



Opportunity study on Circular Proteins for Aquafeed in Egypt

Commissioned by the Netherlands Enterprise Agency

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Opportunity study on Circular Proteins for Aquafeed in Egypt

Final Report Phase 2 2

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Ministry of Economic Affairs
and Climate Policy
of the Netherlands

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VD Agri



Embassy of the Kingdom
of the Netherlands



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General considerations

This report has been prepared for the benefit of and commissioned by the Netherlands Enterprise Agency (RVO) in close consultation with the Agricultural Counsellor of the Embassy of the Kingdom of the Netherlands in Cairo, Egypt. Aquaculture Experience and VD Agri executed this “Opportunity study on Circular Proteins for Aquafeed in Egypt” directly or indirectly making use of their extensive network, own knowledge and documentation, literature, internet search and interviews with stakeholders in Egypt and the Netherlands.

Aquaculture Experience and VD Agri are not liable for any damages arising from the use of the results of this study nor the implementation of the recommendations herein.

1. Introduction

Background

Egypt's food system faces great challenges to support sustainable and inclusive growth of the economy in the face of climate change and a growing population. Consumer demand for proteins, essential for healthy diets, continues to grow. Although vegetable proteins have traditionally been an important part of diets for BOP consumers, consumer preference favours animal proteins: dairy, poultry, fish and red meat.

Intensive dairy, poultry and fish farming systems have seen significant growth over the last decades to respond to this demand. Local crop production for animal feed (and fodder) is not able to respond to the demand for animal feed due to the scarcity of fresh water. Water is a limiting factor due to negligible rainfall, reducing groundwater supply and dependence on the river Nile. As a consequence, Egypt is dependent on imports for a significant part of its animal feed ingredients.

The Netherlands embassy in Cairo therefore sees a clear need & opportunity for the local production of sustainable, circular proteins (such as by-products of e.g. the poultry- and brewery sector and insects) into feed.

Local production of protein rich feed ingredients (for i.a. Aquaculture) will decrease dependency on imported feed ingredients and will increase local employment possibilities and income.

Last, but not least, this study will specifically focus on the use of by-products, such as brewery waste & poultry by-products, therefore it completely fits under the circular agenda as well.

Circular proteins such as algae, seaweed, bacterial biomass, rendered products, and insects are globally partly a proven and partly a novel area of production relevant for application as "alternative" aquafeed ingredients.

The agricultural team of the Netherlands embassy in Cairo has an interest to apply Dutch knowledge, technology and expertise to Egypt in the pursuit of Dutch objectives under the Multi-annual Strategic Country Strategy:

- To promote inclusive growth through sustainable trade and investment by strengthening cooperation with the Egyptian private and public sector.
- Strengthened sustainable and inclusive agriculture and food security through improved water management and use of resources in a changing climate.

As circular proteins are a new area of attention for the Netherlands embassy in Egypt, there is little previous Dutch involvement in this area. However from some initial screening activities it appears that there are opportunities for knowledge exchange between Egyptian and Dutch stakeholders in this area. A broader mapping of potential innovation partners in Egypt and the Netherlands, possibilities for knowledge exchange, trade and investment would be useful to inform possible initiatives. Also, there is a need to take stock of potential commercial viability for the production and processing of alternative proteins into aqua feed within the Egyptian context.

The complete opportunities study has been structured in three phases:

- Phase 1: Preparatory desk study – Completed September 2021
- Phase 2: Field study and stakeholder engagement – In Egypt and the Netherlands during December 2020 – March 2021 (this report).
- Phase 3: Presentation of the findings in a hybrid (offline and online) seminar in Egypt.

This report covers only Phase 2 of the opportunity study of “Circular proteins for Aquafeed in Egypt”

1.1. Reading guide

In this report texts marked as the text in this box are a summary of interactions with representatives of governmental organizations, NGO, etc. in physical meetings, by video conference, e-mails, etc.

In this report texts marked as the text in this box are the authors’ recommendations.

In this report texts marked as the text in this box concern are a summary of interactions with Egyptian company representatives by video conference, e-mails, physical meetings, etc.

In this report texts marked as the text in this box are interviewed organization representatives.

In this report texts marked as the text in this box concern are a summary of interactions with Dutch company, governmental organizations representatives, etc. by video conference, e-mails, physical meetings, etc.

2. Management Summary

Fish is an important food source in Egypt, accounting for 25.3% of the average household's protein intake and a fish consumption of 23.5 kg/person/year. The aquaculture sector in Egypt is contributing approximately 80% of the over 2 mln tons of total fish consumption. Capture fisheries and limited imports contribute the other roughly 400 ktons.

The aquafeed production in Egypt amounts in 2020 between 1.5 and 2 mln tons but the required feed ingredients for this production are generally imported. Local crops are largely destined for human consumption rather than animal feed.

There are several promising options to generate high(er) quality nutritional aquafeed ingredients to a big extent derived from presently not or not appropriately utilized waste streams.

Considering the size of the poultry industry (over 1.7 bln birds), the associated potential to render by-products (over 250 ktons sellable poultry by-products with a market value of over well 100 mln US\$) and Egypt being the no. 8 global aquaculture producing country and globally 3rd tilapia producer obviously opportunities will arise in the rendering industry for feed ingredient supply. Poultry-by-products meal (PBM) produced in Egypt today are generally of substandard quality due to lack of hygiene, inappropriate collection practices and processing methods which all can be improved.

Poultry-by-product meals (including also poultry blood and feather meal) of good quality could contribute approximately 16% of the tilapia feed ingredient requirement in volume and 34% of the required protein for the annual 1.5 mln tons tilapia feed that is consumed in Egypt today. This would greatly reduce the import of raw materials and reduce feed cost. In order to achieve this volume and the desired quality it will be necessary to abandon wet poultry markets as they are today, centralize slaughterhouses and rendering and develop cold chains to distribute poultry meat (legs, breast, etc.) throughout Egypt.

Insect protein production is presently not officially authorized in Egypt neither is insect protein (or oil) a registered feed ingredient. Thus from the regulatory point of view some steps need to be taken before considering to produce insects at industrial scale in Egypt.

Proteinea is a startup insect company in that is eyeing a first scale-up to produce 1 ton of live insect larvae per day to produce approximately 2 ktons insect protein meal and 0.8 ktons oil from agriculture waste streams. The economics look promising but a proof of concept is lacking till now. Phase 2 and 3 of the Proteinea project could deliver 0.06% and 0.3% respectively of the protein needed for the Tilapia feed requirement in Egypt.

Brewery-by-products such as spent yeast and grain (dried distillers grains) are already applied in aquafeed in other parts of the world but not in Egypt yet. Al Ahram Breweries (part of Heineken Group) has 2 waste stream that may be upgraded by drying them to supply the aquafeed industry. Surplus yeast processing could render approximately 500 tons brewer's yeast and drying of spent brewery grains would give 3-4 ktons dried distiller's grains. The volumes of dried yeast and spent grain are relatively small ($\approx 0.04\%$ and $\approx 0.33\%$ of the tilapia feed protein requirement) but as such would contribute to the circularity of the Egyptian aquaculture industry. Other circularity enhancing initiatives may be developed after some good examples are established.

3. Market Analysis - The aquaculture and aquafeed value chain

3.1. Aquaculture sector;

In below table the FAO statistics on aquaculture production in Egypt in 2018 are summarized.

Species group	Species groups	2018	Value 2018
Freshwater fish	Nile Tilapia	1,051,444	905,963
	Common carp	47,000	42,325
	Silver bighead carp (<i>Hypophthalmichthys</i> spp)	66,900	60,246
	Other Cyprinids	67,000	60,336
	African Catfish (<i>C. gariepinus</i>)	6,836	5,002
	Total Freshwater fish	1,239,182	1,073,873
Marine fish	Mulletts (<i>Mugilidae</i>)	242,071	258,866
	Gilthead Seabream (<i>Sparus aurata</i>)	29,994	65,838
	European Seabass (<i>Dicentrarchus labrax</i>)	24,914	35,056
	Meagre (<i>Argyrosomus regius</i>)	25,130	35,360
	Total Marine fish	322,109	395,120
Crustaceans	<i>Penaeus vannamei</i>	155	436
	<i>Penaeus</i> spp	0	0
	Total Crustaceans	155	436
Diadromous fish	<i>Anguilla</i> spp	11	40
	Total Diadromous fish	11	40
Total Egypt	Freshwater fishes	1,239,182	1,073,873
	Marine fishes	322,109	395,120
	Crustaceans	155	436
	Diadromous fishes	11	40
	Total Egypt	1,561,457	1,469,470

Table 1: Fish and shrimp production Egypt (in MT and x 1000 US\$) 2018 (FAO, FIGIS - Fisheries Statistics, 2020).

The aquaculture sector grew in volume from approximately 700 Ktons in 2008 to approximately 1.600 Ktons in 2018 which is illustrated in annex 2 (Production statistics of the Egyptian Fish and shrimp production Egypt (in MT and x 1000 US\$) 2008 - 2018 and feed demand (in MT).

Aquaculture in Egypt is concentrated in Northern Egypt and farming takes place mostly in intensive pond culture in fresh, slightly brackish in and around the Nile delta (Rothuis, 2013), (Soliman, 2016) and sea waters near the Mediterranean coast.

Species of finfish and crustacean cultured in Egypt at present are: Nile tilapia (*Oreochromis niloticus*), blue tilapia (*Oreochromis aureus*), North African catfish (*Clarias gariepinus*), flathead grey mullet (*Mugil cephalus*), thinlip mullet (*Liza ramada*), bluespot mullet (*Valamugil seheli*), European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*), meagre (*Argyrosomus regius*) and penaeid shrimp. The introduced species are: common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idellus*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*), black carp (*Mylopharyngodon piceus*) and the giant river freshwater prawn (*Macrobrachium rosenbergii*).

Table 2: Major aquaculture production areas in Egypt in 2012 (Soliman, 2016)

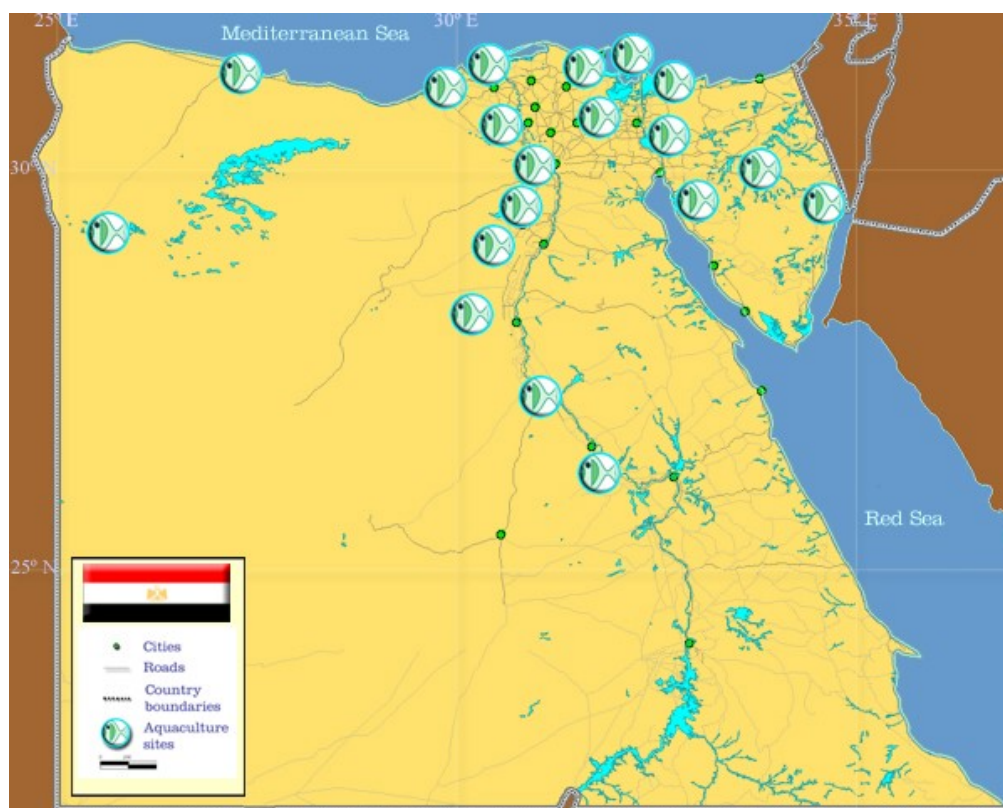
Area and production of private fish farms (temporary) by fish group/MT during 2012

Governorate	Area/ feddan	Production						Total
		Meager	European sea bass	Gilthead seabream	Carp ^a	Mullet nei	Tilapia nei	
Kafr El Shaikh	61,400	–	–	–	19,897	11,940	183,063	214,900
Daqahlia	221	–	–	–	151	34	478	663
Sharkia	25,000	–	–	–	121,813	3866	61,477	77,526
Damietta	35,000	2859	4230	4009	1754	3881	3217	19,950
Port Said	50,000	–	–	–	–	50,410	99,590	150,000
Ismailia	1500	–	–	–	300	1200	1500	3000
Total	173,121	2589	4230	4009	34,285	71,331	349,325	466,039

There are farms by north of Salam Canal of 40,000 feddan and another by south of Ports Fouad of 10,575 feddan, both were added to Port Said

^a Carp includes common, silver and largehead carp

The most important farming areas in 2012 of private fish farms were concentrated in the Nile Delta in the Governorate of Kafr El Shaikh including Burullus Lake (46%), Port Said (32%), Sharkia (17%) and Damietta (4%). This situation didn't change too much till today 2020 as illustrated in the below figure.



(FAO, Fisheries and Aquaculture Department - National Aquaculture Sector Overview Egypt, 2020)

Some areas missing in the FAO overview are Fayoum (Faiyum) area that has developed as an important farming area. South of Lake Quaroun there is a secondary cluster of tilapia ponds. Wadi Fish and others are fish farming in Wadi el Rayan.

In volume and value tilapia is the dominant aquaculture species fed almost exclusively on compound feed either on traditional pelleted feeds (of lower quality) and modern floating extruded feeds. According to the FAO in 2018 the aquaculture volume of tilapia reached 1.050 Ktons.

Mullets are second in volume however these are farmed in polyculture with tilapia. Mullets are not fed intentionally and live of the waste of tilapia production and algae in the pond and only fed after the tilapia harvest with tilapia feed until harvest and/or restocking of the same ponds with tilapia (pers. communication Julia Mas, De Heus).

Water quality is the main bottleneck in Egyptian aquaculture due to the fact that governmental regulations allocated the scarcely available fresh water of Egypt's main source the Nile exclusively for human food crops irrigation mainly: rice, wheat and corn. Aquaculture can only use drainage water after irrigation and salt water. According to the FAO statistics there should be a considerable farming volume (\pm 80 kton) of marine species (seabass, seabream and meagre) but seemingly these figures are mixed up with fishery data (pers. Comm. Fish Basket & Wadi Fish Co.). In 2013 Rothuis discovered that aquaculture is low on the political agenda in Egypt and recommended a diplomatic lobby to stimulate a clear policy development (Rothuis, 2013). Several interviewees indicated that the aquaculture output (already accounting for 25.3% of the average household's protein intake) could be very much enhanced if the primary use of the scarce water resources would be directed towards aquaculture after which the nutrient enriched water could without risks be used for irrigation after serving the aquaculture industry (pers. communication i.a. Peter van der Heijden, Julia Mas).

Ministry of Foreign Affairs – Dr. Badr (14-2-2021)

Apart from the private aquaculture sector there are some huge aquaculture operations in development in which the National Company for Fishery and Aquaculture (NCFA) is involved that cater for international export markets of high value fish products such as frozen fish fillet and shrimp, but which were not further investigated in this study.

<https://evergreenegy.com/projects>

<https://en.eipss-eg.org/information-ghalyoun-pond-project/>

<http://english.ahram.org.eg/NewsContent/1/64/399423/Egypt/Politics-/Egypt%E2%80%99s-Sisi-inaugurates-fish-farming-project-in-P.aspx>

<https://www.geosynthetica.com/mega-fish-farm-egypt-geosynthetics/>

Dr. Badr recommended and would support to invite foreign experts to assist the above mentioned projects to improve the technical level (to European standards) and/or creating some demonstration initiatives.

He also asked about a scholarship for young doctors if they can go and get the training outside of the country and to be updated with the recent technology.

Dr. Badr advised to keep the Ministry of Foreign Affairs in the loop of all communication to enable them to support any initiative, as they have direct access to the president office, as a trusted coordinator. However the Ministry is not a technical partner but rather have a facilitating and coordinating role. The Netherlands is considered a supportive country to Egypt and therefore the Egyptian Ministry of foreign affairs will do their best to support any development project initiated by The Netherlands.

Wadi Fish Co (WFC)

WFC farms Seabass (120 tons) in cages near Faiyum and tilapia (40 tons) in ponds and is also developing a start-up cage farming operation of Grouper in the Red Sea.

They are the only company in Egypt processing the seabass and selling fillets via the supermarkets. They are no. 4 in size in Egypt while no. 1 produces 1.000 tons annually illustrating the fragmentation of the Egyptian fish farming industry. There are 3 marine fish hatcheries operational in Egypt which are gradually replacing the practice of wild fry usage for marine fish.

WorldFish

WorldFish is an international, nonprofit research organization with the mission to reduce poverty and hunger by improving fisheries and aquaculture.

WorldFish leads the **CGIAR Research Program on Fish Agri-food Systems (FISH)** and runs research programs on: *Sustainable aquaculture*, *Value chains and nutrition* (availability, access and consumption of nutrient-rich, safe fish, especially for women of reproductive age, infants and young children) and *Resilient small-scale fisheries*. Cross-cutting themes: *Entrepreneurship* (youth engagements in fisheries and aquaculture value chains), *Gender* (enabling women's access to productive assets and resources), *Climate change* (effects on fisheries and aquaculture). (WorldFish, 2020).

Fish is an important food source in Egypt, accounting for 25.3% of the average household's protein intake. Fish consumption is 23.5 kg/person/year.

WorldFish runs nutrition research closely associated with Nutreco/Skretting under guidance of the WUR (emir. Professor Johan Verreth) at their Abassa research station. Following the World fish report (Opeyemi Agboola, 2019) feeding experiments on tilapia were recently concluded on application of DDGS, Sunflower and Meat and Bone meal.

3.2. Aquafeed sector;

Coinciding with the impressive growth of aquaculture production also the aquafeed sector in Egypt has undergone tremendous changes in the last 7 years since the report of (Rothuis, 2013).

A progressively increasing percentage of the aquafeed used in Egypt is extruded and approximately 40% of the remaining aquafeed is pelletized. Several companies mostly with foreign investments or participation have established extrusion lines and dedicated aquafeed production facilities. Pelletized feeds are produced by local 'state factories'. The main producers of higher quality extruded aquafeed are Skretting (Netherlands), Zoo Control (J.V. with Aller Aqua, Denmark), Koudijs Kapo Feed (De Heus, Netherlands), Grand Aqua (local partnership with Ziegler, USA), New Hope (China).

The interviewed representatives of feed companies indicated that locally produced high quality feed ingredients in general and protein sources in particular are very scarce if available at all. However there is strong interest from the sector in locally produced high quality feed ingredients as imported ingredients generally are expensive, have more complicated logistics and in the long term are not sustainable (Koudijs-Kapo Feed, Skretting, Grand).

For fresh water fish species usage of fish meal in their diets is not required but animal proteins in the diets generally improve fish performance. For marine fish usage of fish meal and oil is still considered indispensable. Acceptance of novel ingredients by feed producers and consumers is an important issue to

keep in mind in view of the cultural and religious background of the country (pers. comm. Kees van Dongen, authors view).

3.3. Aquafeed ingredients and suppliers of the aquafeed industry in Egypt;

Egypt has a rather poorly developed agriculture sector due to the lack of fresh water and dry climatic conditions.

The main crops are rice and wheat but there is a large import of wheat and corn that is heavily subsidized. Egypt production and import forecasts 2019/20 (Wally, A., 2019) (Wally, 2019),

Wheat: 8.8 MMT, import 12.5 MMT;

Corn: 6.4 MMT, imports 10 MMT;

Rice: 4.3 MMT, import 200 KMT

Wheat and rice are not allowed to be used as feed material but their by-products such as wheat bran and corn (specifically imported for this application) may be used.

Commonly used (aqua) feed ingredients are generally imported of which the main protein sources and volumes are estimated as follows:

Soybeans: 28 KMT, imports 4.0 MMT (USA) i.e. ± 3.0 MMT soybean meal;

Sunflower meal: 24 KMT, imports 105 KMT i.e. 55 KMT sunflower seed meal;

Corn gluten 73.8 KMT imports (USA);

DDGS: 58.5 KMT imports (USA);

Fishmeal is imported from Morocco, Denmark (70% protein) and other origins but prices are very high.

Locally produced poultry-by-product meals (PBM's) are available in Egypt but the quality is considered very poor and variable in analysis and digestibility. 3 out of 4 interviewed feed companies indicated they don't use locally produced poultry meals in aquafeed due to approximately only 50% digestibility.

An overview of available feed ingredients in Egypt published by World Fish, CGIAR in 2019 is shown in Annex 3 (Opeyemi Agboola, 2019).

4. Circular proteins for Aquafeed - Poultry-by-products (meals)

4.1. The poultry sector in Egypt

Ministry of Agriculture and Land Reclamation (MOALR) (Animal, poultry development sector) (4-2-2021)

Informed the following production figures:

- Egypt has an annual production of 1.4 billion hybrid broiler chicken with an average slaughter weight of 1,9 kg, which result in total poultry meat production of 1.680.000 MT. The sector is almost self-sufficiency (98%) and only grandparents birds are allowed to be imported. The import of hatching eggs and day-old chicks is not allowed.
- In addition, about 350 million local breed broilers (named Baledy) are produced. The average slaughter weight is 1 kg, which result in 350.000 MT poultry meat.
- The layer sector is producing 13 billion eggs per year with an average weight of 60 gram, result in 780.000 MT eggs annually. The layer industry is self-sufficient. Last year 4 million eggs and 44 MT of pasteurized eggs were exported.
- According to MOALR about 3 million families work directly or indirectly in the poultry sector, which makes the poultry sector a very important sector for Egypt.
- Over the last 3 years the number of licenses for life stock and poultry farms increased from 1500 to 65000. Besides a presidential decree was issued In June 2020, to stimulate investment in poultry farms in the desert, in coordination with the World Organization for Animal Health, to allow the farms in the new project area to export their products.

Animal protein feed ingredients are only allowed in poultry fish feed and pet food (cat and dogs), however it is rarely used in poultry feed.

According to the consulted sources the poultry industry in Egypt produces roughly 1.4 bln billion hybrid broilers and 350 mln local breed broilers annually and has a flock of 18 million layer hens ((Shatokhin, 2017), personal communications with Hashem Brothers, El Abed farms, Al-Watania Poultry, ministry of Agriculture).

At present about 20 % of the total broiler number is processed in slaughterhouses and the remainder sold via live poultry shops. Bigger slaughterhouses have their own by-product rendering operations or if they don't have the waste (by-products) get collected for rendering at third parties, either slaughterhouses with a rendering operation or dedicated rendering plants. According to Egyptian law, live animal poultry shops (wet markets) are not allowed to operate, however this law forbidding the trading of live poultry in the main cities (Cairo, Alexandria and Giza) to minimize the spread of infectious poultry diseases is not enforced till today. 95% of the broilers bought via poultry shops to consumers get slaughtered and cleaned at these live poultry shop (FAO, 2020). Progressively this segment is bound to disappear in the future. The poultry waste from these shops gets collected for rendering/processing as well. However all waste from these shops is pooled together, collected and processed.

Storage, collection and transport is primitive thus an inferior quality rendered product (poultry meal) is the results which explains the bad perception of Egyptian poultry meal by the feed industry in Egypt.

The better slaughterhouses separate 3 offal streams: intestines, blood and feathers some of which have found ways to sell chicken heads, feet and even intestines directly to Asian (Chinese) buyers. Seemingly

there are some positive exceptions. The average broiler slaughter weight is 1.9 kg and the wet by-products yield is $\pm 25\%$ of the slaughter weight. From wet to dry by-product the yield is $\pm 30\%$. If all poultry waste (slaughterhouses and shops) in Egypt would be properly separated and hygienically stored and transported and processed according to modern standards an interesting protein source for the Egyptian aquafeed industry would become available.

Hashem Brothers – Mr. Moustafa Alaa

Director and Board member of Egyptian Poultry Association

The company is located 40 km north of Cairo and has 2 divisions:

Egg production (poultry)

Essential oils - Plant extracts

Egypt has approximately 18 mln layer hens, Hashem brothers have 700.000 birds.

At the end of the laying cycle spent layer are sold as boiling or stew hen in wet market poultry shops as well.

The slaughter waste of these spent hens could be processed into another 1.4 Kton PBM i.e. a value of approximately 0.5 mln US\$ which is obviously negligible compared to the volumes from the broiler industry.

El Abed Farms – Mr. El Abed/Abed Ramsis – Founder & Nasser Ramsis - Partner

El Abed farms is growing 1.8 mln broilers and 3.5 mln ducks/year, the latter being 60 - 70% of Egypt.

They used to collect and process slaughter waste from their own and other companies however they ceased the processing due to smell nuisance in the neighborhood of the plant.

Al-Watania Poultry

One of the largest companies incl. full poultry integrations in Egypt and Middle East. Originate from Saudi Arabia. Fully integrated company with own feed mill.

One of the largest poultry integrations in Egypt. 100 mln chicks, 20 mln broilers, 400.000 layers and 5 mln breeders (also having grand-parent stock).

The market in Egypt is 1.3 bln broilers annually according to Mr. Hazem (Corporate Biosecurity Manager). $\pm 25\%$ of their 20 mln broilers (5 mln) are processed and the rest sold as live birds. This is the typical ratio in Egypt.

Al-Watania is processing its by-products in 3 separate streams: intestines, blood and feathers.

Wet by-products yield is $\pm 25\%$ and from wet to dry by-product the yield is $\pm 30\%$

Layers and broilers mortalities during the cycle are incinerated for sanitary reasons.

In Europe cadavers are collected at the farms and may be rendered into Category II by-products and may be used as fertilizer.

Egyptian-Saudi company for food security and industry

The company has a slaughter house and rendering facility.

Collecting approximately 30 – 40 tons poultry waste from their own and other slaughterhouses and processing this into $\pm 8 – 10$ ton protein meal/day with $\pm 60\%$ protein. They are working according to the standards of the Ministry of Agriculture. Products are sold locally to among others also aquafeed companies and exported to Nigeria.

In their brochure they claim to produce their PBM in a Batch Cooker System according to “Haarslev design”. Actually they are creating their own machines/equipment to produce Poultry-by-product meals and might want to explore this as a separate business.

Sharkia Poultry Company – Mr. Ahmed Salam - Studying International Food and Agribusiness (HAS University of Applied Sciences, Den Bosch, Netherlands)

Sharkia Poultry Company is a small family owned poultry integration (farm, slaughterhouse, and a small feed mill) in Belbes located 65 km North East from Cairo.

180,000 broilers per cycle, in average 6 cycles per year. Currently they are not working at full capacity and producing 100,000 birds per cycle.

The Slaughterhouse is divided in to two business units Slaughtering and Rendering.

The total capacity for the slaughterhouse is 30,000 birds a day but currently working at minimal capacity (due to Covid 19).

The rendering plant has a capacity to process around 600 tons poultry offal (around 150 tons of poultry meals) a month. Most of the waste is from external sources. Sharkia poultry meal is considered as one of the best qualities with a light color, 55 to 60% protein and 10 – 12% moisture.

The family has plans to expand this profitable business as it is virtually continuously at full capacity and is eyeing two recently temporarily shut down companies for acquisition.

The poultry offal is bought from traders for a price in the range of EUR 30 to 60 per ton depending the season. The poultry offal composition varies depending of the season and often contains a lot of feathers. Current sales price for the poultry meal is about EGP 6500 and sold to traders and factories for inclusion in fish feed and sometimes poultry feed and concentrates.

Options to increase quality of PBM

Working the rendering plant continuously at full capacity results in the best PBM.

Shut down of the life poultry shops would facilitate this however the economy could be negatively impacted and the poultry sector could shrink. Presently the market is not ready for chilled poultry meet because of insufficient capacity of chilling equipment.

Roughly 80 % of the birds, is sold in cash to the market to “life poultry vendors” and 20% of the birds is sold to the slaughterhouses for mainly frozen chicken.

Poultry offal collection

The wastes are collected by traders (each trader has his own area) from small slaughter houses and life poultry vendors. The waste is delivered daily, around 3 pm, without any traceability or control nor guarantees on the freshness of the offal. Since a few years Sharkia Poultry is sorting out the poultry offal at arrival at the plant. The impurities and water are removed and the traders only getting paid for the offal which can be used in the rendering plant.

4.2. Assessment of quality characteristics of poultry-by-product meal (PBM) present in the market in Egypt;

National Food Safety Authority (NFSA) (24-12-2020)

NFSA has recently started auditing the poultry slaughter houses;

- Currently there are no official regulations to control the food safety in the rendering plants. Slaughter houses until now are still controlled by the ministry of agriculture. However, there is a “Mandate” which places that responsibility in 2021 with the NFSA officially. The NFSA is in preparation to take this responsibility.
- The directorate of the NFSA, has the ambition to start controlling the recycling processes to improve the food safety.

The recycling process of the poultry slaughterhouses (NFSA):

- Inedible parts such as intestines, feathers, legs, wings, and blood are collected. (Some slaughterhouses are adding all the blood, some partly and others add no blood at all);
- The mix of all parts are very well cooked at a temperature of 140-150 °C for 20 to 30 min, under high pressure (2-2,5 bar);
- After cooking the cooker is opened to release the pressure but keeping the temp between 100 and 120 °C during approximately 3 hours for the drying process and the mixture to reach a moisture level of approximately 4%.
- The cooker will be unloaded, and the product will go through a mechanical press to extract the fat (to be supplied to the soup industry).
- After that the product will be sieved and packed.
- The poultry meal is mainly used for fish feed and not for chicken feed.

Additional remarks NFSA concerning the process:

- Some factories do not include feathers in the mixture, as it not digestible. Feathers have a high protein level, but when not properly hydrolyzed the digestibility is low and represents a low economic value.
- A high level of blood in the processed mixture results in a dark color of the PBM which is not favored by the customers:
- There is no standard regulation for creating the mixture. The processors are free to decide which chicken waste parts are used as raw material and which not;
- All chicken slaughterhouses in Egypt are privately owned. Only one or two is governmental;
- In the near future the government is planning to close all the wet market for chicken and all chicken to be slaughtered in the slaughterhouse, according to the law;
- High priority to close the wet market even if it represents 75 % of the market. As alternative the shops can continue working as a reselling/distribution point of chilled and frozen chicken. The main reason is to guarantee food safety to the consumers.
- The chicken are frozen in 8 hrs. time, then distributed with the refrigerated vans. The chicken should be sold within 6 days.
- The NFSA is working on a new regulation for the slaughterhouses. Already 8% of the slaughterhouses (27 from a total 322) have been audited according to a special checklist.
- There are 500 slaughterhouses for large animals, which are smaller in size and more distributed over the country.
- The slaughterhouses are mostly found in the country side.
- There are 3 type of poultry slaughterhouses: full-automatic, semi-automatic and manual. The manual slaughterhouses (about 200) are relatively small and do not have a rendering facility, they have an agreement with the government for daily waste collection.

- According to the NFSA in Egypt all the animal slaughter waste is processed in the rendering plants.
- Fish feed is the responsibility of the Ministry of Agriculture and Land Reclamation (MOALR).

Destination of farm mortalities

According to the NFSA there is no necessity to burn the chicken mortalities in the farms, which is in average 5-10% of flocks? The sterilization process in the cooker is considered at a very safe level. This means that the quantity of poultry meal could be increased by having efficient logistics (to collect farm mortalities for rendering). However, for large animal it could be obligatory in some infectious disease cases to burn the carcasses. Some of the large animal slaughterhouses have burners to destruct the carcasses of such diseased animals.

In Europe farm mortalities of any kind may only be processed to Category II by products i.e. products like organic fertilizer and may not be fed back into the food chain. Rendering farm mortalities requires a separated processing unit. In the EU governments subsidizes this Cat I and II processing. Actually the present regulation in Egypt (MOALR, next page) is in line with the European regulations.

Foodmate - Patrick van der Linden (18-1-2021)

Foodmate sells and delivers chicken slaughtering and processing equipment.

Earlier Foodmate delivered in Egypt mostly single machines but progressively moves more into complete lines and have more focus on advice including on logistics, infrastructure, etc.

In principle it should be not too complicated to separate the waste streams within bigger slaughterhouses in Egypt.

1. Heads
2. Blood
3. Feathers
4. Feet (nowadays often exported to China)
5. Viscera

Chilling/cooling each of these for further processing in a rendering plant would improve the quality of the final rendered products. Processors/renderers could even pay for properly collected and chilled by-products and could be an extra income source for the slaughterhouse.

Foodmate also supplies machines for partitioning the broiler carcasses in breasts, wings and legs and in some cases deboning (MDM meat). Also offal from this process may be rendered.

Mavitec - Helmus Damen (12-1-2021)

Mavitec is specialized in rendering equipment for virtually any kind of animal-by-products. Smallest may be a steam operated cooker of 1 – several tons per day till turnkey projects up to 15 mln €. They supplied quite some equipment in Egypt already including to Cairo Poultry and Al-Watania Poultry (which was interviewed in phase 1).

It is necessary to separate the by-product (waste) streams (feather, blood, viscera, and carcasses) in the slaughtering lines to produce the best quality by-products meals.

4.3. Imperfections in current poultry rendering practices

There are no guidelines on separation or cold storage of poultry-waste neither at the slaughter houses, wet market shops nor during transport. The results in many cases is spoilage of different kinds of the poultry-by-products pre-rendering and leads to sub-optimal quality Poultry-by-Meal (PBM).

The representative of the Ministry of Agriculture and Land Reclamation (MOALR) emphasized that the quality of the poultry by product is good because the sector is totally controlled by at least 5 authorities, which are involved in the control and regulation of the animal byproduct processing:

1. Livestock and poultry development sector
2. The administration of agriculture of the governorate
3. Regional center for Food and Feed
4. Agriculture research center
5. Specialized police
6. General authority of veterinary services

The MOALR representative mentioned that normal farm mortalities can't be rendered for production of protein powder (either poultry meal or MBM), due to bio-hazards and security reasons.

4.4. Alignment with governmental regulatory challenges and opportunities

Such as enforcement of the ban on live poultry shops and limitations on the use of (i.e. PBM as (aqua)feed ingredient);

Regional Center for Food and Feed (RCFF) (14-1-2021)

Since the outbreak of bird flu start of the H5N1 the importation of meat and bone meal, poultry-by-product and feather meal is prohibited in Egypt, due to concerns for contamination with pathogens.

Ban on live poultry shops (wet market) and the outlook for changes?

General Authority of Veterinary Services (GAVS) (21-1-2021)

Since 2010, law no. 70 is established, which demands discontinuation of all wet market (poultry vendors), however this law hasn't been enforced until now because not all preconditions have yet been met.

For example:

1. Transferring the small local slaughterhouses to a market that should contain cooling refrigerators will need more financial support, therefore the government is looking to provide the vendor with a bank loan for that to support the idea.
2. The cultural habits are playing an important role as Egyptian people are used to get the birds slaughtered in front of them in the small shops (some people do it at home by themselves), to make sure it is fresh. It takes time to change these cultural habit and traditions.
3. Many stakeholders will need to collaborate to get that law implemented and enforced, different departments from police, Ministry of Environment, Ministry of Health, and slaughterhouse.

Recently article no. 499 was amended to force the larger slaughterhouses to process the chicken waste at their own facility including the presence of a wastewater treatment plant. This is controlled and inspected

by the industry department. New slaughterhouses or slaughterhouses that need to renew their license need to comply with the new regulations.

The collection of wastes from the poultry vendors and the smaller slaughterhouses is done by different vendors, where each vendor has its own area from where they collect poultry wastes for rendering however there are no official records, specific timing, or collection schedules. There is very limited control.

Today collection of the processing wastes is often in open truck without observing appropriate hygiene measures and spreading an appalling smell. Obviously under these conditions by-products retrieved this way are not suitable for processing into a high quality aquafeed ingredient. Interviews with feed producers have confirmed this situation as local produced poultry meal is hardly used by the “international” aquafeed companies. Presently an unknown part of the processed by-products are going back into poultry feeds which is an undesirable situation for many reasons.

Some of the industrial processors are already on the right track to produce better/good quality poultry meals.

In order to make a significant contribution in volumes and quality of PBM's to the Egyptian aquafeed ingredients requirement, the main necessary points of improvement are:

- Separation of feather, blood and other waste;*
- Chilling/cooling until collection, during transport and pre-processing;*
- Processing conditions and equipment;*
- Possibly central processing.*

Separation of feathers, blood and intestines at the scattered poultry shops all over Egypt is complicated if economically feasible at all. Apart that separation, storage until collection, chilling in different fractions (blood, feathers, etc.) at the poultry shops cost money also the collection of the by-products in separate compartments, chilling/cooling during transport to the renderers has a cost. The cost is one of the reasons why also in other countries (according to Darling Ingredients) in some case by-products are processed together.

General Authority of Veterinary Services (GAVS) (21-1-2021)

One of the concerns during the waste collection in summertime is the high ambient temperature

At times of high ambient temperatures (summer) the poultry waste collectors (vendors) increase the number of collecting cars to increase the frequency of collection and thus reduce the time between slaughter and rendering of the “fresh” unprocessed poultry-waste.

According to GAVS the poultry offal is processed at a temp of 140 °C, which makes the product completely sterile.

It should be noted that processing as described (heat treatment under pressure) does not neutralize or counteract the pre-processing irreversible biological degradation (production of i.a. biogenic amines such as Histamine, Cadaverin and Putrescine) and oxidation that causes rancidity of the fats that are present.

The Egyptian recycling business of poultry offal is sizeable. In order to encourage more recycling and to support the growth of this sector the authorities shut down several public incinerators/burners already.

GAVS is planning to have a waste collection center, for each governorate. Building the collection center will be very costly therefore authorities are working on a feasibility study.

Waste collection centers could be an option however in the authors' view central slaughtering and processing would be the better option in the long term.

Regulatory, sanitary or practical limitations on the use of poultry-by-products as aquafeed ingredient

According to GAVS Microbial contamination like salmonella could be an issue, but the majority of the samples does not have any problems. In case any positive sample is found the product will be rejected.

Antibiotics residues

GAVS stated that as the poultry-by-products originate from chickens fit for human consumption in principle antibiotics residues in principle couldn't be present in their by-products as this would imply that the poultry itself would not be suitable for human consumption (and that is not the case). Besides there is the processing in the rendering plant at 140 °C. However, due to the high importance of eliminating antibiotic residues, presently an action plan on antimicrobial contamination is in progress. The focus is on poultry because of the large daily production. The controls will start with the farms as the main source. The program will be under the bio security umbrella. The plan is to implement the new rules in 4 to 5 years, and will be coordinated with the Ministry of Health and Population.

It is important to be aware that most antibiotics are very thermostable and that the rendering conditions will not destroy (break down) most of the antibiotics applied in poultry farming.

Obviously it is a good sign that an action plan is under development to reduce the risk of antibiotic residues in consumption chicken and indirectly poultry-by-products. It also implicitly indicates that antibiotic residues are occurring more frequently than desirable.

At least one of the international aquafeed companies has stopped using local PBM due to several cases of Anti-Microbial Residues (AMR's) present in their supplied products. Other producers are using local PBM without testing for AMR!

Darling ingredients (DI)

Darling Ingredients is globally probably the largest renderer of by-products of different kinds. The European/Dutch branch previously known as Vion Ingredients (trade names: Rendac, Son and Sonac) was acquired in 2014. So far DI has no subsidiary in Egypt but could be interested once the opportunity arises to find a suitable partner to tap on the huge volume of poultry waste in Egypt, considering the sizeable tilapia and other fish production and presence of international (incl. Dutch) aquafeed producers.

4.5. Feed and fish farmer and consumer acceptance of PBM in aquafeed

Presently there are some, especially local, aquafeed producers that are using locally produced Poultry-by-Products meal since there is a ban on importation of PBM. Until the ban more companies were using imported PBM's.

Poultry-by-Products meal is included in the Food Composition Tables (for Animal and Poultry Feedstuffs, Ministry of Agriculture, 2001) granting it legal status to use in (aqua) feed. It is unclear to what extent fish farmers are aware of their feed composition, although thus far, the farmers have no influence on feed

composition (pers. comm. Skretting). It may be assumed that like in most countries fish consumers have no idea on feed composition of aquafeeds or usage of poultry-by-products in them.

4.6. Recommendations for quality improvement of Poultry-by-Products in Egypt

To improve quality parameters (improve digestibility, reduce volatile nitrogen, biogenic amines, oxidation, and etc.

Generally it should be kept in mind that the animals are slaughtered at 38 °C, which implies that without taking measures raw material spoilage (like in all material from warm blooded animals) starts immediately after slaughter of the animals. The high temperature, enzymes present in the animals, the unsaturated fatty acids (linolenic acid (n6) in chicken fat, the iron in hemoglobin, etc. are all triggers and/or accelerators of spoilage.

- Anti-Microbial Residues

Strict control on antibiotics usage and observed waiting times are important to avoid anti-microbial residues in chicken meat and its by-products. Also in Europe this remains a point of concern although nowadays there almost never incidents.

- Separation of feather, blood and other by-products at slaughter

For prevention (or reduction) of spoilage blood and feathers must be separated from the rest and processed separately at the moments of birds' slaughter;

- Viscera, heads, feet/paws, etc. must be processed as quickly as possible (within 24 hrs.) after slaughtering the birds and stored as chilled as possible (to prevent biological degradation and oxidation). Antioxidant addition at storage could be helpful.

- Pre-processing chilling/cooling

- When blood is chilled immediately after de-heading and bleeding of the animals a very highly digestible and high protein raw material may be produced. It must be chilled immediately after slaughter and kept at or below 4 °C till further processing.

- Processing conditions and equipment;

- Feathers must be hydrolyzed either enzymatically or at high pressure cooking (autoclaved) and dried to a maximum moisture level of 10%;*
- Blood meal ideally is spray dried or processed by another gentle (low temperature) production method till a maximum moisture level of 10%;*
- Viscera and other by-products should be heat treated, dried, cooled and ground before packaging and storage.*

4.7. Central slaughtering and rendering

As mentioned earlier in this report waste collection centers could be an option to improve the rendering practices in Egypt however central processing alone won't resolve:

- The pre-processing spoilage of the poultry-by-products (at the poultry shop, storage, transport);*
- The incomplete hydrolysis of feathers when mixed with other waste products resulting in low and variable digestibility of PBM;*

- *The complicated and expensive logistics of the poultry waste from the decentralized slaughtering at the wet markets.*

In the authors' view adopting central slaughtering, waste collection and rendering is the desirable future approach to further mitigate the risk of zoonosis such as the bird flu and optimize utilization and quality of poultry-by-products such as poultry feather, blood meal, by-products meal. A gradual enforcement of the 2010 law to discontinue all wet poultry markets could facilitate this process.

4.8. Projections for poultry-by-product volume

In the projections in the table below the present situation available volumes and value of poultry waste from all slaughterhouses and wet markets rendering operation is estimated. With the data we have today it isn't clear which proportion of the poultry-by-products from the industry is processed into PBM. The reality is probably a volume of 100 – 150 ktons.

The potential yield in the future would be around 235 ktons which would be roughly 32% of the total tilapia feed protein requirement and reduce the dependence of raw material imports of fishmeal and other protein sources tremendously.

Table 3: Egyptian poultry sector projection on by-products potential for the aquafeed market.

Annual broiler production in Egypt

2021 PRESENT	No. birds Egypt	Avg. Weight	Slaughter houses rendering	No. birds	Total live weight broilers	Wet by-product (25% dress out)*	Dry PBM (30% Dry matter in waste)**	Sales value per ton estimate	Market value	Tilapia feed mrkt	Tilapia feed mrkt protein***	PBM (65%) volume share protein tilapia feed****
	mln.	kg	% of total	mln	ktons	ktons	ktons	US\$	mIn €	ktons	ktons	%
Integrated/slaughter houses (hybrid broilers)	1,400	1.9	20	280	532	133	39.9	450	18	1,500	450.0	5.76
Poultry vendors/wet market (hybrid broilers)		1.9	80	1120	2,128	532	159.6	350	56	1,500	450.0	23.05
Local Breed Broilers	350	1.35	0	350	473	118	35.4	350	12	1,500	450.0	5.12
Total/Average			80	1,750	3,133	783	235	367	86	1,500	450	34
FUTURE	mln.	kg	% of total	mln	ktons	ktons	ktons	US\$	mIn €	ktons	ktons	%
All poultry centrally slaughtered	1,750		100	1,750	3,133	783	235	500	117	1,500	450	34

* At slaughter of broilers in average 25% of the weight is waste/by-products

*** Tilapia feed in average contains 30% protein

** Poultry waste contains in average 70% water and 30% matter

**** Poultry by-products average protein level is assumed 65%

It should be noted that the poultry-by-products in the future should consist of poultry-by-products meal, poultry feather meal and poultry blood meal each with their own specifications and price.

4.9. SWOT analysis poultry rendering situation

SWOT Poultry Rendering project

Strengths	Weaknesses
1. Big and growing potential to contribute to the sustainable protein demand of the aquaculture sector in Egypt	1. Need for big investments to upgrade/replace small to centralize slaughterhouses incl. rendering and developing cold chains
2. Economic gains ahead for processors and renderers (from max 86 mln market value of 117 mln US\$)	2. Restructuring of the sector required
3. Domestic employment development in numbers and safety	3. Need for cold chains for poultry products (breasts, legs, wings)
Opportunities	Threats
1. Enhancement of sustainability of poultry and aquaculture sector	1. Bureaucracy and lack of leadership in Egypt as result of control and regulation by many governmental authorities
2. Reduction of import dependence of the aquafeed sector in Egypt (trade balance)	2. Reluctance of the public and private sector to reform
3. Big improvements in economics and sustainability of the poultry and aquaculture sector	
Update 18-3-2021	

4.10. Opportunities for investments and intervention in rendering and feed ingredient production

During the course of this study we didn't come across many concrete immediate investment requests/opportunities however considering the size of the poultry industry (over 1.7 bln birds), the associated potential to render by-products (over 250 ktons sellable poultry by-products with a market value of over well 100 mln US\$) and Egypt being the no. 8 global aquaculture producing country and globally 3rd tilapia producer obviously opportunities will arise in the rendering industry for feed ingredient supply.

Private sector opportunities

- *Sharkia poultry is interested in partners for expanding and quality upgrading of their poultry waste rendering operations and final product.*
- *Egypt counts more than 300 PBM processing plants and around 500 rendering plants, most plants are equipped with relative outdated processing technology. To process separated waste streams the factories, need to be re-engineered. Know-how and supply of specific systems and more*

advanced equipment will be required. Besides there is a demand for equipment to build the required wastewater treatment facilities.

Public sector opportunities

For the Dutch public sector, more specifically the Embassy of the (Kingdom of) the Netherlands (EKN) and RVO there are several possibilities for intervention.

- *The opportunities and insights of this study including the insect protein farming and nutritional value are to be shared at the “Aquaculture Africa 2021” Conference and Exhibition in Alexandria end 2021. Funding of the presenters participation possibly together with Dutch Aquaculture Experts participation to, share their insights and develop business opportunities.*

Public and private sector opportunities

From this study it has become apparent that the most important opportunity for developing circular proteins for aquafeed in Egypt is the upgrading of existing rendering practices of poultry slaughter waste. Thus several opportunities for interventions arise:

- *Further explore opportunities for cooperation, trade and investment in poultry;¹*
- *Training & knowledge transfer on poultry waste storage hygiene, rendering practices, quality control and management, etc. by interventions of e.g. the Dutch Food and Drug Administration (NVWA), consulting companies, agriculture colleges and universities. Potentially there is an interest for NVWA (and Wageningen Food Safety Research) to work G2G with NFSA.*
- *A demo-project on integrated poultry slaughtering, cold chain distribution and waste (by-products) rendering. Potential partners could be one of the participating companies in this study, Wageningen UR, a Dutch rendering company, Dutch Equipment suppliers, etc.*

There are opportunities for Dutch companies to co-invest in the Egyptian rendering sector. Egypt is keen to attract foreign investment and has facilitating laws and processes <https://www.investinegypt.gov.eg/English/Pages/default.aspx>. In practice companies can incur challenges however there are interesting examples of agribusiness joint ventures: Kernile, EPEC, Farm Frites.

¹ Taking into account ‘one health’ issues connected zoonosis (avian flu) and anti-microbial residues .

5.0. Circular proteins for Aquafeed - Insect meal and oil

Presently there is no real insect production sector in Egypt among others due to the young age of this sector globally, the unfamiliarity with insect production in the country, absence of a legal framework and cultural prejudice. The companies presently involved in the development of insect production in Egypt are in a startup phase and are operating without production and operating license!

5.1. Alignment with governmental regulatory opportunities and limitations (i.e. insect meal as feed ingredient);

Research Center for Food and Feed (RCFF) (14-1-2021):

Registration of new feed ingredients in Egypt:

- The company shall submit a request to register a new raw material for feed;
- Documents that must be submitted alongside the registration request are among others: Commercial registration of the company, production and operating license;
- The board of committee will check, if the requirements are in compliance with quality standards and Egyptian legislation;
- Expert will visit the company for inspection and advice on the company's capabilities to produce the feed ingredient;
- Samples to be taken, and to be tested in RCFF labs (EU regulations are often used as a reference standard);
- When the samples are approved, the product specification needs to be in accordance to the findings of RCFF, and will be send to the ministry of Agriculture for final registration as approved feed ingredient.

Insect meal

- Presently insect production is not recognized by the government, and the few producers that are present in Egypt are small scale producers, without a production and operating license to produce insect protein.
- It is unclear who (which governmental body/ authority) has the authority to issue the production and operating license to an insect protein producer in Egypt.
- There is no clear official timeline with regards to legalizing insect protein production and registration in Egypt until now.

Regulatory opportunities and limitations regarding the production and the use of Insect protein in poultry or fish feed:

- General Authority of Veterinary Services (GAVS) (21-1-2021) stated there is no harmful or illegal reasons to introduce insect proteins sector in Egypt. At the moment there is no specific authority that could issue the regulation and standards.
- GAVS suggests to create a committee including different authorities with representatives from relevant ministries such as Ministry of Environment, Ministry of Agriculture, Ministry of Health, and the Netherlands embassy.

- The initiative for this committee should start by submitting at first a request to the Ministry of Foreign Affairs. The Ministry of Foreign Affairs will delegate and coordinate to the involved Ministries. Actually a meeting between representatives of the Dutch Embassy Dr. Melle Leenstra, Mr. Omar Abdellatif and the ministry Dr. Badr took place on 14-2-2021

Proteinea Mahmoud Eljendy, Co-Founder & CEO & Abdulaziz Elgammal, Co-Founder & CTO

- Proteinea rightly indicated that basically two different but related bottlenecks need resolutions namely legislation allowing the production of insects (protein) on the one hand and registration of insect protein (and oil) as an approved feed ingredient to allow its inclusion into animal and aqua feed. The acceptance of insect protein will be crucial.
- The Dutch and other international feed producers could be instrumental and as they may be more influential than Proteinea with the regulators. For example they could request permission to add insect protein into the feed and/or request to import insect protein. That would be a good first step which could open the market for local production of insect protein. Such action could be considered as part of Corporate Social Responsibility (CSR) (Dr. Melle Leenstra, Agricultural Counsellor of the Embassy of the Kingdom of the Netherlands (EKN)).
- Several parties (especially from the scientific world) in Egypt have started to show interest and focus on insect production which may help to resolve the “chicken-and-egg” situation re. insect production and application of the products.

Dr. Melle Leenstra, Agricultural Counsellor of the Embassy of the Kingdom of the Netherlands (EKN).

- EKN offers to help connect Proteinea to the right departments in the Ministries of Environment, Agriculture and Foreign affairs.

5.2. User (feed company and fish farmer) and consumer acceptance of insect meal in aquafeed

The National Food Safety Authority (NAFS) (24-12-2020)

NAFS expects that due to the novelty of insect production in Egypt that it will be hard to accept the idea and it might be rejected by most people in the Middle East. However the representatives of NAFS did not hear about the application of insect protein in feed before. In Egypt ink color made from insects is used in Egypt, and people are already having a problem with that and some reject to buy it.

General Authority of Veterinary Services (GAVS) (21-1-2021) appreciates the Dutch approach re. the support in developing of circular proteins in Egypt as feed ingredient however considers Insect protein a culturally complicated issue.

Ministry of Agriculture and Land Reclamation (MOALR) (Animal, poultry development sector) (4-2-2021)

The representatives of the ministry (MOALR) mentioned that they have a large concern on the social acceptance of the society on the social media, in case insect protein will be introduced as animal feed ingredient.

MOALR recommends that different authorities of different ministries should create a committee, to study which regulations need to be in place to control and regulate (licensing) the production of insect protein.

Actually, a committee of the animal production department was formed and together with some scientists, before the corona lockdown, agreed to follow the European standards. No information on the present status was available.

5.3. Proteinea – Insect meal

Mahmoud Eljendy, Co-Founder & CEO & Abdulaziz Elgammal, Co-Founder & CTO

Proteinea is a startup company growing black soldier flies on agricultural waste streams that are presently either used for Bio-energy production or are disposed of in landfill. For the moment this material is provided for free to Proteinea

Proteinea has divided the business in two divisions:

1. Insect farming 1.0

Producing feed ingredients (for poultry, aqua and pet food). This activity is still in experimental stage and is aiming to bring this up to scale with large volume and low cost.

2. InsectaPro 2.0

Patents on Bio-tech innovations with a wide range of applications in recombinant proteins production.

Registration Proteinea in Egypt

The holding company of Proteinea is registered in US with a local registration in Egypt.

As mentioned earlier in this report Proteinea learned the hard way that there is no authorized institute nor regulation in Egypt for registering insect farming companies and products (Food Composition Tables). Black Soldier Fly (BSF) farming is not approved yet, however the BSF is not considered a pest nor blacklisted and therefore Proteinea operates in a gray area. Proteinea's activities are not illegal but it's currently not possible to get a license for BSF production and their activity is covered under R&D.

Proteinea production technical and financial projections

The company is projecting to construct a first scale up "farm" to produce 1 ton live larvae/day.

Roughly 400 ton live larvae/year which gives 80 mtons insect meal (yield of 21%) and 35 mtons oil (yield of 9%) which is comparable to data from European operations.

The owners expect to be able to produce much cheaper than the European companies due to several potential savings in Egypt.

A plant to produce 25 live larvae tons/day would require an investment of 2.5 – 3 mln US\$. In comparison with e.g. industrial initiatives in Europe this investment in machinery and buildings would be 5 times less for a comparable production level due to cheaper alternatives for equipment and buildings.

Table 4: Production parameters and projections Proteinea.

Black soldier flies Proteinea								
Live larvae per day	Live larvae per year	Yield meal	Yield meal	Yield oil	Yield oil	Investment	Depreciation	Depreciation avg.
mton	mton	%	mton	%	mton	US\$ * mln	US\$/year	US\$/ton product
1	365	21	77	9	33			
25	9,125	21	1,916	9	821	3	300,000	110

At a land surface of 1000 m (including the service area) about 2 tons live larvae per day can be produced, with a height of 2.2 m. With a vertical farm setup of 6 m height with the same surface 5 ton live larvae can be produced. About USD 250-300k is required for all the equipment, besides the building cost. Yield of meal, can increase from 21% to 22% according to the latest field trails. Yield of oil product can increase from 9% to 15% (in case the oil is not purified, which is not required for application as animal feed ingredients).

It should be noted that less purification or drying of the insect oil may also reduce its value considerably.

Operational costs of insect production in Egypt at Proteinea would also be significantly lower than in for example the Netherlands: Minimum wages: € 1650/month in NL versus ± € 140/month in Egypt; Energy: € 0.09/kW vs. € 0.03/kW; Feed cost: € 300/ton (estimate) vs. € 20/ton presently but maximum increasing to € 100/ton (estimate) Building rental (storage): € 40-50/m² vs. 13 €/m² in Egypt. In Europe insects are considered animal production and fed with a compound feed (EU regulations) while production in Egypt has been started with agriculture and food waste streams.

It is important to investigate the nature of agricultural waste streams used to feed the insect larvae:

- *How stable is the composition and to what extent do the likely variations in composition cause disruption of the production process of the larvae.*
- *What is the impact on the consistency of the final product, the insect protein quality;*
- *What are the risks of contamination of the feed material?*

Partnership potential for Proteinea (to upscale their model in connection with Dutch companies)

Proteinea already has several partners among others in the USA, France and Germany. The co-owners are interested in Dutch-Egyptian partnership for example to produce in Egypt and export to the Netherlands and EU. Proteinea targets domestic feed and pet food producers.

The followings parties and services could be of benefit for Proteinea:

- Dutch Universities of applied science to help to bring the 1.0 to scale and in the future to improve productivity;
- Consultation firms on insect farm management;
- BSF Strain Improvement Science;
- Wageningen Biotech could play a role in the 2.0 project;
- Financing the assets to scale up the 1.0 insect farm;
- Raising capital for the 2.0 R&D activity;
- A franchise concept could also be an option to avoid large investment in assets;
- Egypt based food processing and waste management companies who could provide Proteinea with stable organic waste stream such as Farm frites and Al Ahram Beverage;
- The international (aqua) feed producers (Skretting, Koudijs Kapo) to create acceptance in the market, facilitate registration of BSF production and registration of BSF as feed ingredients. Co-development of the product according to the needs of the aqua feed producers.
- Grants to mitigate the risk to scale up the activity to a larger commercial size.

5.4 Benchmark Proteinea with Insectipro involved in FeedTech Kenya

Mahmoud Eljendy, Co-Founder & CEO & Abdulaziz Elgammal, Co-Founder & CTO

Proteinea considers a medium scale production with an output of 5 to 25 ton per day live larvae the minimum to realize a good ROI. One of the reasons for this assumption is among others the importance of a stable predictable stream of biologically safe organic waste for insect feed. Also the logistic cost should be minimized and can only be realized if the production facility has a minimum size as earlier indicated.

Larive international – Wouter van Vliet, Managing Partner (8-1-2021, 1-2-2021)

Larive (www.larive.com) is a Dutch company that helps Dutch companies to grow their business abroad predominantly in fast growing developing countries. Local presence in 20 countries (Asia and Africa). Key competences: Business intelligence, Market entry, Implementation and Public Private Partnerships. 80% food & feed related projects.

Relevant example for this study of one of the Larive coordinated projects is Food Tech Africa

(www.larive.com/ppp/foodtechafrica/) including the alternative protein production of

Insectipro Kenia. Insectipro is a local company in which the local partner invested over 1 mln Euro.

Unga is the local partner that owns a greenhouse complex in which they grow the Black Soldier Flies (BSF).

In Nairobi vegetable and fruit waste are collected at large scale and serve as feed for the BSF larvae. The larvae are dried whole. It is a struggle to produce at a cost that can compete with fish meal and it's not certain they will succeed.

Larive considers scalability in combination with low local costs a prerequisite for successful insect farming.

An earlier cricket farming project involving approximately 300 small-holders that produced the crickets for central processing failed.

A certain industrial scale is necessary in order to guarantee consistency of the insects "feed", hygiene and final product. The end users request a uniform and predictable raw material to include in their aquafeed formulas.

The business concept of Proteinea may offer a good potential for producing a price competitive insect meal in Egypt compared to fishmeal and other high protein meals. A proof of concept has not been obtained yet.

5.5. Other information regarding Proteinea and insect products

Export of insect protein

For export of protein meal a registration of the product at the NFSI (national Food Safety Institute) is not required. In the commercial registration of Proteinea export activity is already included.

Mitigation of risks for biological contamination

Biosecurity and the contamination risk are controlled by the following ways:

- Proteinea is a non-voting member of the International Platform of Insects for Food and Feed (IPIFF), and they are following the USA standards;
- The BSF is by nature a very lazy fly and does not has the power to fly distance;
- The BSF is not inter-breeding with local species;
- BSF are very sensitive and cannot survive easily in the Egyptian climatological conditions in case of occasional fly escape. The house fly is outcompeting the BSF under Egyptian conditions;

- The housing construction is secured by a double net caching system.

Koppert/Bestico - Jonathan Koppert (1-2-2021)

Koppert is a large Dutch diversified Insect Business involved in i.a. biological pest control and pollination in greenhouses. Third generation family company with subsidiaries in 28 countries and ± 1.500 employees.

Bestico has 8 years' experience with insects for feed with focus on:

- Technology transfer
- Breeding
- Schaling
- Processing

Not interested in investing in feed insects production.

Viscon Group – Maren Schoormans (27-2-21)

Viscon Group is specialized in creating innovative, solid and smart logistic solutions for all handling processes in Food, non-Food and Agro businesses. Viscon Group is located near to Rotterdam and has a history over 50 years in product & material handling. During the past few years Viscon has been working on among others innovations relating to BSF production units. The company is present in the Egyptain market through their local distributor El Sabeel for trade and distribution, a subsidiary of Fat Hens Group. Viscon is interested to provide their innovative sollutions to Egypt, which is one of the 77 countries were they are active.

Skretting – Dr. Ayman Rostom

Skretting indicated to be interested to import one container of insect protein for trial purpose. On the other hand, Mr. Ayman sees more benefit to make a trail with local produced insect protein at the Skretting experimental farm in collaboration with the World Fish institute and Dr. Amira from the central lab fisheries, located at the World fish institute. It would be preferable if EKN could be a stakeholder in such project.

Considering the issues with registration of insect production and insect protein as feed ingredient a request from a multinational company such as Skretting could very well encourage steps from the responsible authorities in Egypt to work on this.

According to Dr. Melle Leenstra, the opportunities and insights of this study including the insect protein farming and nutritional value are to be shared at the “Aquaculture Africa 2021” Conference and Exhibition in Alexandria. The conference could offer an opportunity for Dutch Aquaculture Experts to, share their insights and develop business opportunities. At this conference Dr. Marc Verdegem, Associate Professor at Wageningen University and Research is to present results from collaborative research with WorldFish and Skretting.

5.6. SWOT analysis insect project Proteinea

SWOT Insect protein project	
Strengths	Weaknesses
1. Favourable economic projections, due to high yield/m2, low water usage, low investment, cheap labor, high nutritional value (selling price)	1. Regulatory environment in Egypt. Insect farming has no legal status in Egypt today
2. Waste to feed; Convert low value organic substrate waste to high value products (circular economy)	2. Economies of scale and price competitiveness still needs to be developed and proved
3. Very large long term market potential	3. Initial small contribution (0.3% in phase 3) to the total protein requirement of the aqua feed industry
Opportunities	Threats
1. Innovations and development are needed to have a stable substrate, farming house systems and genetics	1. Legal framework; risk related to insect uses, welfare, safety and legislation
2. Scale up insect production and provide various products to the market (powder, whole larvae, oil)	2. Economic loss if failing
3. Proof of concept of economic insect farming	3. No social acceptance of insect as feed ingredient
Update 18-3-2021	

5.7. Opportunities for investments and intervention in insect farming and feed ingredient production

Insect protein production making use of agricultural and food waste streams is considered a promising area to increase the circularity and sustainability of aquafeed production and in Egypt to reduce the dependency of imported feed ingredients. The breeding and farming process is in the development stage and the economic proof of concept of industrial scale production is still pending.

Public and private sector opportunities

- *Presently Proteinea is still in a startup phase and has several investment needs to proof their concept at a semi-commercial scale.*
- *A demo project for the first upscale of production would be a good test case;*
- *Skretting has shown interest to import one container of insect protein for trial purpose and test it at Skretting's experimental farm from Skretting, in collaboration with the World Fish Institute. An*

intervention and/or granting of this initiative would be an interesting option. Such project will facilitate the registration process in Egypt;

Public sector opportunities

For the Dutch public sector, more specifically the Embassy of the (Kingdom of) the Netherlands (EKN) and RVO there are several possibilities for intervention such as in the registration/legislation of insect production as feed ingredient producing entity.

Secondly for admittance of insect protein meal into the feed chain in Egypt the cooperation of EKN with the Ministry of Foreign Affairs may be instrumental to admit insect protein into the Food Composition Tables (for animal and poultry feedstuffs);

- Participation in a committee as suggested by the Ministry of Foreign Affairs to support the above mentioned;*
- Sponsoring the participation of Dr. Marc Verdegem, of Wageningen University and Research “Aquaculture Africa 2021” Conference and Exhibition in Alexandria end 2021 to present results from collaborative research with WorldFish and Skretting is a good option for funding for the Dutch public sector.*

6. Brewery-by-products

Brewery-by-products are an option for application in aquafeed and can certainly be applied in tilapia, catfish and other aquafeed. Brewer's yeast and Dried Distillers Grains (DDGS) are commonly applied ingredients in aquafeed in other parts of the world.

Al Ahram Beverages (Heineken) – (8-7-2020, 29-12-2020)

Ahram Beverages (AB) has 3 "waste" streams:

1. "Surplus yeast" that after fermentation of the wort is separated. This product is approximately 80 - 100 tons "wet" product per month. The protein content is 30 - 35 % and dry matter content 40 % - 65 %.
- Until the outbreak of Covid the product was sold/given to a local Chinese company as a trial for the symbolic amount of 5 EGP/ton + transportation cost to take our yeast , however we sell 1 ton for 5 EGP in addition of the transportation cost as a trial phase). Landfill disposal cost are approximately 235 EGP/ton ≈ 13 €/ton.

Although the volume is rather small it is certainly an option to bring the "surplus yeast" to market in dried form (approximately 50 tons/month).

2. The second by-product (waste stream) is spent grain (distillers grains = Brewery grains mainly malt & rice) that are fed to ruminants. The volume is 1000 mton/month (2019) and is sold for 1050 EGP /ton ≈ 60 €/ton. Brewers grain can be dried and sold as DDGS to aquafeed companies for tilapia and carp feed however in this case not very interesting as the volume is relatively small and Al Ahram found already a good destination for the product. A dried DDGS would fetch a 5 - 7 times higher price but the drying loss would be a factor 3.5 so the economic benefit seems minimal.

3. The 3rd and biggest waste stream is the Vinasse from wine processing and it is approximately 2.500 ton /month. It's a by-product stream with possible opportunities for further processing in extracting valuable materials however not suitable for aquafeed (low in protein and fat and very rich in fibers. The products is presently disposed of at a cost of 164.0 EGP/ton ≈ 8 €/ton. It is outside the scope of this project.

The above data and potential values are summarized in table 5 on page 33

Brewery-by-products are considered interesting protein sources for aquafeed and as it is quite simple to dry these waste streams and channeling the dried product into aquafeed producers.

In order to market brewery-by-products (and any other feed ingredient) it is important to have samples of the sellable product analyzed and provide technical data sheets to the potential buyers (product data sheet (COA) and nutrient matrix values).

Considering the small volume of by-products from Al-Ahram brewery the intervention in this phase of the project is hereby concluded

In theory brewery-by-products may be used as feed material for insect growing. However it is the authors' view that the value of spent yeast and grain is too high for this purpose and have more economic value in other applications such as aqua and other animal feeds.

7. Other/General points

7.1. Other waste sources fit for feed protein generation

It is very well possible that other waste stream of agriculture-by-products or food processing are present in Egypt but were not discovered in this study. Such streams when present could be tested for single cell processing (bacteria, yeast, and fermentation) or a production of duck weed production. There is some duck weed production in Egypt for duck farming. Whether duck weed is an economical viable option as feed ingredient production for aquafeed needs further study also considering the high fiber content of duck weed. Moreover, on a global scale various research is taking place to investigate the opportunities of seaweed as protein source and bio-active substances. The geographical and climatological conditions in Egypt could be in favor for growing seaweed. The economic feasibility of this activity and technicalities are still not certain.

Another example of other underutilized waste streams that may be brought to value as protein source in aquafeed are Animal Bone Grist

Star Glue Works - Monir Shehfe (10-1-21)

Star Glue Works was the first local manufacturer for Liquid and Pearl Glue in Egypt. It is a medium size company operating within the Animal By-product Industry. The factory situated in Borg El Arab, can process up to 10,000 tons of raw Bones per year, producing Fat/Grease, Liquid and Pearl Glue, Tri-Calcium Phosphate, animal bone grist and Hoof & Horn product.

Bone grist is a possible raw material which is relative unknown and undervalued, because the product was never included in the Food Composition Tables (for Animal and Poultry Feedstuffs, Ministry of Agriculture, 2001).

1. Bone Grist is produced in the second stage of the animal glue production process, after de-greasing the bones, the bones are dried and then polished. The outer layer of the bones, which is removed by the polishing process bone grease, result in a meal which is called Bone grist. From the polished bones the pearl glue is extracted.
2. In case there is not sufficient demand for pearl glue there is the option to crush the whole bones after the de-greasing process into bone grist as well.

Bone grist contains 28-30% protein, 20% Calcium and 10% Phosphorous. Up to a few percentage, bone grist added into poultry or aqua feed could give a cost price benefit. To do so the product should be accepted by the RCFF and added to the Feed Composition Labels by the Agricultural Research center.

7.2. Comparison protein options volumes, market and prices

To improve the overview of the different options in this study in table 5 below the envisaged production volumes, protein levels and their respective possible market share in volume and of the protein in tilapia feeds as well as the roughly estimated values are summarized.

Table 5: Protein sources volume and value projections including market volume and protein sources share

Protein sources volume and value projections including market volume and protein sources share

Poultry-by-products meal (PBM)	Broiler no. heads	Total live weight broilers	Wet by-product*	Dry PBM volume**	Protein content	Dry PBM protein	Tilapia feed market	PBM volume share tilapia feed market	Tilapia feed market protein ***	PBM % protein requirement tilapia feed market	Estimated sales price/ton	Estimated total value
	mIn.	% of total	ktons/year	ktons	%	ktons	ktons	%	ktons	%	US\$	* mIn US\$/year
Present situation	1,750	3133	783	235	65	153	1,500	16	450.0	34	367	86
Future = All centrally slaughtered	1,750	3133	783	235	65	153	1,500	16	450.0	34	500	117
Black soldier flies Protinea insect meal (IM)****	Live larvae per day	Live larvae per year	Yield meal	Dry IM volume	Protein content	Dry IM protein	Tilapia feed market	IM volume share tilapia feed market	Tilapia feed market protein ***	IM % protein requirement tilapia feed market	Estimated sales price/ton	Estimated total value
	mton/day	kton/year	%	kton	%	ktons	ktons	%	ktons	%	US\$	* mIn US\$/year
	1	365	21	0.08	70	0.256	1,500	0.01	450.0	0.06	2000.00	0.15
	25	9.1	21	1.9	70.0	1.3	1,500	0.13	450.0	0.30	2000.00	3.83
Al Ahram brewery-by-product (BBP)	By-product/month	By-product/year	Yield meal	Dry BBP volume	Protein content	Dry BBP protein	Tilapia feed market	BBP volume share tilapia feed market	Tilapia feed market protein ***	BBP % protein requirement tilapia feed market	Estimated sales price/ton	Estimated total value
	mtons/month	ktons/year	%	ktons		ktons	ktons	%	ktons	%	US\$	* mIn US\$/year
Surplus yeast	80	0.96	50.0	0.5	40.0	0.2	1,500	0.03	450.0	0.04	700.00	0.34
Spent distiller grains	1000	12	25.0	6.0	25.0	1.5	1,500	0.40	450.0	0.33	250.00	1.50

* At slaughter of broilers in average 25% of the weight is waste/by-products

** Poultry waste contains in average 70% water and 30% matter

*** Tilapia feed in average contains 30% protein

**** Next to a protein meal in these scenarios (1 and 25 ton live larvae/day) additionally 33 or 820 mtons insect oil would be produced (value ± US\$ 800/ mton)

7.3. Relevance of this project to Dutch companies, social enterprises, organizations, government (the economic diplomacy network), RVO

In the course of phase 1 and 2 of this project a number of Dutch companies and organizations have been contacted, interviewed and/or to a bigger or lesser extent contributed. All interactions have been summarized in Annex 1.1. The Dutch origin contacts are summarized in Table 6 below.

Table 6: Dutch directly involved stakeholders

Dutch companies, stakeholders and organizations that were involved in this study directly

Category	Companies
Feed Companies	Skretting
	De Heus/Koudijs Kapo Feed
	Wageningen-UR Centre for Development Innovation
Dutch Companies	Darling Ingredients
	Larive International
	Mavitec
	Foodmate
	Koppert Bestico
	Viscon Groep
Dutch Governmental	Embassy of the Kingdom of the Netherlands Cairo
	RVO

Apart from the direct stakeholders from table 6 additionally the project may have relevance in a broader context for the mother companies of the parties directly involved such as Heineken International, Nutreco (Skretting), De Heus (Koudijs) but also possible stakeholders not directly involved in the project thus far such as:

Wageningen University and Research (WUR), partner in the WorldFish/CGIAR research;

Dutch Aquaculture Experts, provider of aquaculture know how and hardware;

The Dutch government the economic diplomacy network in other countries than Egypt.

7.4. Workers health and welfare

During this study the team did not directly come across risky workers conditions. However considering the obtained information re. the poultry rendering practices outside the integrated broiler integrations and slaughterhouses with own rendering operations there may be health risks for workers around the collection and in the rendering plants of the poultry waste

7.5. Phase 3

The outcomes of this study and possibilities for further intervention will be presented at an upcoming hybrid (COVID-proof), event on 1 April 2021 and followed up at the Aquaculture Africa Conference and Trade Fair in Alexandria (Afraq), in December 2021.

8. Conclusion and Recommendation

8.1. Poultry by products (chapter 4)

Optimization of poultry-by-products meal production and logistics has by far the biggest potential in terms of protein delivery to the aquaculture sector in Egypt (up to $\pm 34\%$ of the total protein requirement), reducing import dependence and increasing already present production.

8.2. Insect protein (chapter 5)

Upscaling (next phase) of the insect meal project of Proteinea from the present facility (to a projected production 1 ton of live larvae per day) would be an interesting proof of concept of a low cost insect protein production. It is especially interesting due to the transformation of food and agricultural waste into feed raw material. It should be noted that even a scale up to 25 ton live larvae per day the order of magnitude in terms of volume impact is only $\pm 0.3\%$ of the protein requirement of the tilapia feed market. From a circularity concept point of view insect protein production at a competitive price level to fish meal has not been demonstrated yet.

8.3. Brewery-by-products (chapter 6)

Brewery by products are interesting products as aquafeed ingredients. The available volumes of “surplus yeast” and “spent grain” are really small in Egypt at Al Ahram relative to the aquafeed market. It is relatively simple to dry these products but the economic benefit to deliver them dried to aquafeed producers as ingredient is negligible versus the extra processing cost. An intervention from Dutch companies or government doesn't seem necessary.

9. Annexes

9.1.1. Annex 1.1. – Company, stakeholders and organization contacts summary

Company, stakeholders and organization contacts summary

	Companies	Person	Person	Person	Person	Person	Person	Number reached direct
Feed Companies	Skretting	Arjen Roem	Alaa Badr	Ayman Rostom				3
	De Heus/Koudijs Kapo Feed	Yasmine Kamar	Julia Mas Muñoz	Jan Kampschoer	Kees van Dongen			4
	Aller Aqua	Hussein Adel Mansour						1
	Grand Aqua	Hamid Nabil						1
	New Hope							0
Local Companies	Proteinea	Mahmoud Eljendy	Abdulaziz Elgammal					2
	The Fish Basket (Multitrade group)	Mr. Ali Elhaddad						1
	Wadi Fish Co.	Mr. Salah Taher						1
	Al Ahram Beverages (Heineken)	Ramez Ekram	Moheb Samir	Fady Girgis	Ehab Mahfouz	Hans Essaadi	Paul Stranger	6
	The Star Glue Works	Mounir Shehfe						1
Local Poultry Companies	Egyptian Saudi Co. (for food security and industry)							2
	Hashem Brothers company	Mr Moustafa Alaa						1
	El Abed Farms	Abed Ramsis	Nasser Ramsis					2
	Al-Watania Poultry	Dr. Hazem Darwish						1
	Sharkia Poultry Company	Ahmed Salam	Omar AbdelAziz Salem					1
NGO's	WorldFish	Harisson Charo-Karisa	Diaa Al-Kenawy					2
	Wageningen-UR Centre for Development Innovation	Peter van der Heijden						1
Local Governmental authorities	National Food Security Authority	Dr. Sherin	Ms. Marwa Badr,					2
	Regional Center for Food and Feed (RCCF)	Dr. Ashraf Hesham						1
	General Authority of Veterinary Services	Dr. Abdelhakim Mahmoud Mohammed	Dr. Ahmed Abdel Kareim	Dr. Mohamed Ahmed Akal	Dr. Hisham Ezat	Dr. Mervat Zarif	Dr. Heba Fahem	6
	Ministry of Agric and Land Reclamation	Dr.Tarek Soliman Tawfeek	Eng Walla Anis					2
	Foreign Minister for European Department.	Dr.Badr Abdelatty	Bassem Saber					3
	General Authority on Veterinary Services GAVS	Dr. Hatem						1
Dutch Companies	Darling Ingredients	Louis van Deun	Carine van Vuure					2
	Larive International	Wouter van Vliet						1
	Mavitec	Helmus Damen						1
	Foodmate	Patrick van der Linden						1
	Koppert Bestico	Jonathan Koppert						1
	Viscon Groep	Maren Schoormans						1
Dutch Governmental	Embassy of the Kingdom of the Netherlands Cairo	Melle Leenstra	Omar Abdellatif					2
	RVO	Gertrude Wagemans						1
								55

9.2. Annex 2 – Fish and shrimp production in Egypt 2008 - 2018

Fish and shrimp production Egypt (x 1.000 MT and x mln US\$) 2008 - 2018 and feed demand (x 1.000 MT) estimate

Species group	Species groups	2008	2010	2012	2014	2016	2018	Value 2018	Avg. per kg	FCR	Feed demand 2018	CAGR 2008-2018
Freshwater fish	Nile Tilapia	386,186	557,049	768,752	759,601	940,309	1,051,444	905,963	\$0.86	1.5	1,577,166	10.5
	Common carp	11,400	31,721	23,665	46,000	50,000	47,000	42,325	\$0.90	0.5	23,500	15.2
	Silver bighead carp (<i>Hypophthalmichthys</i> spp)		80,000	21,700	100,829	80,909	66,900	60,246	\$0.90	0.5	33,450	n.a.
	Other Cyprinids	61,806	80,000	21,700	52,000	70,000	67,000	60,336	\$0.90	0.5	33,500	0.8
	African Catfish (<i>C. gariepinus</i>)	13,944	9,717	13,622	13,109	7,627	6,836	5,002	\$0.73	1.5	10,254	-6.9
	Total Freshwater fish	473,459	759,116	850,052	972,188	1,149,457	1,239,182	1,073,873	\$0.87			1,677,870
Marine fish	Mullet (Mugilidae)	209,313	116,029	129,651	119,645	153,776	242,071	258,866	\$1.07	0.5	121,036	1.5
	Gilthead Seabream (<i>Sparus aurata</i>)	4,480	15,065	14,806	16,967	26,663	29,994	65,838	\$2.20	1.8	53,989	20.9
	European Seabass (<i>Dicentrarchus labrax</i>)	4,383	16,306	13,798	15,167	24,498	24,914	35,056	\$1.41	1.8	44,845	19.0
	Meagre (<i>Argyrosomus regius</i>)	2,031	12,246	8,319	5,884	16,162	25,130	35,360	\$1.41	1.8	45,234	28.6
	Total Marine fish	220,213	159,670	166,576	157,664	221,099	322,109	395,120	\$1.23			219,870
Crustaceans	<i>Penaeus vannamei</i>	0	0	0	0	101	155	436	\$2.81	1.5	233	n.a.
	<i>Penaeus</i> spp	131	792	1,109	7,235	0	0	0	\$0.00	1.5	0	n.a.
	Total Crustaceans	131	792	1,109	7,235	101	155	436	\$2.81		233	1.7
Diadromous fish	<i>Anguilla</i> spp	12	7	1	4	3	11	40	\$3.64	1.2	13	-0.9
	Total Diadromous fish	12	7	1	4	3	11	40	\$3.64		13	-0.9
Total Egypt	Freshwater fishes	473,459	759,116	850,052	972,188	1,149,457	1,239,182	1,073,873	\$0.87		1,677,870	10.1
	Marine fishes	220,213	159,670	166,576	157,664	221,099	322,109	395,120	\$1.23		219,870	3.9
	Crustaceans	131	792	1,109	7,235	101	155	436	\$2.81		233	1.7
	Diadromous fishes	12	7	1	4	3	11	40	\$3.64		13	-0.9
	Total Egypt	693,815	919,585	1,017,738	1,137,091	1,370,660	1,561,457	1,469,470	\$0.94			1,897,986

Source: FAO 2020. Updated 8-6-2020

9.3. Annex 3 – Available ingredients for aquafeed production in Egypt

Ingredient	Currently used In aquafeeds	Source
Wheat	No	Local
White maize	Yes	Local
Yellow maize	Yes	Local
Sorghum	No	Local
Barley	No	Local
Kidney bean	No	Local
Soybean meal	Yes	Local and imported
Cotton seed meal	Yes	Local
Sesame seed	No	Local
Lentil seed cake	No	Local
Broken rice	No	Local
Rice bran	Yes	Local
Distiller dried grain soluble (DDGS)	Yes	Imported
Flaxseed (linseed)	Yes	Local
Wheat bran	Yes	Local
Maize gluten	Yes	Imported
Beet pulp	No	Local
Sugar cane bagasse	No	Local
Sugar cane pulp	No	local
Sunflower seed meal	No	Local
Groundnut cake	Yes	Local
Blood meal	No	Local
Fishmeal (local)	Yes	Local
Fishmeal (imported)	Yes	Imported
Meat and bone meal	Yes	Imported
Poultry by-product meal	Yes	Imported
Shrimp meal	Yes	Local
Feather meal	Yes	Imported

Source: author's field survey 2017.

Table 30. Available ingredients (both plant and animal origin) for aquafeed production in Egypt. (Opeyemi Agboola, 2019)

9.4. Annex 4 - Bibliography

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Poultry sector calculations

Annual broiler production in Egypt

2021 PRESENT	No. birds Egypt	Avg. Weight	Slaughter houses rendering	No. birds	Total live weight broilers
	mln.	kg	% of total	mln	ktons
Integrated/slaughter houses (hybrid broilers)	1.400	1,9	20	280	532
Poultry vendors/wet market (hybrid broilers)		1,9	80	1120	2.128
Local Breed Broilers	350	1,35	0	350	473
Total/Average			80	1.750	3.133
FUTURE	mln.	kg	% of total	mln	ktons
All poultry centrally slaughtered	1.750		100	1.750	3.133

* At slaughter of broilers in average 25% of the weight is waste/by-products

*** Tilapia feed in average contains 30% protein

Wet by-product (25% dress out)*	Dry PBM (30% Dry matter in waste)**	Sales value per ton estimate	Market value	Tilapia feed mrkt	Tilapia feed mrkt protein***	PBM (65%) share protein tilapia feed****
ktons	ktons	US\$	mln €	ktons	ktons	%
133	39,9	450	18	1.500	450,0	5,76
532	159,6	350	56	1.500	450,0	23,05
118	35,4	350	12	1.500	450,0	5,12
783	235	367	86	1.500	450	34
ktons	ktons	US\$	mln €	ktons	ktons	%
783	235	500	117	1.500	450	34

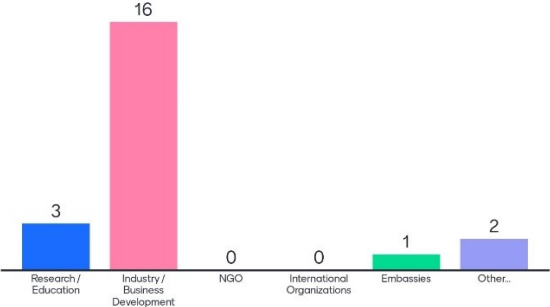
** Poultry waste contains in average 70% water and 30% matter

**** Poultry by-products average protein level is assumed 65%

MOM

Date:	APR 01, 2021
Conference:	Circular Proteins for Fish feed in Egypt. “Opportunities for Co-operation, Trade and Investment “
	LNV Event – 2 (NL-Masr Agri-food Network)
Location:	Cairo Marriott hotel

Agenda		Time
Registration & Welcome drinks		13:30-14:00
Opening Word	Mr. Omar Abdellatif (moderator of the event) Ms. Gertrude Wagemans (online moderator)	14:00-14:05
Presentation	Mr. Hans Boon – Overview on Circular Protein Study & main results	14:05-14:25
Q/A		14:25-14:35
Pitch:	Insects as feed for a circular agriculture, <i>The innovative opportunity</i> Proteinea	14:35-14:50
Panel discussion	Dr. Melle Leenstra - Agricultural Counsellor Egypt & Jordan, Netherlands Embassy	14:50-15:20
	Mr. Ahmed Salam Sharkia Poultry Company	
	Mr. Ayman Rostom, General Manager of Skretting	
	Dr. Somaya Egyptian Ministry of Agriculture, General authority of fisheries	
Presentation	Wouter De Heij, Owner of Food4Innovations, CEO of TOP BV and board member of GMV	
	Q/A	15:20-15:50
Conclusion	Dr. Melle Leenstra , Agricultural Counsellor Egypt & Jordan, Netherlands Embassy	15:50-16:00
	Networking Lunch	16:00-16:30

Point	Remarks														
<p>1. Mrs. Gertrude Wagemans introduced Mentimeter and asked:</p> <p>a. The background of the attendance. Most of the online attendances is attending from industry and business development</p> <p style="text-align: center;">In which sector do you currently work?</p>  <table border="1" data-bbox="435 556 982 861"> <thead> <tr> <th>Sector</th> <th>Count</th> </tr> </thead> <tbody> <tr> <td>Research/Education</td> <td>3</td> </tr> <tr> <td>Industry/Business Development</td> <td>16</td> </tr> <tr> <td>NGO</td> <td>0</td> </tr> <tr> <td>International Organizations</td> <td>0</td> </tr> <tr> <td>Embassies</td> <td>1</td> </tr> <tr> <td>Other..</td> <td>2</td> </tr> </tbody> </table> <p>b. Second poll “why are you interested to know more about circular protein”? Which resulted in the following response:</p> <ul style="list-style-type: none"> → New business opportunity → Sustainability → Add value. → Support partnership between NL and Egypt → It's a new topic that will affect our food → To be updated about the developments in possible protein sources → I am interested to learn and know more information about protein for feed because I work assistant researcher, quality food safety, and quality control job in the regional center for food & feed. → Alternative protein sources to fish meal, sustainability, adding value. → Learning experience, as I'm in a startup in Lebanon also dealing with BSF → We are working in insects breeding and the applications (food - fertilizers - proteins) → Our company works in insect protein production -EGYMAG Circulating the protein <p>2. Dr. Melle started his introduction:</p> <ul style="list-style-type: none"> → This second hybrid conference of the NL major Agri-Food Network. This is a series of events that are meant to exchange knowledge between Egyptian, Dutch, and international Agri-food experts to look at opportunities to Co-create solutions. → Egypt is the largest consumer market in the Middle East and North Africa, it faces the challenge of providing a growing population with access to healthy and sustainable diets, in the context of climate change and water scarcity. → White protein (meat) such as fish and poultry have a great opportunity to be part of such healthy sustainable diets as they have a lower environmental footprint and are healthier for our bodies, than red meats. → Cairo has a larger population than the entire country of the Netherlands. → We are for a long time one of the largest exporters of agri-food products, and that has everything to do with entrepreneurship and innovation. 	Sector	Count	Research/Education	3	Industry/Business Development	16	NGO	0	International Organizations	0	Embassies	1	Other..	2	<p>About 70 persons registered, 35 persons attended online and 25 attended live.</p>
Sector	Count														
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International Organizations	0														
Embassies	1														
Other..	2														

- As a group of entrepreneurs talking about an innovative topic, we realized that our old way of increasing productivity at the lowest possible cost comes with an environmental footprint. We realize that this has negative consequences, biodiversity, climate change and the NL Minister of Agriculture Carola Schouten has formulated a vision on circular agriculture.
- As an agricultural team, we are very proud of the Dutch Agri-food investors in Egypt. An example is Skretting, part of the Nutreco group. Another example is Koudijs Kapo, part of the Royal De Heus Group. These are animal feed companies that have moved from trade to investment and are producing animal feed here in Egypt.
- Now when we, as an agricultural team, decided to look at what opportunities there are to apply this concept of circular agriculture to the Egyptian circumstances, we looked at the circularity opportunities of companies like Skretting and De Heus. We started thinking about what could be done in terms of circular proteins to provide opportunities as an alternative to the Soy imported into Egypt for fish feeds.
- Soy and fish meal that has a consequence for overfishing and deforestation elsewhere in the world, and finding alternatives to these is good for the Egyptian foreign reserves. More money can be generated locally, and less money must be spent on exports.
- Two experts, Hans Boon, and Kees van Dongen were invited and looked at what opportunities there are, what could it mean for business. What investable opportunities could lead to? When it comes to climate-smart and sustainable business, money is not a problem, there are a lot of agricultural banks or International Development banks. Climate funds that have money that they would love to invest in sustainable and inclusive Agribusiness, the big challenge is finding those business cases that respond to those opportunities.
- Hopefully to have a conversation to bring the Netherlands in Egypt together to develop business cases that could provide jobs, provide climate-smart solutions, and can provide investment opportunities.

3. Hans Boon presented the main findings of the opportunity study on circular proteins for Aquafeed in Egypt.

Questions asked after the presentation:

Dr. Somaya asked about the ingredients? Could it replace fish meal?

- Yes, basically how a feed formulator looks at the insect meal is as a nutrient source and as such provides protein and amino acids.
- The good thing about insect meal is that the protein content is high.
- It has a good amino acid profile which could compete with fishmeal indeed.
- Insect protein could replace soybean meal or other protein rich ingredients.

Dr. Somaya asked about the level of Amino Acid content of insect proteins?

- It depends on which insect is used for production. In the case of the black soldier fly meal, it is about 60 - 70% depends on how much of the oil is extracted.
- As insect larvae have quite a high amount of oil, you may choose either to take out the oil and just use the oil and protein meal separately or use whole dried insect larvae.

Question from Proteinea, what is the legal status of insect farming in Egypt?

- For insect farming, there is not a licensing system at this moment in Egypt which is a problem when producing feed ingredients.
- There is not a legal framework present in Egypt today and that needs to be addressed as soon as possible because foreign investors will not be eager to invest in this industry in Egypt as long as there is no legal status.

Question from “Ahmed Hamed- online” After feeding the black soldier fly with manure, can we then feed the larvae to the chicken again?

- There are some very simple principles in general that we use as nutritionists: what you feed to the animal that you are growing, it kind of resembles what it was fed on. So, if you feed manure to insects, they can be used as ingredients for feed after cleaning however in this case, the nutritional profile may not be as ideal as when you feed the insects other substrates.
- Insects produce a lot of fats and fatty acid that is present in the insect will reflect the fatty acid profile that is present in the manure which is fed to the insect.
- In principle, it can be done but has some limitations.

Question from “Dr. Sabry Gamal online” what the nutritional classification of the insect meal?

- It depends on how you process it; some producers decide to just dry the insect larvae and sell it. In that case the insect meal contains roughly 50 - 60% protein, 20 -30% fat, and some ash and moisture.
- And if you process and separate meal and oil, the protein content will be higher but fat lower.

Question from “Ahmed Yam Company- online” Is insect protein going to be cheaper than a fish meal in the future? And how is the price of the extracted substances from the insects compared to other proteins?

- Again, linked to insect species and the nutritional quality and value of the extracted substances from insects depends on the kind and quality of the substrate.
- The mainstream insect producers have a selling price on their product, which is roughly double the price of the fish meal today.
- We must realize that fishmeal prices in the long-term trend are increasing and on the other hand the production cost of insect proteins could go down gradually when scale of production is increasing and especially if you can use organic waste to feed the insects.

4. Proteinea, presentation:

- We do not define ourselves as an insect feed company. We define ourselves as an insect technology company.
- We are using the insect as a companion for a sustainable future, we use the insect to produce everything from pharmaceuticals all the way to the feed, and everything in between.
- We are insect-based biotechnology platform and use insects at the core.
- The global population growth is a challenging problem that will lead to a protein demand gap of 60 million tons. There is currently not a reliable solution and insects might be one of the solutions.
- The case of insect protein is very interesting, because the conversion efficiency, land use and water usage is exciting. Producing 1 kg of Protein from cows needs 30,000 liters of water vs. 15 liters of water to produce 1 kg of insect protein.
- Proteinea is using high technology like IoT, machine learning and robotics to derive the cost lower and to control critical processes in the production.
- BSF is used because it is the most unique organism which can grow 1 million % in 12 days. The BSF is FDA approved, which means it's not a pest and therefore there is no risk.
- The market in Egypt is not ready for that yet. However globally there is a big demand gap: There is 20,000 ton production and a demand of 500,000 ton, at the high level prices.
- Globally, in 2020 more than USD 400 million was invested in insect protein farming sector.
- The farm and processing at a professional level will be in a factory style.
- The products can be divided into 3 categories: Insect oil, insect protein, bio fertilizer (by-

product).

- Due to the sustainability perspective, currently big players are entering into this space for petfood and fish feed, i.e., Mars is opening a large factory to produce insect based petfood and Nestle is sourcing large quantities of insect proteins, which is creating a large supply demand gap.

5. Panel Discussion

Dr. Somaya mentioned:

- There is not sufficient analysis yet for protein content and amino acids in insect proteins.
- We need more information about this product.
- In order to make a fish feed, amino acid must be balanced, it must be stable for all insects to be use.
- Government is supporting the idea, to be supported by research from all aspects (health, culture, and most important results).

It should be noted that the nutrient composition (analysis) of the different kind of commonly commercially farmed insect (larvae) are quite well documented by scientific publications. However like with all feed ingredient there are variations between the different origin and suppliers depending of the specific growing conditions, processing conditions, etc. For example if we look at soybeans in the market we find full fat soybeans (not fat extracted), soybean meal with protein levels varying from 42 – 49% protein and soybean oil.

What do you think from the private sector? What has been mentioned about this new idea, actually?

Dr. Ayman Rostom:

- It's pretty good opportunity that we are looking again for the by-products.
- The main production in Egypt is about tilapia.
- We are importing and depend mainly on soymeal as a source of protein.
- With a relatively small investment we can be able to utilize the by-products better.
- Tilapia does not need high protein levels in the feed except in the early stage.
- For marine and shrimp, it will be a good alternative for us.
- We need to maximize the products locally in Egypt at least to provide sustainable solutions for the farmer, feed producer and consumer it's our duty to find the right solution.

Cultures and private sector have an important role to help to move towards adopting the circular proteins idea. Do you think there's opportunities for this?

Dr. Melle Leenstra:

- I think there are great opportunities, but there's also a lot of learning for us to do.
- Our companies are learning, they are slightly ahead of the curve, but there are also challenges because of the regulatory environment in in the Netherlands.
- In poultry and rendering, our companies are very efficient, and Egypt could have something to learn from that.
- There are business cases that can be found for investment to increase the efficiency.
- The Netherlands became an agricultural economy not because the government engaged in business but because the private sector was supported to engage in business.
- The government provided investment in knowledge, training, and research. And that allowed the private sector to move on and to be innovative and entrepreneurial.

How do you see opportunities to improve the poultry by-products?

Mr. Ahmed Salam:

- Poultry sector in Egypt is large.
- We currently source waste from our farms, slaughterhouse, and traders.
- Most of poultry consumption in Egypt is through live poultry vendors. The biggest opportunity in this industry is centralizing, when centralizing you can control what is exactly being put in the processing, improve traceability and quality.

6. Audience remarks and discussion:

- The government must educate people in how to collect poultry wastes.
- There are a lot of misconceptions currently in the market and a lot of people are afraid to consume from slaughterhouses and would rather go to live poultry vendors. but they do not understand that the poultry supplied to the live poultry vendors is from the same companies.
- Many people who are the local traders who collect the poultry waste. But the challenge is quality, and the safety barrier to ensure there is no salmonella.
- Centralized centers can help to structure poultry waste very well to avoid any kind of unexpected problems.
- A trial or demonstration project is needed (for the government), as a proof for the safety of using insect protein as a fish feed.
- Today insect protein research and protein farming is very expensive, but the economic improvement will show in the future.
- Is there any concrete business case for circular proteins in Egypt? And how can we make it more concrete as a business case for investors and other companies who want to move into the sector?

Poultry rendering is already well established in Egypt and is a clear example of circular protein production in Egypt. The conclusion of the project has been that there is a big scope for improving quality and volumes.

Doing more rendering of poultry by-products through investing, because at the moment poultry producers focusing on getting the meat to the customer, but they're not paying enough attention for the value of the by-products.

There is indeed a huge extra earning potential.

- Sharkia Poultry: In giving the extra attention to the waste, it's about resource efficiency.
- Great opportunities in the Netherlands, rendering is large business with some cooperation it could be a very successful business in Egypt.
- Now we have a line for pet food (dog food line), using insects in Egypt.
- We are inviting companies in the Netherlands that have expertise in poultry, poultry processing and rendering to look at opportunities in Egypt. create partnerships to invest in Egypt.
- Efficiency would be the key in this.
- The consumers are not educated about slaughterhouses properly and have a lot of misconceptions.
- Dr. Ayman mentioned that we do not have to wait for the government to create the regulation, as a private sector we need to start looking for the path, to be followed and present it to the authorities.
- We can unlock opportunities by working together, government needs to be convinced with research with facts and figures.
- Private sector is doing its own research, and they're also interested in partnerships.
- We can and will convince government that things are safe to make sure that the Egyptian consumer is protected.
- There's a great opportunity in getting more efficiency in poultry.
- In the wet markets people will lose opportunities if it becomes more efficient. But it's very

important to see what comes in the place of that.

- We can use these opportunities to take it one step further so that Egypt can profit and if the Netherlands can provide knowledge and expertise.
- We need to work in the culture, to understand the insect protein.
- The role of the Media is to make people understand, to adopt with the new culture.

7. Online Questions

- Does insect meal have any effects in the taste of fish after cooked? "Ahmed Bondok Ain Sham University"
Generally feed doesn't have a big impact on the taste of final (fish) product. The fat fraction in the diet has the biggest impact on taste if any.
- Do you expect insect meal to be cheaper? "Mohamed Hosny- online questions"
All expectation indicate a slow but steady decrease of the cost of insect meal due to scale up and technology development. It will also depend to the extent that for example food waste will be approved as feed for the insect larvae.
- What is the type of insects that increase the protein content in the feed without causing aflatoxin to the animal and then to the human, and do these insects increase the protein content of poultry feed in the same proportion as fish feed? "Rasha Bondok- online questions"
Aflatoxin is a kind of mycotoxin (there are many different ones) that is produced due to humid storage or pre-harvest conditions of raw materials (or feed). It is mostly found in cereals and unlikely to occur in insect production. Feeding heavily contaminated cereals to insects must be avoided. The feed formulation principles in poultry and fish feeds are comparable. The feed formulator/nutritionist will set the desired minimum level of (in this case) protein. The inclusion rates of the different ingredients in the feed formula will then determine the final protein level in the diet. Insect meal my help to reach a higher protein level in the diet.
- Egypt is moving towards organic production system would insect use in fisheries help to produce fish organically and how difficult is it in terms of certification? "Ali Elhakeem - online questions"
Organic certification schemes may adopt insect as an admitted ingredient for organic fish feed production but to the author's knowledge there is no such approval in place yet.
- Why there is not any standard for insect protein in Egypt, because at the moment it's not well known and not all experiments are completed, but with the cooperation of knowledge it will be much easier to understand and introduced to the Egyptian culture. "Ibrahim Hammad - online questions"
The answer to this question is answered in the main report.
- Feather meal will be much better digestible if we hydrolyze it separately from other wet products before rendering. "Hans Boon – online"
- Given the mentality of fish farmers in Egypt they are very meticulous about raw materials used in fish feed how will Proteinea support the industry in fish farmers accepting insect meal as an alternative protein, it will be hard for them to accept it even if it's more economic. "Yasmine Kamar – online"
In other parts of the world fish farmers are adopting the use of insect meal in their diets so it is unlikely that Egyptian farmers will be different in the long term. It is questionable if
- Does insect meal have any effect on the palatability of feed and attractiveness to fish?
"Kareem Ahmed – online"
→ *This hasn't been studied extensively yet but the early signs are positive.*
- Do we have insect's meal examples in Companies in other countries too in Europe?
"Riham Abdel Bary (Second Secretary European Dep of Ministry of foreign affairs) – online"
There are insect farms in several countries in Europe. In the Netherlands Protix is the most known company.

8. Dr. Melle, closing words:

- The Dutch like to think out of the box, think in the box and move the box forward.
- There are many alternative options for circular proteins for that we have to be looking at.
- Approaching Egypt was good opportunity but now I think we need to focus more about culture in order to introduce insect protein.
- We have to think about the future, we have to think about the culture, we have to think about the culture in the future, let us look for opportunities to work together and let us try to find and create demonstration projects, feasibility studies and partnerships to make the food "future proof".
- Dr. Melle is very excited of what he heard today, we can move forward as your partner to bringing the word together to find the solutions for your sustainable future and looking forward to more Netherlands Agriculture Food network.

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