

2019:00362- Unrestricted

# Report

## Summary of Workshop and project meetings in Mumbai, 27-30 Nov 2018

Projects: ReFood and ReValue

Kristina N. Widell, Guro M. Tveit, Maitri Thakur, Marit Aursand  
SINTEF Ocean



# Report

## Summary of Workshop and project meetings in Mumbai, 27-30 Nov 2018

Projects: ReFood and ReValue

**KEYWORDS:**  
Surimi, food processing,  
food loss and waste,  
cold chain,

<b>VERSION</b> 3	<b>DATE</b> 2019-03-22
<b>AUTHOR(S)</b> Kristina N. Widell Guro M. Tveit, Maitri Thakur, Marit Aursand	
<b>CLIENT(S)</b> Research Council of Norway	<b>CLIENT'S REF.</b> 261709, 281262
<b>PROJECT NO.</b> 302002523, 302002535	<b>NUMBER OF PAGES/APPENDICES:</b> 22

### ABSTRACT

#### Workshop in Mumbai 27-30 Nov 2018

This report is a summary of meetings, activities and ideas from the 2018 combined RE-food symposium and ReValue open-day conducted in Mumbai November 2018. The annual meeting is organized to disseminate research, innovation and education results achieved by the RE-food and ReValue projects, as well as to serve as an opportunity to create new contacts to strengthen the cooperation on bio-economy between Norway and India.

The symposium had 43 participants from Norway and from India, and the participants included researchers and students, industry participants and representatives from Innovation Norway and Research Council of Norway (New Delhi office).

<b>PREPARED BY</b> Kristina N. Widell	<b>SIGNATURE</b>		
<b>CHECKED BY</b> Ana Carina Carvajal	<b>SIGNATURE</b>		
<b>APPROVED BY</b> Maitri Thakur	<b>SIGNATURE</b>		
<b>REPORT NO.</b> 2019:00362	<b>ISBN</b> 978-82-14-06833-7	<b>CLASSIFICATION</b> Unrestricted	<b>CLASSIFICATION THIS PAGE</b> Unrestricted

# Document history

---

<b>VERSION</b>	<b>DATE</b>	<b>VERSION DESCRIPTION</b>
1	2019-02-28	Version sent to project participants.
2	2019-03-20	Version sent to workshop participants.
3	2019-03-25	Final version

---

# Table of contents

<b>1</b>	<b>Background</b> .....	<b>4</b>
<b>2</b>	<b>About the projects</b> .....	<b>5</b>
2.1	ReFood .....	5
2.2	ReValue .....	5
2.3	Yearly symposium/ Open day/ Workshop .....	5
<b>3</b>	<b>ReValue meeting (27<sup>th</sup>, Nov)</b> .....	<b>6</b>
3.1	Agenda ReValue meeting (Nov 27) .....	6
<b>4</b>	<b>Industry visit to Kaiko surimi processing plant (28<sup>th</sup> Nov)</b> .....	<b>7</b>
<b>5</b>	<b>RE-food symposium and ReValue open day (29<sup>th</sup>, Nov)</b> .....	<b>8</b>
5.1	Agenda symposium .....	8
5.2	Workshop participants.....	9
5.3	Presentations .....	10
5.4	Group discussions .....	11
5.5	Summary of group discussions .....	13
5.5.1	Rest raw materials .....	13
5.5.2	Resource utilization .....	15
5.5.3	Energy efficiency.....	16
5.5.4	Increase collaboration .....	16
5.5.5	Financing.....	18
5.5.6	Extracting protein from wash water.....	18
5.5.7	Reducing food loss and waste .....	18
5.5.8	Other topics .....	18
<b>6</b>	<b>RE-food meeting (30<sup>th</sup>, Nov)</b> .....	<b>19</b>
6.1	Agenda ReFood meeting (Nov 30) .....	19
<b>7</b>	<b>New project ideas and project proposals</b> .....	<b>20</b>
7.1	Project proposal on nanotechnology.....	20
7.2	Clusters within surimi or fish processing .....	20
7.3	Biosensors .....	21
7.4	Additional ideas and applications for further collaboration.....	21
<b>8</b>	<b>Conclusions</b> .....	<b>22</b>

## 1 Background

Globally, 1.3 billion tonnes of food are lost every year<sup>1</sup>. Within EU, the food and drink value chain alone cause 17 % of direct greenhouse gas emissions and utilizes 28 % of material resources within EU<sup>2</sup>. By 2020, the EU aims to spread the incentives to more sustainable food production and consumption and to have driven a 20 % reduction in the food chain's resource inputs. In Norway, the authorities have recently expressed their concern regarding food loss challenges in the value chains and have urged for a closer collaboration of different food sectors so that they facilitate a sustainable value chain and solve the complex challenges regarding food loss<sup>3</sup>. Food loss refers to the food resources that go unutilized during the production, handling and processing stages while waste refers to the food thrown away by the consumers. While majority of food waste occurs at the consumption stage in Europe, in India most of the loss occurs at the post-harvest stage due to improper handling and cold chain management. There is an urgent need to provide food for the growing world population while at the same time tackling the problem of food loss at a global scale.

India is a major producer and exporter of food products (ranking 6th in the world in 2013), and food processing is recognised as a priority sector in their new manufacturing policy<sup>4</sup>. The food processing industry generates a variety of by-products (referred to in this proposal as Rest Raw Materials – RRM) from the seafood, meat and fruits and vegetables processing that go unutilized.

India, with a coastline of 8118 km and about 7 million hectares of inland water bodies produces nearly 10 million tonnes of fish annually and is a major supplier of fish to the world. Fish offers one of the fastest ways to address malnutrition and food security in the world<sup>5</sup>. In addition, a lot of RRM are generated from fish industry and there is a huge potential for their utilization into value added products. India is also a major exporter of fruits and vegetables to Europe and vegetables and fruits loss in India ranges from 15% for potatoes to up to 50% for citrus fruits<sup>6</sup>. The total food loss in India amounts to over 26 billion Euros annually, as about 30 percent of all food produced is spoiled after harvesting due to lack of cold chain management and proper food processing units<sup>7</sup>. There is an opportunity to further process the RRM and convert them into value added and marketable products for food, feed, or other purposes. In addition, the need for climate friendly refrigeration technology, especially for highly perishable food products like fish, fruits and vegetables, needs further development. India is in a position to provide ingredients for food and feed to the world. The choice of international partners is related to the global challenges to bioeconomy and food security, and Re-FOOD will develop a new Indo-Norwegian partnership for excellence in research to address these challenges in an environmentally friendly manner.

SINTEF Ocean (before Fisheries and Aquaculture) has had a focus on India as an international strategic partner in the area of Bioeconomy since 2014 and has worked to establish a partnership with top institutions in this area. The Re-FOOD project has further strengthened this partnership to focus on the challenges to global Bioeconomy.

---

<sup>1</sup> FAO 2011 Global Food Losses and Food Waste

<sup>2</sup> Brussels, 20.9.2011Com (2011) Roadmap to a Resource Efficient Europe

<sup>3</sup> St.meld. nr. 30 (2008-2009): Klima for forskning, Oslo, Kunnskapsdepartementet.

<sup>4</sup> Make in India program, <http://www.makeinindia.com/sector/food-processing>

<sup>5</sup> The Global Alliance for Improved Nutrition, <http://www.gainhealth.org/>

<sup>6</sup> Neetu Jakhar, Shalini G. Rudra, , Jyoti Nishad, Kanika Walia, Charanjit Kaur (2015) Waste Utilization from Fruits and Vegetables Industry, Proceedings Biotechnology for food and Fuel, TERI Press

<sup>7</sup> Dhakal et al. 2014. Effect of Inadequate Processing and Cold Storage Unit on the Horticultural Crops of India, Conference Paper – 48th Annual Convention of Indian Society of Agricultural Engineers

## 2 About the projects

### 2.1 ReFood

RE-food is a three-year (2017-2019) interdisciplinary project focusing on developing a partnership between Norway and India to contribute towards strengthening of the global bio-economy by improving the food resource utilization in an energy efficient and climate friendly way. The project is funded by Research Council of Norway's INTPART program that supports international partnership projects for excellent education, research and innovation.

The project is coordinated by SINTEF Ocean (Norway) and includes Norwegian University of Science and Technology. The international partners include CSIR-Central Food Technological Research Institute, Indian Institute of Technology Kharagpur, Amity University and BITS Pilani from India. All partners are active contributors to excellent re-search, innovation and education activities, are involved in collaborative projects and provide high calibre graduates and researchers.

### 2.2 ReValue

ReValue will contribute to achieving the SDG target on food losses reduction, by developing innovative technologies for Surimi industry, namely reducing losses by improved cold chain management and efficient conversion of RRM and wash water into value added protein and oil ingredients for food and feed applications.

#### Objectives:

1. To propose concepts for efficient supply chain logistics, cold chain management and climate friendly refrigeration technologies for optimal handling and storage of the fish resources and RRM in order to maintain their quality (WP1).
2. To increase the efficiency, profitability and environmental sustainability of the European and Indian marine processing industry by valorization of Surimi processing RRM and waste water into high added value protein and lipid ingredients (WP2)
3. To evaluate the functionality of derived protein and oil ingredients as food and feed components (WP3)
4. To build a basis for joint market exploitation for Europe and India for safe and nutritional ingredients for food and feed applications (WP4)
5. To establish a sustainable partnership between ReValue partners and other relevant stakeholders from Europe and India working in the field of Bioeconomy (WP4, WP5)

### 2.3 Yearly symposium/ Open day/ Workshop

Both the RE-food and ReValue projects include activities to arrange annual symposiums/open-day/workshops. These annual meetings are organized to disseminate the research, innovation and education results achieved by the projects, as well as to serve as an opportunity to create new contacts to strengthen the cooperation on bio-economy.

In RE-food the first symposium in 2018 focused on Sustainable technologies for food processing and preservation including advances in rest raw material utilization, cold chain management, energy efficiency, and robotics in food handling. The symposium was divided into 4 sessions:

- Utilization of bio-based rest raw materials
- Energy efficiency in food handling and processing
- Robotics and automations in food industry
- Industrial challenges

The symposium had 43 participants, both from Norway and from India. The participants included researchers and students, industry participants and representatives from Innovation Norway and Research Council of Norway (New Delhi office).

ReValue arranges annual open-days in the three partner countries Norway, India and Spain. The project started in 2019, and the first open-day was thus arranges in India, Mumbai.

### 3 ReValue meeting (27<sup>th</sup>, Nov)

A meeting between all research partners in project was held at the Norwegian General Consulate in Mumbai, which was located only a 5 min walk from the hotel. Project partners from Spain also joined the meeting through Skype and we had several good discussions regarding results and ongoing research in the ReValue project.



*Figure 1. Research partners in ReValue attending the yearly meeting in Mumbai.*

#### 3.1 Agenda ReValue meeting (Nov 27)

- Introduction (Guro)
- Presentations of project participants (Guro)

- Work packages Status (20 min each, WP leaders)
  - WP1 (Souvik)
  - WP2 (Rasa)
  - WP3 (Nutan)
  - WP4 (Carinsa/Leitat)
  - WP5 (Guro)
- Group discussion – planning of further project activities
- Summary planned activities (WP leaders)
- Closure (Kristina)

## 4 Industry visit to Kaiko surimi processing plant (28<sup>th</sup> Nov)

There are 7-8 surimi plants in India, and Kaiko surimi is one of the smaller ones. On Wednesday the 28<sup>th</sup> of November Kaiko surimi welcomed the interested workshop participants to visit their plant in Mumbai. About 40 participants joined for the industry visit. The visit included a tour of the facilities and gave the researchers and industry partners a very interesting view into the Indian Surimi industry.

At the facility fresh fish is washed, mechanically deboned and meat mince is separated which is subjected to four washing steps before being added to cryoprotectants and packed. The process parameters depend on raw material quality and final product requirement. Currently the rest raw material produced from surimi manufacturing are either sold to fish meal industry or discarded.



Figure 2. All the happy participants joining the visit to Kaiko Surimi.





Figure 3. Interesting visit inside the Surimi factory.

## 5 RE-food symposium and ReValue open day (29<sup>th</sup>, Nov)

### 5.1 Agenda symposium

#### Thursday Nov. 29

#### ReFood symposium and ReValue open day at Hotel Trident Bandra Kurla

**09:00** Introduction (Marit Aursand, SINTEF Ocean)

09:30 SINTEF research on processing of fish and marine rest raw materials (Inger Beate Standal, Jannicke Remme, SINTEF Ocean)

09:50 Results from ReValue (Nutan Kaushik, Amity University)

10:05 Results from ReValue (BITS Pilani)

10:20 Poultry industry (Ashwin Joshi, Srinivasa Farms)

10:30 Non-thermal processing techniques as potential tools for improved quality products in food industry (P. Srinivasa Rao, IIT Kharagpur)

10:40 Bioeconomy in the food technology education and involvement of external actors of the food value chain (Eva Falch, NTNU)

**10:50** Coffee break

11:10 Discussions in groups: Improving the fish processing industry

**12:30** Lunch

13:15 Q&A about surimi industry (Asif Naik, Kaiko surimi)

13:30 Central institute of fisheries technology (Annamalai Jeyakumari, CIFT)

13:50 Reducing food waste throughout the value chain by the use of technology (Charlotte Aschim, TotalCtrl)

14:00 Concept of CO<sub>2</sub> container storage (Ashish Kadam, Johnson Controls India)

14:10 Get RID of your conveyors, Using the RID pump as a conveyor (Jan Petter Urke, MMC First Process)

14:20 India Gelatine (Naresh Nanda, India Gelatine)

14:30 Extending Surimi value chain converting lost washwater to high value nutrition (Ebbe Torp, Due Miljø)

14:40 Kahoot quiz

**14:50** Coffee break

- 15:10 Upcoming funding opportunities for Indo-Norwegian R&I collaboration (Inger Midtkandal, Innovation Norway)
- 15:20 Discussions: Further collaboration, new projects, student internship etc
- 16:20 Group discussions: Summary
- 17:10 Summary and closure (Marit, Kristina, Guro, SINTEF Ocean)
- 17:30** End of workshop

## 5.2 Workshop participants

Last Name	First Name	Company
Aakre	Sara	NTNU
Annamalai	Jeyakumari	ICAR-CIFT
Aschim	Charlotte	TotalCtrl
Aursand	Marit	SINTEF Manufacturing
Bhattacharyya	Souvik	BITS Pilani
Brustad	Kristin	NTNU
Dasgupta	Manisankar	BITS Pilani
Eikevik	Trygve M.	NTNU
Falch	Eva	NTNU
Greiff	Kirsti	SINTEF Ocean
Gupta	Khushboo	Amity University
Hjellnes	Veronica	NTNU
Jadhav	Chhaya	Matsyagar innovative
Joshi	Ashwin	Srinivasa Farms
Kadam	Dr. Ashish	Johnson Control India
Kaushik	Nutan	Amity University
Kumari	Asha	Amity University
Larsen	Frida Holm	NTNU
Marak	Sengnolotha	Amity University
Midtkandal	Inger	Innovation Norway
Mozuraityte	Revilija	SINTEF Ocean
Naik	Asif	Kaiko surimi
Nanda	Naresh	India Gelatine & Chemicals
Nandanwar	Akash	TotalCtrl
Patodia	Parikshi	Ati Infraprojects

Pungaonkar	Pramod	VIJAYAC
Ramgopal	Maddali	IIT Kharagpur
Remme	Jannicke	SINTEF Ocean
Routroy	Srikanta	BITS Pilani
Saini	Santosh Kumar	BITS Pilani
Singh	Sandeep Kumar	IIT Kharagpur
Slizyte	Rasa	SINTEF Ocean
Srinivasa Rao	Pavuluri	IIT Kharagpur
Standal	Inger	SINTEF Ocean
Sultan	F Abdullah	BITS Pilani
Thakur	Maitri	SINTEF Ocean
Tolstorebrov	Ignat	NTNU
Torp	Ebbe	Due Miljø AS
Tryti	Helge	Innovation Norway
Tveit	Guro Møen	SINTEF Ocean
Urke	Jan Petter	MMC First Process As
Wale	Avadhoot	Johnson Control India
Widell	Kristina N.	SINTEF Ocean

### 5.3 Presentations

On the 29<sup>th</sup> of November the Indo-Norwegian projects #ReValue and #Re-FOOD arranged a annual symposium in Mumbai to foster new relations and opportunities. The annual symposium was used to disseminate research, innovation and education by the projects as well as an opportunity to create new contacts and ideas and to strengthen the cooperation on bio-economy between Norway and India.

Below you will find the programme and a link to the event page where all the presentations that were made during the joint symposium in the projects Re-FOOD and ReValue are made available.

<https://www.sintef.no/arrangementer/re-food-and-revalue-symposium/>

Name	Company	Presentation
Marit Aursand	SINTEF Ocean	Introduction
Inger Beate Standal	SINTEF Ocean	SINTEF research on processing of fish and marine rest raw materials
Jannicke Remme	SINTEF Ocean	SINTEF research on processing of fish and marine rest raw materials
Nutan Kaushik	Amity	Results from ReValue

Souvik, Srikanta, Dasgupta	BITS Bilani	Results from ReValue
Ashwin Joshi	Srinivasa Farms	Poultry industry
P. Srinivasa Rao	IIT Kharagpur	Non-thermal processing techniques as potential tools for improved quality products in food industry
Eva Falch	NTNU	Bioeconomy in the food technology education -
Annamalai Jeyakumari	Central institute of fisheries technology	Central institute of fisheries technology
Charlotte Aschim	TotalCtrl	Reducing food waste throughout the value chain by the use of technology
Ashish Kadam	Johnson Controls India	Concept of CO <sub>2</sub> container storage
Jan Petter Urke	MMC First Process	Get RID of your conveyors, Using the RID pump as a conveyor
Naresh Nanda	India Gelatine	India Gelatine
Ebbe Torp	Due Miljø	Extending Surimi value chain converting lost washwater to high value nutrition
Inger Midtkandal	Innovation Norway	Upcoming funding opportunities for Indo-Norwegian R&I collaboration

## 5.4 Group discussions

To get a break from all the presentations and get an opportunity to process all the information made available the participants at the workshop were divided into six discussion groups (see Table 1). The first person in each group was the group leader, taking notes during the discussion and presenting a summary towards the end of the workshop.

All groups had the same questions and topics for discussion:

- Within fish processing industry: Is resource utilization sufficient?
- Can it be improved?
- How can energy efficiency be improved?
- Extracting proteins from wash water
- Reducing food loss and waste
- Improving cold chain
- How to increase collaboration between industry and research institutes (student trainees etc.)
- Which possibilities are there for new collaboration projects within Bioeconomy?
- What are the funding opportunities for research in Norway and India?

The group discussions were summarized in one power point presentation from each group. Ideas for new projects and activities are included in section 7.

**Table 1. Participants in discussion groups (group leader in bold text – leading the discussion and summarizing results)**

group number	Last Name	First Name	Company
1	<b>Falch</b>	<b>Eva</b>	NTNU
1	Annamalai	Jeyakumari	ICAR-MUMBAI
1	Aursand	Marit	SINTEF Manufacturing
1	Jadhav	Chhaya	Matsyagar innovative Pvt LTD
1	Midtkandal	Inger	Royal Norwegian Embassy/Innovation Norway
1	Singh	Sandeep Kumar	IIT Kharagpur
1	Thakur	Maitri	SINTEF Ocean
1	Tolstorebrov	Ignat	NTNU
2	<b>Remme</b>	<b>Jannicke</b>	SINTEF Ocean
2	Aschim	Charlotte	TotalCtrl
2	Kumar	Abhay	ICAR- MRC of CIFT
2	Lakshmi	Narasimha Murthy	ICAR-MUMBAI
2	Naik	Asif	Kaiko Surimi
2	Torp	Ebbe	Due Miljø AS
2	Tveit	Guro Møen	SINTEF Ocean
3	<b>Standal</b>	<b>Inger</b>	SINTEF Ocean
3	Dasgupta	Manisankar	Bits pilani
3	Kadam	Dr. Ashish	Johnson Control India PVT LTD
3	Ramgopal	Maddali	IIT Kharagpur
3	Routroy	Srikanta	BITS Pilani, Pilani Campus
3	Sultan	F Abdullah	Bits pilani
3	Widell	Kristina N.	SINTEF Ocean
4	<b>Greiff</b>	<b>Kirsti</b>	SINTEF Ocean
4	Bhattacharyya	Souvik	BITS Pilani
4	Eikevik	Trygve M.	Norwegian University of Science and Technology
4	Joshi	Ashwin	Srinivasa Farms Pvt. Ltd.

4	Pungaonkar	Pramod	Vijay Refrigeration and air conditioning Services
4	Saini	Santosh Kumar	BITS PILANI
4	Srinivasa Rao	Pavuluri	Indian Institute of Technology Kharagpur
4	Urke	Jan Petter	MMC First Process As
5	<b>Mozuraityte</b>	<b>Revilija</b>	SINTEF Ocean
5	Aakre	Sara	NTNU
5	Brustad	Kristin	NTNU
5	Marak	Sengnolotha	Amity University
5	Nanda	Naresh	India Gelatine & Chemicals Ltd
5	NM	Sachindra	CSIR-CFTRI
5	Singh	Soumya	Amity University
6	<b>Hjellnes</b>	<b>Veronica</b>	NTNU
6	Gupta	Khushboo	Amity University Uttar Pradesh
6	Kaushik	Nutan	Amity University
6	Kumari	Asha	Amity University Uttar Pradesh
6	Larsen	Frida Holm	NTNU
6	SJ	Laly	Mumbai Research Center of ICAR CIFT
6	Slizyte	Rasa	SINTEF Ocean

## 5.5 Summary of group discussions

Below is a summary of the discussions from the six different groups based on theme.

### 5.5.1 Rest raw materials

**Higher utilisation of rest raw materials particularly from fish export companies:** Today Indian exporters are generally not utilizing the rest raw materials sufficiently. They export frozen and the rest raw materials are usually wasted or goes into low value products. This could be improved.

- Value chain focus
- Improve cold chain and hygienic collection which gives better raw materials
- Combine the cold chain to the waste chain.
- Special equipment needed
- Look at the infrastructure and logistics – cooperation in fish supply (to keep the cold chain). Small fish might collect

**Infrastructure project to increase the utilisation of rest raw materials:**

- More fish should be processed (on a general basis)

- State fisheries department is an important player in this. Each state is doing their own thing.
- Need of refrigeration containers
- Investigate on-board processing (even a surimi plant can be installed in a vessel). On-board processing requires high tech processing (High quality). Space on-board is a limiting factor.
- Important with resource availability
- In India the fish can be 10 days at sea (on ice). What is the capacity of the catch? Space is the main challenge and limiting factor.
- Fishing is banned in June to August
- Is it possible to use the same system for fish as for the dairy – small chilling centres for milk (local centre) (40 km). Use experience from that?
- It's expensive to have the ice machine alone
- Fuel, electricity and ice storage (and production of ice) is expensive in India. Possible to make systems for accumulating the heat – to heat water (produce ice)

**Aquaculture:** The aquaculture in India should grow and also more rest raw material should be utilised

- It should be shorter distance between the farm, slaughter and processing plants
- Possibilities to cluster companies that are close in the production chain? (e.g. aquaculture and processing plant) these is district politics as well.
- Need to be done a lot of work on aquaculture feed in India. Rest raw materials are potential sources to look more into.
- Potential to utilize the rest raw material from aquaculture (specially blood)

**Rest raw materials in general:**

- Skin and scales (produce skin and scales in India and not export unprocessed)
- Shrimp shell – huge amount – chitin/chitosan (automatic system). Automate the system. Make it in industrial scale. Purity. Expensive product. Value chain focus (included logistics and cold chain)
- Waste water (see above)
- Aquaculture (see above)
- Infrastructure project (see above)
- Deboning can be optimized (utilize the bones)
- Collagen – focus on high end products
- **Lipids** – during first steps of gelatin extraction, surimi processing some lipid/oil rich water "is produced" and lipids could be recovered.
- **Di calcium phosphate fraction** (from demineralization) used for chicken feed, could this be adapted in other countries?
- **CaCl<sub>2</sub>** some of the process water fractions during e.g. gelatin extraction
- **Water recovery** is needed because of the regulations and the water needs: to grow algae?, mineral source for fermentation process?

**RRM quality has large possibilities to be improved:**

- RRM is utilized– but generally for feed purposes
- Not structured cold chain
- Cold chain is needed (600 km till large RRM processors - or 18 hours). This degrades the quality.
- Possibilities to establish smaller scale RRM processor localized – for value added by products ? Such establishment will have to add employment to the local area (socio-economy-political issues).
- Possible to develop small refrigerators for the fishermen. (like coca cola refrigerators on beaches etc)?

- Sorting and grading of RRM could be a way to improve the quality– but may be difficult for smaller species fish, than larger ones.
- Fish quality/landing: Bigger factories have- registered fishermen – (but they are not employees). Possibly easier to implement changes in such.
- RRM by products – technology for high value added products - know-how and technology is needed.
- In Norway – RRM is profitable, but more for the oil than meal when it comes to value added products (human consumption).
- Many factories (e.g herring, mackerel to come) today in Norway also use RRM for feed instead of investment to upgrade it to human applications – are some investing in food grade factories at present – maybe Pelagia?
- What would be the pay-back period in India (2-3 years would be acceptable for the players)
- Fresh water fish is also usually consumed locally without further processing (than e.g. freezing).

### 5.5.2 Resource utilization

- Heat from refrigeration can be used to heat wash water.
- We have to take a look at the ocean, we need to eat more from the sea. We have to develop the Indian industry to use more food from the sea. We have to develop more blue economy. We can collaborate for developing technology and knowledge transfer. We have to take step by step. We have technology, and we can develop equipment for Indian conditions
- **Quality** of the raw material – important for process efficiency and the market of isolated product
- **Fractionation** – different product can be produced from the right fractions
  - skin, scales, bones for gelatin extraction?
  - Separate scales and skins for gelatin extraction as probably the process should be optimized
- At this point resource utilization is not sufficient
  - Fish meal producer
    - Uses only whole fish – small fish that are too small for food production
      - Separate oil
      - No degutting/beheading
    - Washed → pressure cooker → pressed (press cake/ press liquor) → drying (water back to press liquor)
    - Rest raw material results in feed with only 55 %
      - Increase protein content of rest raw material that they are supplied
      - Norway: water-soluble fraction is added back to the feed to increase the protein content.
      - India: water-soluble fraction discarded
  - Filleting
    - **India:** fish filleted in the marked and the rest raw material is discarded
    - **Norway:** fish filleting rest raw material for fish feed, rarely whole fish
  - **Subject of research: Where does the rest raw material go in India?**
  - **Subject of research: Find suitable feed formulas for different animal feed based on quality (aa composition, omega-3 content, digestibility etc.)? Can an equation/simple software be developed (taking into account composition and price)?**



### 5.5.3 Energy efficiency

Fishery industry is an energy demanding industry: Low temperatures, ice, water chilling.

**Energy saving** means are not easy to implement always. It needs to be communicated to all players in the factory. Measurements of energy use is present. But how to access the energy savings?

This is often difficult in Norway – e.g. other things in the production chain is changed at the same time.

Standards to measure energy savings etc needs to be adapted to the country (India and Norway conditions would be very different)

Experience from chicken industries – knowledge transfer – for energy savings? It is quite different volumes of these productions – but some things may be adapted/applied.

**Regarding refrigeration equipment:** After purchasing refrigeration equipment – sometimes unskilled employees maintain them. Unskilled employments may also lead to accidents –and not optimal operation conditions. (e.g. ammonia release).

Training module for how to operate such equipment? Documentation is needed – management system. Often – it is the buyers that requires such – but presently – e.g. Japanese buyers does only evaluate quality.

It is more profitable to import it from other countries (i.e. China). A few Indian companies used to develop such, but they are now closed or bought up. Some equipment is available also within India (e.g compressors and similar). The know-how on maintaining and operation is thereby not available.

To establish many and small factories – would probably be more relevant than bigger (due to the mentioned socio-economic and political issues.). Efficient solutions are needed – but automatization and high efficiency will not be a wanted solution. Employment is a very important factor here. (Smart, effective, ice plant – centralised production – and two smaller centrally – smaller plants locally.

**Green Energy** – increasing the costs – so will have to document energy efficiency. Cascade energy system (CO<sub>2</sub> + ammonia)

Equipment need to be low costs.

**Live fish – market – quality** – fresh fish – quality – not proper storing facility. Could improve the quality by such. Portable / refrigerated portable system – such as for coca cola. Improve efficiency. Solutions for market – quality maintaining.

Processes like chilling, heating (sterilization) requires energy and cost money, processes improvements are in demand

How can energy efficient be improved?

- Use of silage instead of chilling when rest raw material is transported to processing facilities
  - Stop microbial growth and facilitates acid hydrolysis and enzymatic hydrolysis by endogenous enzymes in fish viscera.
- Subject of research: Can silage be used as an energy efficient alternative to cold transport of rest raw material?
- Subject of research: Should we transport the rest raw material to the processing unit (build new), or should we bring the processing unit to the factories?

### 5.5.4 Increase collaboration

How to increase collaboration between industry and research institutes:

- Seminars like this works well - collect different actors in one place and sit around a table
- Students that are on exchange can visit industry (and have internships in the industry)
- Students in Norway and India (3-6 months) internship – stipend
- Need project that can finance
- They get practical knowledge.
- In India food students have 6 months internship in industry during their education, some study programs in Norway have 5 months internships, other study program have less or no internship
- Also important for stakeholders to have internship
- Workshops for stakeholders
- Introduction of technology through demonstration (linking). Combining student internship with demonstration equipment for project might improve the outcome of the stay.
- Demos to be tested in the fishing gears (RSW e.g. implement)
- Increased involvement of industry in research
- Close collaboration – visit plant, invite to meeting, problem-shooting together
- Master thesis in industry
- Researcher need to sell their ideas and knowledge
- Very positive to include students in the collaboration projects especially when industrial activities are involved.
- Technological trials could be tested during the education of the master/PhD students. This would give opportunity to get wider and scientifically deeper knowledge within the different possible technological solutions.
- For students from
  - Norway
    - NRC has some mobility programs for young researchers.
  - India especially for pursuing PhD:
    - Ministry of Tribal Affairs
    - Ministry of Minority Affairs

Importance in **bioeconomy**: Collaboration between industry and research institute (and academia) in higher utilisation of raw material

**Norway**: Research council – quite slow process to get funding. Innovation Norway – alternative for industry.

**India**: Application funding takes time also in India.

- Entrepreneurs can basically have facilities /know how available at the Universities. Professors can also help to find financing sources). It will also be possible for Norwegian companies to approach the institutes.
- Student work can be related to industry – and kept in the dark 6-12 months. (relevant for smaller, and start-up companies). Larger company does generally not take risks, and it is difficult to have commitments.
- Contact between industry, research, and financing bodies(??) need to be on **the top level (e.g. professors, CEOs etc)** to achieve cooperation projects. There are some financing sources e.g :
  - \*IIRD : funding : Government 50 % , industry pays 50 %. As mentioned, good contact with industry is a prerequisite, but still it is difficult to get the industry to pay this 50% share.

- **One approach to reach the industry is to get powerful organizations onboard (such as ISHRAE– ISHRAE is a (powerful) association** for refrigeration, heating and air conditions. (standards and regulation measures). They also held conferences. This does also requires good contact with ISRHAE on top level.
- **State owned enterprises PSU (larges)** are obliged to keep some fund for students – for entrepreneurship – initial funding.

### 5.5.5 Financing

- Funding is the challenge
- Industry funding: «Show benefit for the industry– then collaborate»
- In Norway it is a Fisheries fund and companies are also forming clusters that co-operates on specific areas (and get money from the authorities)
- What research is important
- Join projects with money from both India and Norway

### 5.5.6 Extracting protein from wash water

- Filtration
- Fractionation
- Same technology as used for whey production? Membrane filtration – is this cost effective?
- Protein coagulation (acid) and centrifugation
- Fertilizer of land with the nitrogen content or fish meal production?
- UV-Irradiation of water after removal of dry matter to reduce sterilize → circulate and reuse the water in the surimi production

**Subject of research: Develop easy to use technology? Can technology developed for cold climate be transferred to a hot climate in India? Compare the cost efficiency of different technologies for protein extraction from waste water?**

### 5.5.7 Reducing food loss and waste

- Topic of focus is relevant and important in both Norway and India
- The app “Too good to go”
- India: buffet from arrangement distributed to poor people
- Reducing portion size

**Subject of research: Utilization of poultry feathers for production of proteins, packaging, isolation, feed and fertilizers for poultry industry in India and Norway? Isolate proteins and natural films from egg shells?**

### 5.5.8 Other topics

- Need of more gentle handling on board fishing vessels – pumping – fishing equipment on board - gentle– a model for clustering

- RSW?
- Lack of collaboration with the industry – should be improved (but some companies such as those in this seminar is dedicated and should be focused on)
- An increase in utilisation should benefit the stakeholders – motivation, incentives, cost benefits. Good technology to make the stakeholders interested. Why sell if it is easier today?
- Interesting experience from visiting Norway that a company in Norway (Lerøy) differentiate the fish in two qualities
- In India trawlers catch most fish
- **Clean municipality waste** – biogas production – biofertilizers - implementation is ongoing (i.e. green and blue bucket. In Norway – and Europe – there are several initiatives to use/recycle waste for cultivation of insects (marine small crustaceans, worms, black soldier fly). But much research is needed
- Microalgae cultivation – to take up Phosphorus and Nitrogen from waste (e.g. wash water?) and to upgrade such nutrients. Bits Pilany and SINTEF already works with microalgae. May be challenging to use waste that has such varied composition (ref Portugal industry uses sugars at present)
- **Refrigerants: R22** – refrigeration systems still commonly used on boats (ammonia could be an alternative if you know how to use it).

## 6 RE-food meeting (30<sup>th</sup>, Nov)

### 6.1 Agenda ReFood meeting (Nov 30)

- Introduction
- WP 2 – Status and planned activities
  - Presentation: Sandeep Kumar Singh
  - Next year plans
- WP 3 – Status and planned activities
  - MOU
  - Student exchange NTNU (Trygve and Eva)
  - Professor visiting Norway
- WP4 – new projects
  - Sent proposals
  - Follow up discussion from yesterday
- WP5 – Management and dissemination
  - Dissemination
  - Economy
  - Meetings regularly
- WP 1 – Status and planned activities
  - Mumbai workshop
  - Symposium 2019

## 7 New project ideas and project proposals

During the annual symposiums the project participants try to identify future collaborative opportunities in the field of Bioeconomy through different funding mechanisms including the Research Council of Norway (INDNOR programme), Horizon2020 (where India is eligible for funding through the Department of Biotechnology and Department of Science and Technology, Govt of India) and EraNets. The results from these workshops will form the basis for new project proposals and future collaboration between the institutes involved in Re-FOOD

Below is a table of potential ideas to further the Indo-Norwegian partnership established through ReValue and RE-food. The table is a summary of all the ideas that were discussed during the week in Mumbai in November 2018. Below are some of the ideas that have been discussed during the meetings during the week in Mumbai.

### 7.1 Project proposal on nanotechnology

The application with title: Optimizing microalgae biomass production using nanotechnological materials (NanoOpt) was submitted to NANO2021 program. Project partners: SINTEF Ocean, NTNU and Amity University Uttar Pradesh. Norwegian partners submitted proposal to the Research Council of Norway (13.02.2019) and Indian partner submitted proposal to the Department of Science and Technology in India (22.02.2019).

The aim of NanoOpt is to exploit bilateral cooperation between Norway and India to improve microalgae biomass production using engineered nano/micro-technological solutions to contribute to profitable production and harvesting of microalgae. Higher biomass production and lipid yield in photobioreactors, better use of nutrient-rich side streams and optimized processing methods for microalgae will provide society with new technological solutions for production of materials for high-value applications such as health, feed or fuels. RRI is central in scientific activities and the potential risks associated with the use of nanotechnology will be addressed in this project. Optimized microalgae production, followed by new opportunities for value creation based on natural resources, can create highly desired job opportunities in rural areas. The knowledge and technology transfer and cooperation of R&D institutions will increase the research level of each R&D partner and strengthen research and technological development and innovation through transnational cooperation.

### 7.2 Clusters within surimi or fish processing

Starting up clusters in India (surimi and/or fish processing). This is an idea that can be developed further. Clusters are a very popular constellation in Norway, and India could benefit from applying similar models. An example is the Norwegian NCE Blue Legasea cluster which consists of 46 partners from the whole marine value chain, including fishing companies, land-based processing facilities, technology and equipment suppliers, and researchers, academics and clinical teams. Greater collaboration throughout the marine value chain and at the interface between marine and maritime industry is core focus in the NCE Blue Legasea project that aims to be a catalyst for a unique cross-sectoral collaboration. This shall strengthen value creation and competitiveness for member companies and for Norway as a fishing nation. Through radical innovations in catching, fishing and processing technology as well as an increase in the value of marine products, the cluster project can help to enhance the profitability of Norway's fishing industry and grow one

of Norway's most important export industries. Sustainable solutions from the cluster will help to increase value creation and exports in adjacent industries, have transfer value both nationally and internationally, and help to position Norway as a pioneer in blue/green value creation based on full utilisation of marine raw materials while meeting the UN's sustainability goals.

### 7.3 Biosensors

There is a lot of interest from the partners regarding biosensors which is an interdisciplinary research area with applications ranging in several areas like food, health, agriculture, environment, value chain, bioeconomy etc. Biosensors, with focus on seafood application could be used for quality aspects during transportation as well as shelf life (metabolomics). Several of the partners are interested in working within this field. BITS Pilani, AMITY University, SINTEF Ocean and NTNU will continue to discuss collaboration within this idea. However, there is no current funding call available now.

### 7.4 Additional ideas and applications for further collaboration

- Utilization of poultry feathers for production of proteins, packaging, isolation, feed and fertilizers for poultry industry. It is possible to have VTT in Finland if programme conditions allow this. SINTEF and AMITY University is aiming for a joint application when there are any relevant calls. SINTEF discussed cooperation possibilities with India Gelatine & Chemicals and look for possible financing for this cooperation. India Gelatine & Chemicals works with Kaiko surimi and have started extraction of gelatine from scales.
- Silage can be used as an energy efficient alternative for preserving and transportation of rest raw materials. AMITY and SINTEF have an idea for a joint project. They need a relevant financing call.
- Compare the cost efficiency of different technologies for protein extraction from waste water. Both AMITY and SINTEF have discussed this. Part of the idea can be included in the ReValue project.
- RRM from fish processing industry as a raw material for marine gelatine extractions. This idea has been discussed with India Gelatine and Chemicals Ltd and SINTEF will keep in touch.
- SINTEF has discussed cooperation possibilities with Srinivasa Hatcheries and will look for possible financing for this cooperation.
- Use of membrane technology on waste water from surimi processing. This is a sent application to NORAD and is a collaboration between the partners Due Miljø, Kaiko surimi and Srinivasa Farms. If approved this can be linked to the ongoing work in ReValue.
- Sustainable energy use. Here NTNU and IIT Kharagpur sent a SPARC-application in 2018.
- Look into the possibilities for production of fish meal and oil on, or close to the processing plant. This would be very relevant for industry partners like Kaiko surimi in the ongoing ReValue project as well as for new projects.
- On board processing to ensure material of better quality. This is an idea which has been discussed due to the results from the mapping of the current value chains in fish and surimi production in the ReValue project.

- Processing and energy efficiency in Indian chicken farms/chicken processing. This could be a possible project with Srinivasa Farms, which already have done work within this topic.
- Container for Indian farms to cool/freeze/heat produce from harvest. This could be a possible collaboration with Johnson controls and MMC.
- Industry 4.0. Here it would be interesting to get a collaboration project between SINTEF Ocean, SINTEF Manufacturing, BITS Pilani and Fraunhofer.
- Development of new packaging (non-plastic) from for example starch could make a dissolvable and edible film for packaging. The starch could be from banana stem e.g. (or potatoes).

## 8 Conclusions

This report is a summary of information from meetings, activities and ideas from the 2018 combined RE-food symposium and ReValue open-day conducted in Mumbai November 2018. The symposium had 43 participants from Norway and from India including researchers, students, industry participants and representatives from Innovation Norway and Research Council of Norway (New Delhi office).

We had fruitful project meetings in both ReFood and ReValue with engaging presentations and discussions regarding ongoing research and further work. Meeting once a year in person results in longer discussions and many new ideas and serves as a good addition to the regular Skype meetings in the projects. Visiting the surimi processing industry was also highly interesting both for the partners in the projects and the other participants at the symposium. Most of the participants had never visited this type of industry before and found it interesting to compare with previous experience of other industries. Seeing the type, size and processing of the small fish lead to many good discussions about further work both in the project ReValue and new possibilities of development.

The presentations held at the Trident hotel was a mix of industry and researcher presentations. These presentations were also mixed with group discussions, which resulted in a long list of ideas for further work. Even though we come from different parts of the world, we understand each other and agree on the topics, the challenges and the solutions. We also got to know each other better over very good food at different restaurants in the Mumbai area.



Technology for a better society

[www.sintef.no](http://www.sintef.no)