoint and Food Ingredients & Technology.
[90] Examples of Dutch companies active on engineering and equipment include: Aquaculture Consultancy and Engineering, Catvis, Fleuren & Nooijen, Holland Aqua and Viqon.
[91] Examples of Dutch companies active on feed formulation and production include: Aquaculture Experience, Coppens International, De Heus and Skretting
[92] Examples of Dutch organisations active on research and education include: Wageningen University and Research, Aquaculture Experience, COSTA, Fleuren & Nooien, Hendrix Genetics, Holland Aqua, HZ University of Applied Sciences, IMARES, Kamstra Consult, Sustainable Aquaculture Solutions and Til-Aqua.
[93] Email Netherlands Ministry of Economic Affairs. 15 February 2017.
[94] Hans Boon. Dutch Aquaculture Experts. Email 15 November 2016.
[95] Interview Mr. Willem van der Pijl. Director Seafood Trade Intelligence Portal, 17 November 2016.

India is a large producer of aquaculture and production promises to grow in the future. Andhra Pradesh is the aquaculture state. For brackish water aquaculture (shrimp), Odisha, West Bengal and Gujarat are states where production will increase in the future. Clear business opportunities exist also in Andhra Pradesh with regard to feed additives, processing equipment, quality testing equipment and storage and transportation.[96] This state has the best organised aquaculture sector, which may be easier to enter for foreign companies. Odisha and West Bengal also experience a growing freshwater aquaculture. In West-Bengal the feed sector offers clear opportunities. Joint-venture approaches might be the most successful approach for Dutch companies. Moreover, for the export of shrimps, in general opportunities for Dutch companies exist in improving the processing chain and contributing to the supply of high-quality feed. Also the prevention of diseases and the enabling the provision of high-quality seed and hatcheries are possible sectors of interest to Dutch companies.

In freshwater aquaculture, opportunities are less clear. In this sector Dutch companies can possibly contribute with high-quality inputs. The potential of catfish and tilapia in freshwater aquaculture offer more opportunities in the domain of production enhancement. However, in this sector most clearly, it is important to adapt to the Indian circumstance of small-scale farming.

In both the brackish water and freshwater aquaculture a complete chain approach may be beneficial, since there does not only exist a need for better inputs, but also the infrastructure involved in the post-harvest process is underdeveloped. Awareness creation and promotion of better farm management practices are essential and state governments realize the necessity. Especially with regard to domestic market access, which mainly contributes to the demand for freshwater aquaculture products, this lack of infrastructure and processing facilities hampers market access. A safe first step to enter the Indian aquaculture market can be to focus on the shrimp production for export markets, after which domestic demand may be targeted, possibly through freshwater aquaculture production. The latter will be beneficial for food security purposes. Andhra Pradesh offers a more organized sector, but more unexplored (and thus more difficult) market to enter can be found in West-Bengal and Orissa. Gujarat is developing its sector as well, although the obtaining of land leases remains a blockade. General opportunities lie furthermore in contributing to sustainability and traceability of fish production, especially for the export markets. When the aquaculture sector expands, sustainability will become a more pressing theme. The willingness of MPEDA to contribute to matchmaking and a possible explorative mission is an opportunity for the Dutch aquaculture sector.

High-tech production techniques might prove more difficult to export since these techniques have to be adapted to the Indian circumstances and price levels before being attractive. Nevertheless here as well, there do exist opportunities, as TNO's testing of an innovative filter membrane in Gujarat proves. Dutch companies have a broad experience in adapting their knowledge of circulation systems, chain approaches, breeding and disease prevention to local circumstances. Entering the market through cooperating with a government institution or a local partner, as is done in other sectors of the economy, might be beneficial. The use of demonstration projects is a way to gain market share more quickly. This is also valid for marine aquaculture. Although not existing on a large scale, large possibilities exist. These possibilities are largely unexplored and will require research and investments by companies willing to enter this sector.

April 12, 2017

[96] NBSO Hyderabad, 16 March 2017.