



## The role of Bioeconomy in a changing world: Fostering partnerships for a better future.

### A summary report from Indo-Norwegian joint workshop on Bioeconomy (6-7 Sept, 2016, Oslo, Norway)



Sponsored by Research Council of Norway (RCN) and Department of Science and Technology (DST), India

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(with inputs and comments from workshop participants)

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### 1.0 Introduction

The world is suffering from serious societal, economic and environmental challenges including climate change, resource scarcity, demographic changes, food, energy and water insecurity and migration. We need a paradigm shift in the way we use our resources optimally in the future, and the way we address these challenges. Bioeconomy is one such approach that could provide a sustainable way to go ahead. Bioeconomy comprises those parts of the economy that use renewable biological resources from terrestrial and marine sources – such as crops, forest, animal and fish resources, and micro-organisms - to produce food, fibre, materials, medicines and energy. The high level of political interest in bioeconomy, is based on a number of potential benefits it can generate, including: reduced greenhouse gas emissions, decreased dependence on fossil resources, improved food, and nutrition security. Further, bioeconomy is expected to generate employment, and to create new markets, thus leading to overall rural development. In the process, we also contribute towards enhanced ecosystem services, zero waste and adequate societal value. The timing is right to promote bioeconomy, as it will support or contribute to several of the sustainable development goals. This is highly relevant for all countries in general, India and Norway in particular. The big question is How do we draw the road map for future cooperation on Bioeconomy and how do we realize the benefits? To promote bioeconomy, we need right technologies; infrastructure, skilled workforce, timely investments, supportive institutions and policies, and inclusive growth. All these are essential, and we cannot just focus on one and expect success or good results.

The Indo-Norwegian Joint Workshop on Bioeconomy (INJWB) was one of the main steps jointly initiated by the Research Council of Norway (RCN) and the Department of Science and Technology (DST), India, to develop the future roadmap for bioeconomy cooperation between the two countries. This report provides a summary of the discussions and recommendations from the workshop, which could be further used in the preparation of the roadmap.

### 2.0 Bioeconomy: Concept in Brief

Bioeconomy is defined as the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, fibre, other bio-based products and bioenergy (EU, 2012). Relevant sectors among others include:

- > Agriculture; Forestry, Food processing and packaging
- Biotechnology (microbes, krill, proteins, antibiotics, plant-based products etc);
  Pharmaceuticals
- Bioenergy (Biogas, Algae etc)
- Fisheries and Aquaculture (Marine and inland)

Relevant crosscutting issues include Value chain Analysis; Gender/Social inclusion; Policy and regulatory frameworks; Innovative Bioeconomy-business models. Barriers and constraints to develop bioeconomy include: regulations due to intellectual property rights, rigid legal frameworks, lack of skilled workforce in rural areas, lack of quality control and lack of processing, handling, storage and market infrastructure.

Bio-economy through bio-based innovations has the potential to stimulate economy and markets both in India and Norway. An innovative knowledge based bio-economy – will help in stimulating green growth and economy. It has the potential to enable the sustainable use of biomass produced, and reduce the effects on climate, environment and nature. Since India and Norway have different social, environmental and economic situations, a variety of approaches need to be developed to identify bioeconomy interventions and their implementation. In both countries, the role of bioeconomy in creating more employment, particularly for youth and women, promoting sustainable and inclusive growth needs has to be explored and identified.



### 3.0 Indo-Norwegian Joint workshop on Bioeconomy

RCN and the DST funded the joint workshop (that was organized in Oslo at Thon Opera Hotel from 6-7<sup>th</sup> September, 2016), facilitating the meeting of relevant actors working with Bioeconomy in India and Norway. The main goal of the workshop was to facilitate this interaction, identify the most relevant thematic areas, and provide inputs to develop the roadmap for the future Indo-Norwegian cooperation on Bioeconomy. The main objectives of the workshop were as follows:

- To generate discussion for a better understanding of the Bioeconomy concept
- To share experiences, good practices/ cases/ and policy scenarios
- To enable networking of Indian and Norwegian partners working with Bioeconomy
- To provide inputs for future Indo-Norwegian cooperation on Bioeconomy

The Norwegian Institute of Bioeconomy Research (NIBIO), Norway and the M. S. Swaminathan Research Foundation (MSSRF), Chennai, India (see Program, Annex 1) jointly organized the two-day workshop. About 40 participants from both countries representing scientific institutes, universities, private sector and government agencies actively participated in the workshop (see participant list, Annex 2). At the workshop, participants from India and Norway made more than 20 oral presentations in the different sessions. This was followed by group work sessions in which participants were divided into four groups representing four thematic areas. The potential areas identified for the collaboration between Norway and India on Bioeconomy were: Agriculture, forestry, food technology and processing; Biotechnology, microbes, algae and other plant based sources; Bio-based resources and bio-energy; and Fisheries and Aquaculture (Marine and Inland).The summary of the discussions are provided below.

### 3.1 Main thematic areas at the workshop: summary of the Group Work

### i) Agriculture, forestry, food technology and processing

Key words: Food security, nutrition, sustainable methods of production, inclusive policy, improving smallholder rural economy and job creation.

### Securing food resources: to secure Food and Nutritional Security

There are large differences in the forestry and agriculture sector between Norway and India; Norway operates at high technology level with larger costs and high emphasis on environmental and societal concerns. Whereas, in India, both the forest and agriculture sector is dominated by indigenous and low technology production and management systems with serious environmental impacts and societal inequalities.

A common challenge is land availability where forest and agricultural land are under pressure from different sectors and the outlook for land availability is that it will



only decrease with increasing population growth. In India, there is a greater pressure on land from a wide range of sources, especially due to competition from urbanization and real estate expansion, as well as agriculture and inland aquaculture. There is no easy solution for this as land is a scarce resource. Therefore, the focus should be on increasing productivity on the existing land using sustainable efficient production methods and minimizing post-harvest losses. Following a landscape approach and finding potential synergies between forest, agriculture, and other land uses should be considered.

Land tenure should be a priority, and the access and user rights to land should provide farmers with incentives for future investment in both infrastructure and equipment. In theory, a farmer with well-defined land rights or tenure security will be better able to utilise the land in a sustainable manner. It is imperative to make the farmers understand the value chains and build capacity of rural youth and women on realizing the value chains. This could be applied to the handling of local produce such as food and wood products. By understanding the value, he or she can add value to the locally produced products and consequently less waste.

The potential for added value within bioeconomy depends on availability of renewable natural resources and optimizing its use adopting cascading approach while using resources. It requires investment in developing new technologies and products adopting trans-disciplinary framework by venturing in new research, knowledge and innovation domains.

### Sustainable methods of production: central to future of Bioeconomy

Sustainable production of forest and agriculture is needed to reduce the depletion of land resources. It would help to look at lifecycle analysis of land use and in the process ask: *What are the inputs and outputs of the area used? Can it be utilized in a more efficient manner* 

*creating more produce per hectare of land?* There is a need to find alternative use of farm and forest residues that can be transformed into fertilizer for farmland.

Both the countries have a common interest in sustainable, climate-smart and eco-friendly production management systems that encourage and improve biodiversity, soil biological activity and nutrient cycles. With this in mind measures to promote sustainable and organic production systems, innovative technologies including post-harvest processing, and development of new markets for value added innovative products should be the way forward to generate benefits for the two countries through cooperation.

A large amount of biomass is burnt after harvesting in India; as the product is considered a low-value product (e.g. wheat straw is burnt in the field itself after harvesting in parts of northern and north-western India). Are there any ways of changing the low-value product residue from the farm into a more valuable product that can be transported or used in energy production? Sustainability is often linked to certification and standards, hence:

- What is the value addition in getting the production certified such as FSC (Forestry Stewardship Council) or other standards/or labelling?
- > How can farmers' awareness be increased?
- > How can the farmers get access to finances that enable them to become certified?
- What initiative can be made available to make it more rewarding to participate in certification and labelling systems? (An example from the forestry sector is the FSC standard, but it is very costly to participate.)

These are some of the important questions that are relevant both for Norway and India.

### Nutrition: to be an integral part of Bioeconomy (addressing SDGs)

Getting the right nutrition is closely linked to planting the right crop species. While it is important for the right species and products to adapt to the local conditions, it is equally important to take care of the products produced from the land by focusing on post-harvesting processing and handling. This is to make the food and wood products more durable by looking at sustainable packing and post harvesting procedures and technologies (in both Norway and India) and combine this with a focus on value chain enhancement. This can increase the potential revenue for farmers and reduce waste and transport costs, not at least, it is evident that with extra income, the smallholders can buy more nutritious food for the family. Using information technology can increase the farmers' awareness on the handling of food products and give access to market intelligence. There is a need to look into the price structure of crops after planting, as well as the possibilities for giving farmers access to secure storage of food. For example in Tanzania, the prices of Maize is low just after harvesting season where there is plenty of food available. However, the prices increase further from the harvesting season, and farmers are often the losers in this process as they do not have the technology or the financial resources to store the food and sell the produce later. This could be very similar to most parts of India. Even though the Government of India sets minimum support prices for the major cereal crops, farmers often have to take up expensive loans to finance their next planting season. Another example, in Kenya, 30% of the production of fish is lost due to post-harvest losses because of lack of proper storage and handling.

### Inclusive policy: all interest groups to be involved

There is a need for policy amendments that include all interest groups and stakeholders combining related sectors. All relevant stakeholders should be involved in the planning of policies, and they should be able to provide inputs and be heard so that ownership can be

increased. This work should be performed in close cooperation with governing bodies so that the policies can be implemented and monitored better. There is a need to invest more in innovative extension services and knowledge exchange that can act as a bridge between the farmer and the local authority.

### Improving smallholder - rural economy and job creation

One way is to organize smallholders into collectives such as farm producer organizations or cooperatives. Consequently, this would move production from "middle-men", to farmers. However, this needs to be analyzed to see the impact on the whole value chain. If this can create jobs, what will be the potential consequence in the upstream. Can this be a good business model

### Summary and the way forward

Norway has advanced logistical and management systems in the forestry sector. India is good at satellite and remote sensing technologies, and there could be complementarity in cooperation to develop sustainable production systems in forestry and agricultural sectors. A good example is the assessment of forest resources in Norway that uses the LIDAR (Light Detection And Ranging) in the monitoring of forest cover and forest change. With the increased demand for wood and forest resources, information is critical to making the right decision and therefore making good analysis of existing land uses.

Some of the relevant topics for Bioeconomy cooperation between Norway and India in the future include: Forest inventory; Remote sensing; LIDAR to promote sustainable production management systems; Research to find the optimal species and crops for sustainable food production and nutrition; Pest and diseases monitoring tools and control; Economics of returns; Training and government investment in innovative extension services.

### ii) Biotechnology, microbes, algae and other plant based sources

Key words: bioprospecting, sustainable utilization, methods for large-scale cultivation, product development, policies and regulations.

### Sustainable production systems: to increase biobased biomass sources

Bioeconomy is biomass-based economy, and this biomass can be sourced from two systems viz. Green/land based system and blue/ocean based system. The green system is mostly explored (almost 95%) while the blue system is largely unexplored (95%). In order to utilize these resources, we need socio-economically acceptable technologies like biotechnology, exploration, production and processing technologies. We also need right policies and regulations with appropriate management systems to promote the development of green and blue bioeconomy.

For sustainable supply of biomass for bioeconomy, sustainable production systems are needed. India has strong regulations on use of farmland. Farmland is used for crop production for domestic food security so there are fewer options to use farmland for industrial purposes, to promote bioeconomy industry. Norway, on the other hand, does not have a land problem, and land is available for growing crops for industrial production. Further, Norway has developed technology for production of high value chemicals through plant systems that can be used for production of various industrially important plant based chemicals. Collaboration on sustainable biomass production systems using the biorefinery approaches could be established between the two countries at scientific and business levels.

### New species and sources: bioprospecting

Drug resistance in microbes is an emerging problem in both countries, so there is a need to look for newer antibiotic sources. Similarly, for promoting biobased economy in the future, the need for new enzymes and newer sources of enzymes for bioconversion at industrial scale could be explored between India and Norway.

In India, algae is primarily used for biodiesel production and looking for newer strains/species for marine water cultivation, as a policy decision has been taken in India not to use fresh water for algae cultivation. Collaboration can be established on bioprospecting of newer marine strains suitable for biodeisel production.

Seaweed extract is prepared in India and is mainly used as biofertlizer. While India imports seaweeds (mainly for soil fertilization) and domestic cultivation is small, Norway produces plenty of seaweeds which is used for production of alginate. Norway has also developed technology for offshore cultivation. Collaboration can be developed on Norwegian technology for offshore cultivation of seaweed and develop process for use of seaweeds for both alginate and biofertilizer production. There could be mutual benefits through cooperation in these areas.

Medicinal plant species is a potential area in which bioprospecting, link with traditional knowledge systems, development of bio-based products, new technologies of production and markets are important.

Food and fish processing industry in India and Norway produces several bi-products, which have the potential to be used for development of feed for the aquaculture sector. The demand for feed in Norway for the aquaculture sector is high, and there is expertise available in converting the industrial bi-products into valuable protein ingredient for fish and cattle feed. This is one of the potential areas of collaboration between the two countries, not only at scientific level but it could also generate business potential.

### Summary and way forward

The group identified the following topics for future joint collaboration:

- Bioprospecting for new antibiotics and enzymes for green and blue systems; and bioprospecting of food and fish processing industry waste for feed.
- Efficient exploitation of microalgae/seaweed; Norwegian technology for offshore cultivation; optimization for alginate and bio fertilizer use; biomass handling, storage, conservation, processing, advantages and disadvantages from sun/heat-based processing and marketing.
- Sustainable biomass production systems using the biorefinery approach; Norwegian technology on production of high value plant based chemicals/products through plant systems and production of various industrially important chemicals/products.
- Validation of Indian traditional knowledge and bioprospecting of medicinal plants and its role in promoting rural bioeconomy
- Issues related to ecological sustainability:
  - Resource cycling, emphasis on establishing cycles that returns resources lost to the ocean (Carbon, Phosphorus and Nitrogen, freshwater) back on land.

• Combining Bioeconomy production with emerging energy technologies such as Ocean Thermal (OTEC), wave and wind, to get new access to clean sea water, freshwater and nutrients from the deep sea.

### iii) Bio-based resources and bio-energy

Key words: sustainable utilization, methods for large-scale production, technology, policies and regulations.

### *Bioenergy sector: need for efficient collection and treatment systems*

For bioenergy production and its sustainability, feedstock plays an important role. Listed below are few sustainable feedstocks that are available in plenty in the Indian subcontinent.

- 1. Agricultural residues (crop residues like straw, stalk, leaves, post processing residues etc)
- 2. Food waste (House hold, hotel, café etc)
- 3. Fruit and vegetable waste (from whole-sale market)
- 4. Algae (micro and macro)
- 5. Forest residues
- 6. Municipal solid waste
- 7. Cattle dung, poultry droppings
- 8. Sludge from fish waste

A main concern for India is the issue of collection and transport of the materials to the centralized/decentralized facility for treatment of these wastes. Norway has good experience on waste collection/sorting at source and transport. For waste transport to be efficient, the following steps have to be followed:

Collection --> Densification --> Efficient transportation of waste

Experts from Norway can help Indian partners to further plan and design the system as per Indian requirements. Indian municipal waste collection system is currently not well organized and needs to be structured. A nation-wide awareness drive in India is essential and pilot programs are necessary to create awareness about the need to reduce waste and show the value and potential to produce energy and resources. If properly treated, the negative impacts on public health and hygiene can be drastically reduced in India.

Creating value from waste will also generate employment as new industries/or companies are involved in the entire value chain. Issues that need immediate consideration include:

- i. Awareness of public on waste segregation at source
- ii. Scientific tailored waste disposal/management/treatment

### Policies and regulations

- Creation of centralized database for waste generation and its classification.
- Incentives for initial 5-10 years for Bioenergy companies/plants.
- Enforcement of segregation of waste at source and its collection in sorted form by municipalities for its integrated treatment.
- Municipalities to address the issue of overall organic waste management with the least/no impact on public health and environment, minimal consumption of resources and economical feasibility.

- Hiring skilled/trained manpower.
- Periodical monitoring of plants and surveillance of activities.



### Bioethanol production

Need to enhance knowledge and research work in the area of enzyme production and its engineering as different enzymes are required to carry out the hydrolysis of the biomass for liquid biofuel production (here bioethanol). Issues of concern are:

- i) Production of robust cellulase enzyme
- ii) Engineering of Rubisco enzyme for increasing yield of biomass
- iii) Hydro-liquefaction of biodiesel

### Summary and way forward

The biogas area requires special attention for enhanced rate of production and over all yields. Issues of concern are:

- Sustainability of the production process
- Food and fish waste, fish cages —> Multi feedstock biogas production technology
- Purification and bottling of biogas
- Improved yield and high quality biogas (more methane)
- Effect of Heavy metal and nanoparticles on biogas production process
- Steam reforming (CO<sub>2</sub>) sequestration
- To identify and carry out studies on the key policies that will lead to sustainable and economically viable bioenergy production in both the countries

The group identified the following research topics as very important to consider for joint collaboration between Norway and India:

Research work on the production of bioethanol and biobutanol by using cellulase enzyme and developing the concept of biorefineries further.

Research work on enhancing the photosynthetic efficiency by engineering the Rubisco enzyme. This would help in enhancing the yield of both land as well as aquatic biomass which is important for biosequestration of  $CO_2$  as well as for obtaining value added chemicals and products.

Research work on both micro algae and macro algae is again related to both biosequestration of carbon dioxide as well as production of biofuels.

### iv) Fisheries and Aquaculture (Marine and Inland)

Key words: Food security and nutrition, sustainable methods of production, inclusive policy, economy and job creation.

### Social, utilization, production and technical Issues

- Educated new generation fishermen are moving out of the profession industry is now hiring migrant labourers. Need for development of awareness, education and organized systems.
- > Over exploitation of sea resources in near shore areas in India.
- Hilsa herring contributes to 12% of the total fisheries in India. The species is overfished and it is becoming rare to land 3 or 2 kg specimens. There has been a consequent price increase and collapsing populations, heading towards extinction in certain regions. Moreover, the fish is anadromous similar to salmon, and hence experiences from salmon farming technology in Norway can be relevant for sustainable culture of Hilsa in India. This is both for food security and nutrition as well as to protect Hilsa from extinction. The following issues need to be addressed in India and some of them are also relevant to Norway.
- Under utilization/untapped deep-sea potential in India. This should be utilzed by improved fishing technology and resources.
- High percentage of fisheries waste from marine catch is generated. Most of the bycatch is wasted or unmanaged. This requires immediate attention to fully utilize the catch including the bycatch and rest raw material, and to develop proper handling technology to maintain the quality of the targeted catch.
- Mariculture leasing policy needs to be changed in India.
- Lack of centralized collection, handling and processing facility for rest raw materials and by products from the fishing sectors so that these can be further processed into value added ingredients for other relevant industries. Identifying market niche for the unutilized rest raw material and byproducts is highly relevant, and will enhance job creation and economy.
- In India, ad-hoc management of supply chain in the fishing sector exists without proper logistics, handling and quality preservation techniques.
- Unexplored sector of seaweed and algae production.
- > Increasing resource dependent population.
- Increasing climate related disasters.

### Recommendations from the group

- Ensuring productivity, sustainability, profitability, gender and social equity in capture fisheries (marine and inland), aquaculture and non-food fisheries (eg. Seaweeds).
- Conserving and sustainable usage of marine resources through harmonized fishing practices and elimination of destructive fishing methods.

- Introduction of resource enhancement programmes, e.g. artificial reefs, mariculture technologies and by catch reduction devices with the participation resource dependent population.
- Performing resource management studies to assess the current stocks to ensure the sustainable utilization.
- Development of new technologies to incorporate sustainable, environmentally friendly and cleaner methods in the fishery supply chain from collection, handling, processing, transport, storage and disposal.
- Setting up of small-fisher aquaculture estates to bring in social equity with backward linkages with research and development institutions and forward linkages with assured and remunerative markets.
- Efforts for reducing post-harvest losses and increase value by processing plants of rest raw materials.
- Popularization of low cost value addition technologies.
- Demonstration of new technologies such as low input sustainable integrated fish farming practices.
- Bringing awareness among public and policy makers on the need for conservation and sustainable and responsible fisheries including adoption of good management practices.
- Introduction of women friendly fish processing technologies. Technologies and interventions which are easily adoptable would be identified, initiated and de-mystified.
- Explore the potential of under utilized meso-pelagic fish resources.
- Explore early diagnosis of diseases in aquatic organisms and their management.
- Promotion of technology transfer programmes at mass scale. Strengthen the institute and industrial collaboration.
- Information and dialogue within the society (stakeholders, traders, consumers) to communicate societal expectation and requirements and encourage open mindedness to bio-based products and innovation.
- Establishment of model demonstration units on the development of high end products; and total utilization of fishery waste including development of feed from waste.

### Possible topics for joint cooperation suggested by the group

- Develop technology for breeding, larval rearing and cage culture of Hilsa using proper health management practices from Norwegian advanced technology.
- Development of welfare indicators in aquaculture for better management and production practices in India using expertise from Norwegian aquaculture.
- Development of cost effective disease resistance and better growth variety of fish through developed breeding technology from Norway.

- Research and development for lower water utilization in aquaculture production technology in India.
- Seaweed and micro algae production, farming practices and product development in Indian context using experiences from Norway.
- Development of small-scale demonstration units for utilization of fish and shellfish processing discards.
- Minimize post harvesting loss and handling: Piloting the introduction of cold chain management, climate friendly refrigeration technologies and infrastructure of logistics using experiences from Norway.
- Develop and promote low cost value addition technologies to increase the fish consumption and address the issues of nutritional security.
- Research and development in sustainable organic waste and Biogas production.
- Research and development in mass production of biofuel from aquatic weeds and algae.
- To develop quality production in aquaculture by proper health management for increasing the slaughter volume and sustainable production.
- Joint initiative to solve the problem of bycatch using cost-effective user-friendly gears for targeted catch and proper utilization of what is required.
- > Developing and introducing climate smart fishing techniques.
- Collaborative research to explore and develop the technologies to capture the underutilized mesopelagic fish resources.
- Capacity building and institutional collaboration to exchange technology and facilitate bilateral knowledge transfer among key stakeholders in India and Norway.
- Prioritizing the bilateral development of economy, legislation and policy, market and social acceptance.
- > Cost effective diagnostic kits for unorganised small-scale farmers.
- > Joint collaboration to explore resources for deep-sea fishing and storage.

### 3.2 Panel Discussion – Recommendations

Panel represented by Indian and Norwegian representatives generated useful comments and recommendations as summarized below. In general, comments by the Panel promote cooperation based on principles of sharing, equality and mutual advantages (as in Article I in



agreement the between India and Norway). However, Norway is advanced in the field of Bioeconomy and several technologies are in an advanced stage (e.g. Biogas, deep sea fishing etc.).

### i) India-Norway - Commonality and possible areas of cooperation

Resource management and logistics in forestry are common areas of interest for India and Norway. Increasing the green cover and maximizing the biomass in forestry is of special interest for India given the current environmental and climate change concerns. Technology development and use to tackle these issues is of common interest for both countries. Here Norway's experience in technology and management of land and forest resources could be useful for India.

A 100% efficient utilization of available raw material is of relevance for both countries. Use of available raw material for food should be first priority, especially for India, and hence value addition is an important factor from a Bioeconomy point of view. Optimum refrigeration and temperature management technologies for reduction of post-harvest losses and maintaining the quality of raw material and rest raw materials is relevant for both India and Norway. In India, almost 20% of resources are lost in post-harvest phase and this needs to be reduced.

Norway and India both have long coastlines with an abundance of resources. Tackling the environmental problems and providing safe food and medicines is relevant for both countries. Developing medicines for drug resistant bacteria is of potential interest. Identifying new sources of enzymes and sustainable production systems is highly relevant for both Norway and India.

Water management, disease management and developing optimal feeding practices is of relevance to the aquaculture industry, both in Norway and India. Exchange of knowledge and technology in the field of aquaculture could be of mutual interest for the two countries.

### ii) Most important benefits for the two countries through better cooperation

India can benefit from the Norwegian research infrastructure and Norway can benefit from the skilled resources available in India. Norwegian products and technologies can have a great market potential in India.

The Indian IT industry is a successful model that can be replicated in the Bioeconomy sector where supportive government policies, infrastructure development and skilled workforce has made India a leading IT destination. Similar is the case of pharmaceutical industry in India.

Norway needs new feed ingredients for the aquaculture industry, and this can be supplied by India (from both land based and marine sector). The Norwegian equipment industry can find new markets in India throughout the food supply chain from harvesting technology, post-harvest technologies and food processing technology.

Together, Norway and India can develop processes for better utilization of seaweeds, biobased medicines and validate the traditional knowledge system of Indian medicine. From the point of view of trade, India and Norway can benefit from import and export of products, technologies and knowledge towards a stronger bioeconomy.

### iii) Measures to strengthen science and business cooperation

The cooperation between industry and science could be further strengthened by use of funding mechanisms such as funding for innovation projects and businesses, and supporting more PhDs.

Currently, the cooperation between industry and science in India is not adequate. The government of India has several ongoing programs such as *Make in India* and support for startups that can be used to mobilize the industry and strengthen the industry and science linkages. Including industry in research projects can lead to spinoffs for industry participants. More funding for industry partners as in EU projects should be considered. Industry is not keen to collaborate with research institutes without funding. Industry could provide their infrastructure (farms, etc.) to be used for research purposes and demonstration activities. The following measures might help to strengthen science-business cooperation:

- Strengthening social enterprises: Good Cooperatives already exist in India, but they lack technology and infrastructure.
- Strong leadership is needed to make a change.
- Lab-scale technology should be implementable with a commercial potential in order to be of interest for the industry to strengthen science-business linkages which need long-term support.
- Match making and B2B events should be given importance in order to engage industries from both countries.
- Tax exemptions may promote Research and Development innovations in bioeconomy and biotechnology.

### Final comments by the Panel

- Focus on topics/themes that will lead to a large scale shift with low risk
- New technologies should be cost effective and scalable
- Industries from both countries should be actively engaged in mutually beneficial projects
- Capacity building should be high on agenda, e.g. education of PhD students; vocational training
- Research should be of mutual benefit, applicable, scalable and replicable

### 4.0 Overall conclusions

The two-day workshop was seen as an important initiative to strengthen networking between Indian and Norwegian agencies working with Bioeconomy. It provided an opportunity to share knowledge and experiences within the four Bioeconomy themes identified for the workshop. There was a general consenus that Bioeconomy has the potential to address food and nutritional security, generate employment, create new markets, contribute towards enhanced ecosystem services and adequate societal value. The participants felt that the timing is right to promote bioeconomy, as it will contribute to addressing several of the sustainable development goals and challenges the countries are facing and provide mutual benefits.

Relevant sectors identified for the cooperation:

- > Agriculture; Forestry, Food processing and packaging
- Biotechnology (microbes, krill, proteins, antibiotics, plant-based products etc);
  Pharmaceuticals
- Bioenergy (Biogas, Algae etc)
- Fisheries and Aquaculture (Marine and inland)

Relevant crosscutting issues emphasized at the workshop included: Value chain Analysis; Gender/Social inclusion; Policy and regulatory frameworks; and innovative bioeconomybusiness models. The participants also discussed the barriers and constraints to develop bioeconomy such as the regulations due to intellectual property rights, lack of clear legal frameworks and lack of skilled workforce and the need for addressing the constraints.

Overall, the workshop concluded that bio-economy through bio-based innovations has the potential to stimulate economy and markets both in India and Norway. And, that an innovative knowledge based bio-economy – will help in stimulating shift towards green economic growth and at the same time enable sustainable use of biomass produced and reduce the effects on climate, environment and nature.

### Some of the important recommendations from the workshop

The following issues came up in all the four thematic groups and emphasized the need for:

- Sustainable methods of production: central to future of Bioeconomy
- Strengthening science-business linkages in the future cooperation, through match making and B2B events, actively engaging SMEs from India and Norway.
- Focusing on research and technologies that provide large scale impact, that are cost effective, mutually beneficial, scalable and sustainable
- Emphasizing on capacity building, not only at higher level, including PhDs; but also through vocational training/skills for enhancing job creation
- Inclusive policy and investments needed to promote economy

### Within the various themes the following recommendations are highlighted:

Within Agriculture, forestry, food technology and processing important recommendations were:

- Increasing productivity on the existing land using sustainable efficient production methods and minimizing post-harvest losses
- > Nutrition: to be an integral part of Bioeconomy (addressing SDGs)
- Improving smallholder rural economy and job creation
- Value addition/ improving value chains, seen as an important factor from a Bioeconomy point of view.
- Following a landscape approach and finding potential synergies between forest, agriculture, and other land uses.
- Resource management and logistics in forestry could be common areas of interest for India and Norway.
- A 100% efficient utilization of available raw material is of relevance for both countries.
- > Providing safe food and medicines are relevant for both countries.

### Within Biotechnology, the following topics were identified for future joint collaboration:

- Bioprospecting for new antibiotics and enzymes from green and blue systems; bioprospecting of food and fish processing industry waste for feed; validation of Indian traditional knowledge and bioprospecting of medicinal plants and its role in promoting rural bioeconomy.
- Resource cycling, emphasis on establishing cycles that returns resources lost to the ocean (Carbon, Phosphorus and Nitrogen, freshwater) back on land. Efficient exploitation of microalgae/seaweed; Norwegian technology for offshore cultivation; optimization for alginate and bio fertilizer use; biomass handling, storage, solar based processing, and marketing.
- Sustainable biomass production systems using the biorefinery approach; Norwegian technology on production of high value plant based chemicals/products through plant systems and production of various industrially important chemicals/ and products. Developing medicines for drug resistant bacteria of potential interest.

Within Biogas sector, the group identified the following research topics as very important to consider for joint collaboration between Norway and India:

- Research work on the production of bioethanol and biobutanol by using cellulase enzyme and developing the concept of biorefineries further.
- Research work on enhancing the photosynthetic efficiency by engineering the Rubisco enzyme for enhancing yield of both land as well as aquatic base biomass, which is important for biosequestration of CO<sub>2</sub> as well as for obtaining value added products.

Within Fisheries and Aquaculture main recommendations were:

• Ensuring productivity, sustainability, profitability, gender and social equity in capture fisheries (marine and inland), aquaculture and non-food fisheries (eg. Seaweeds).

- Conserving and sustainable usage of marine resources through harmonized fishing practices, elimination of destructive fishing methods, artificial reefs, mariculture technologies, exploitation of mesopelagic fish resources
- Sustainable, environmentally friendly and cleaner methods in the fishery supply chain from collection, handling, processing, transport, storage and disposal, including water and disease management and optimal feeding and feed sources.
- Efforts for reducing post-harvest losses and increase value chains; low input sustainable integrated fish farming practices; awareness among public and policy makers on responsible fisheries, good management practices.
- Information and dialogue within the society (stakeholders, traders, consumers) to communicate societal expectation and requirements and encourage open mindedness to bio-based products and innovation. Establishment of model demonstration units on the development of high end products;



### Annex 1 – Workshop Program

## PROGRAM

08.30	Registration
09.00	Opening session Chair Lidava Sekhar Nacothu
09.00	Welcome and workshop expectations
	Bioeconomy - Technology and innovations: Where do we stand?
09.10	Nils Vagstad, Acting Director General, NIBIO / BIONÆR Steering Committee
09.20	Terje Halleland, State Secretary, Ministry of Agriculture and Food, Norway
09.35	Indo-Norwegian cooperation: Potential for business development in Bioeconomy N. Ponnappan, Embassy of India, Oslo
09.45	Bioeconomy - an Indian perspective and role of gender Rengalakshmi Raj, MSSRF, Chennai, India
09.55	Innovation driven Bioeconomy - potential for Indo-Norwegian cooperation Marianne Jensen, Research Council of Norway
10.05	Norwegian bioeconomy business interests in India Inger Midtkandal, Norwegian Embassy, New Dehli/Innovation Norway
10.15	Coffee break
10.30	Plenary - Oral Presentations
	Biotechnology, microbes, algae and other plant based sources Chair: Durlubh Kumar Sharma
10.30	Searching new products from plant and microbes for human and plant health Nutan Kaushik, TERI University, New Dehli
10.45	Operations focusing on kelp harvesting and sustainable management Trond Helgerud, FMC BioPolymer AS, Norway
11.00	Plant green factory for bioeconomy Jihong Liu Clarke, NIBIO
	Bio-based resources and bio-energy Chair: Nutan Kaushik
11.15	Emerging role of bioenergy to promote bioeconomy - Focus on biofuels and other value added chemicals Durlub Kumar Sharma, IIT, New Dehli
11.30	Indian experience in liquid biofuels and the emerging new breakthrough opportunities Jai Uopal, Alternate & Renewable Energy, New Debli
11.45	Sustainable organic waste management
	Agriculture, forestry, food technology and processing
12.00	Community based sustainable natural resources management - Innovative model or medicinal plant species management and value addition
12.00	Muthu Velayutham Nagamalai, Covenance Centre for Development, Chennai
12.15	Bioeconomy, smallholders and agriculture - ensuring food security and nutrition through sustainable methods of production
40.00	Maggi Brigham, Norwegian Centre for Rural Research Bioeconomy - Economic challenges with a focus on Norway
12.30	Eirik Romstad, Norwegian University of Life Sciences
12.40	into the ocean back to the land Trond Rafoss, NIBIO
12.50	Opportunities in bioeconomy from a forestry perspective Jakob Sandven, Norskog
13.00	Lunch
	Marine sector, fisheries and aquaculture Chair: Marit Aursand
13.45	Improved resource utilization in marine value chains: Opportunities for India and Norway Maitri Thakur, SINTEE

# PROGRAM

	PROGRAM – 6 September				
14.15	Use of environmental management system to conceptualize sustainability and circularity in the marine sector Paritosh Deshpande, Norwegian University of Science and Technology				
14.25	Promoting an inclusive small scale fishery value chain for sustainable development: Case from South India Velvizhi Singaravelu, MSSRF, Chennai				
14.35	Possibilities for increased harvest from the ocean Åsmund Bjordal, Center for Development Cooperation in Fisheries, Institute of Marine Research				
14.50	Offshore Seaweed System (OSS) - Micro algae growing system Øyvind Johnsen, CoreMarine AS				
15.00	Group work Moderator: Per Stålnacke, NIBIO Issues to focus on: Bio-based resources, technology innovations, investments, policy support, gender, value chain enhancement, job creation, economy				
	Group 1: Agriculture, forestry, food technology and processing Group leaders: Maggi Brigham and Muthu Velayutham Nagamalai Key words: Securing food security, nutrition, sustainable methods of production, inclusive policy, improving smallholder - rural economy and job creation				
	Group 2: Biotechnology, microbes, algae and other plant based sources Group leaders: Nutan Kaushik and Trond Rafoss Key words: Bioprospecting, sustainable utilization, methods for large-scale cultivation, product development, policies and regulations				
	Group 3: Bio-based resources and bio-energy Group leaders: Vivekanand Vivekanand and Jai Uppal Key words: Sustainable utilization, methods for large-scale production, technology, policies and regulations				
2	Group 4: Marine, fisheries and aquaculture Group leaders: Velvizhi Singaravelu and Jaya Kumari Key words: Food security and nutrition, sustainable methods of production, inclusive policy, economy and job creation				
16.30-17.15	Short films and Network Café				
18.00	For those who are interested: Sightseeing by walk in Oslo Suggestion: Walk from Opera House to Akershus Fortress and Rådhusplassen				
19.00	Workshop dinner Der Pepper'n Gror, Fridtjof Nansens pl 7				
PROGRAM – 7 September					
08.30	Excursion visiting Romerike Biogas Plant Bus from Thon Hotel Opera to Romerike Biogas Plant				
09.45	Presentation and demonstration of Romerike Biogas Plant, showing the potential for this type of biogas installation Nils Finn Lumholdt and Espen Govasmark				
11.30	Bus from Romerike Biogas Plant to Mathallen, Oslo				
12.30	Lunch at Mathallen, Oslo				
13.30	Panel debate: Creating value from bio-resources: Innovation in bioeconomy Moderator: Udaya Sekhar Nagothu				
	Panel Lokesh Jayaswal, Telangana State Government, Hyderabad Marit Aursand, SINTEF, Norway Nutan Kaushik, TERI, Delhi Petter Nilsen, Research Council of Norway Gayathri Rao, Coastal Corporation Limited, India				
14.30	Presentations from the group work and discussion Outcome: Recommendations from the workshop				
15.30	Summary and follow-up Rengalakshmi Raj, MSSRF and Udaya Sekhar Nagothu, NIBIO				
16.00	End of workshop				

Annex 2 – List of participants

Indo-Norwegian Joint Workshop on Bioeconomy						
6-7 September 2016						
List of participants						
Name	Title and organisation	Email				
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	Department of Forests,					
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Name	Title and organisation	Email
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Anyaniveetii	(CIFT), KUCHI, KEIdid	zynd@reannall.com

### Feedback from some participants

Dear all,

Thank you all for an inspiring workshop last week and a good organization of it! Looking forward to the following up activities. I have no further comment on the summary report than those already given.

Best regards, Petter Nilsen, PhD Special Adviser; The Research Council of Norway, Divison for Energi, Resources and the Environment Land-based Bioresources and Environmental Research Tlf: +47 98094860; E-post: pn@rcn.no

### Dear Sekhar,

I am impressed by the work that you and your colleagues have done before, during and after the workshop, including writing the summary report. This report is identifying a huge scope of opportunities related to the Bio Economy in India and Norway.

### Best Regards,

Andreas Rosenberg Rådgiver, Seksjon for forskning og innovasjon Avdeling for forskning, innovasjon og regionalpolitikk Landbruks- og matdepartementet Telefon 22 24 91 41

### Dear Sekhar

Thanks you for very interesting and inspiring two days with NIBIO and yourself and all the amazing people who attended. It truly was for me a great experience. Thanks again and kindest regards,

### Øyvind Johnsen



Dear Prof.Sekhar,

First, let me congratulate you for conducting such a nice & informative workshop successfully. I really enjoyed attending the same & I wish to thank you for the kind hospitality provided during the workshop.

I have gone through the detailed report that has been very nicely prepared. However, I do have some suggestions for the portion Summary and Way forward especially related to my area of bioenergy. I would again like to thank you & your other colleagues for the kind hospitality during our stay at the Oslo.

With best wishes Prof.D.K.Sharma IIT Delhi

### Dear Dr. Sivaji,

A quick note to let you know that we just concluded a very successful workshop on bio-economy with great participation from both Indian and Norwegian side. The organizers NIBIO and MSSRF have done a great job, including full knowledge triangle from both countries. I am confident this work will bring fruits in the long run.

Please see published news below. Looking forward to see you in Oslo for the Joint Working group next week! Best regards, Inger Midtkandal, Innovation Norway/Royal Norwegian Embassy, Delhi

Thanks a lot. It was a very good experience from the workshop. Lot of take home messages to NOFIMA and opportunities for collaboration. Thanks for this opportunity and looking forward for your co-operation in future. Best regards, Jaya Kumari NOFIMA

### Sekhar and Marte

I once again congratulate both of you for the excellent conduct of the workshop. it was a really wonderful experience to attend such a programme which was extremely well managed. It was marvellous with the time management as the programme was over by 3.59.

The walk around the city, the return walk from Mathallen to Thon hotel though the stream side, the food festivals all the days; everything we really enjoyed. You both have taken lot of pain for the conduct of the programme, for arranging the stay, visit to Romerike etc etc. once again thank you for everything. Thanking you both once again on behalf on CIFT.

with warm regards Dr. Zynudheen CIFT , Cochin

Hei,

Vi vil gjerne takke deg for et godt bidrag til Joint Working Group-møtet med India sist torsdag (15.09). Din presentasjon ble riktig godt mottatt på både norsk og indisk side, og det var svært nyttig å få oppsummeringen fra workshopen. Dette temaet blir jo særlig aktuelt nå som bioøkonomi etter planen skal nevnes spesielt i arbeidsprogrammet.

Vennlig hilsen - på vegne av Kunnskapsdepartementets India-gruppe, Hanne Hvatum

Seniorrådgiver Hanne Hvatum Forskningsavdelingen, Kunnskapsdepartementet hah@kd.dep.no