



Ministry of Foreign Affairs

“FROM BURNING TO BUYING: CREATING A CIRCULAR PRODUCTION CHAIN OUT OF LEFT-OVER CROP RESIDUE FROM INDIAN FARM LAND”

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**“FROM BURNING TO BUYING: CREATING A CIRCULAR
PRODUCTION CHAIN OUT OF LEFT-OVER CROP
RESIDUE FROM INDIAN FARM LAND”**

MAT18IN01, Final Report
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1. Acknowledgements

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2. Introduction

About MVO Nederland

MVO Nederland is the largest sustainable business network in Europe. Together with almost 2000 entrepreneurs, it forms a movement that accelerates the transition to a new economy. A healthy economy in which positive financial results go hand in hand with care for our planet and people.

Therefore, the focus is on four themes, with emphasis on innovation and upscaling:

- **Climate neutral business;**
- **Circular economy: doing business without waste;**
- **Inclusive entrepreneurship:** entrepreneurship in which every talent, with or without limitations, counts and participates;
- **Inclusive and sustainable entrepreneurship in the supply chain: entrepreneurship with added value** for people and the environment, where human rights and good working conditions are the norm.

Context of the project

This document is the final report of the project **“From burning to buying: Creating a circular production chain out of left-over crop residue from Indian farmland”**, with reference MAT18IN01, executed by MVO Nederland.

MVO Nederland, with the “Omzet met Impact” program, financed by the Netherlands Ministry of Foreign Affairs, identifies sustainable market opportunities and Corporate Social Responsibility risks in 12 countries on 3 continents. Dutch entrepreneurs are matched with local entrepreneurs and develop projects focused on sustainable sourcing, delivery and production, providing solutions to real life problems.

India is one of the program countries of “Omzet met Impact”. In 2017, MVO Nederland carried out a Sustainable and Inclusive Business Scan, commissioned by the Netherlands Embassy in India. As a follow-up, the INDUS platform was developed, an online matchmaking platform. On this platform, Dutch and Indian Business partners can find each other, share sustainable challenges and solutions and work together on sustainable business cases. Within Indus, two pilot projects have been defined that act as a “showcase” for the active matchmaking of Indus. This is the circular yarn project on the one hand, and the valorization of Paddy straw project on the other hand. The aim of this project is to play a key role in transforming left-over crop residues into sustainable new products. Valorisation or upcycling the crop residues contributes to the circular economy in the agricultural sector, which will create social, environmental and economic impact. Waste will become a feedstock and can create extra farmers income, less air pollution and less deforestation. During the trade mission in May 2018, MVO Nederland signed a Memorandum of Understanding (MOU) with 16 partners, entrepreneurs, knowledge institutions and NGOs, to come up with solutions for the valorisation of crop residues.

Expressing interest was a very important first step. It is just the beginning, since the overall question on how to develop a sustainable business case for high-end re-use of paddy straw, in the districts of Punjab and Haryana, remains.

In an effort to address the overall question, the Netherlands Embassy in India assigned the current project to MVO Nederland. This **project is called “From burning to buying: Creating a circular production chain out of left-over crop residue from Indian farmland”, with reference MAT18IN01.** The period of its implementation is from December 2018 to June 2019. The project focus is on residual crops from the districts of Punjab and Haryana, for their proximity to Delhi. This project

received financial support from the Netherlands Enterprise Agency, within its Private Sector Development App program. MVO Nederland considers this project of strategic importance, and a vital step towards a long-term Indian-Dutch business relation towards circular economy. The project consists of three phases, as chapter 3 explains. MVO Nederland entirely finances the phase 1 from the **“Omzet met Impact”** program. **Phase 2 and phase 3 are co-financed by RVO.**

The objectives of the project are:

- Exploring which residual crops are most suitable for setting up a circular production chain (either paddy straw, bamboo or sugar cane);
- Bringing together Dutch and Indian stakeholders¹ to set up circular production chains out of one or more of the mentioned residual crops.

Firstly, the problem analysis will be discussed in this final report, followed by the project approach. Secondly, the project outputs per project phase will be explained. The most suitable residual crop for setting up a circular production chain will be described and which Indian companies have been approached during the field trips. Attention will then be given to important developments. Finally, the sustainability of the project will be discussed and the follow ups.

3. Problem Analysis

According to the Directorate of Economics and Statistics, India, with 17% of the world population, in 2012–2013, India generated 361 million tons (Mt) of sugarcane, 94 Mt of wheat and 105 Mt of rice. The annual production of bamboo in India is about 4.6 Mt; about 1.9 Mt is used by the pulp industries² (table 1). Of the various crops grown, majority crop residue of rice, wheat and sugarcane are burned³.

These crops are preferred by farmers since they provide higher economic return, as compared to other crops.

Crop	Production Estimate of Major Crops in India (Mt)
Rice	105
Wheat	94
Sugarcane	361
Oil seeds	30
Cotton	35
Jute	11
Pulses	17
Bamboo	4.6

Table 1. Crop Production Estimate of Major Crops in India

Based on the National Policy for Management of Crop Residues (NPMCR)⁴, it is evident that the generation of crop residues is highest in the state of Uttar Pradesh (60 Mt) followed by the other states Punjab (51 Mt) and Maharashtra (46 Mt) with a grand total of 500 Mt per year, out of which 92 Mt is burned. Rice and wheat contribute nearly 70% of the crop residues.

Causes and scale

The main causes of crop residue burning are two-fold. Firstly, there is a very short window of time between harvesting of paddy and cultivation of wheat, at the end of the Kharif⁵ season. Paddy, or rice, is a water-intensive crop. The high usage of water in its cultivation has resulted in the central and various state governments restricting the cultivation of paddy in the summer months. In order to prevent diversion of scarce water resources in the summer, paddy cultivation can legally begin only around mid-June, when the monsoons typically arrive over North India. Cleaning the land by hand is almost impossible, because of the short term between harvesting and sowing. The disadvantage of the current automatic systems with harvesters is that they leave 6-10 cm of paddy stalk on the field which they burn.

Another factor that delays cleaning the land, is that agricultural labor has become a scarce commodity in parts of Punjab and Haryana. The removal of the paddy stalk that remains on the field is a labor-intensive process. The farmers started to use combine harvester machines to tide over the labor scarcity. The machine finishes the task of reaping, threshing and winnowing in a few hours. However, the machine appears to be the key reason behind the problem because it only reaps the grains, leaving stalks or stubble of around 40 cm.

² <http://www.fao.org/3/ad871e/ad871e10.htm>

³ Bhuvaneshwari, S., Hettiarachchi, & Meegoda, J. N. Crop residue burning in India: policy challenges and potential solutions. International Journal of Environmental Research and Public Health. 2019, 16, 832.

⁴ NPMCR. Available online: http://agricoop.nic.in/sites/default/files/NPMCR_1.pdf

⁵ The Indian cropping season is classified into two main seasons- 1) Kharif and 2) Rabi based on the monsoon. The kharif cropping season is from July –October during the south-west monsoon and the Rabi cropping season is from October-March (winter). The crops grown between March[1] and June are summer crops.

With labor being unavailable and the time window for preparing the field for wheat cultivation being limited, the options that the farmer has are either investing in expensive and rarely used agricultural implements or burning the residue right on the field. Of the two, the latter is both cheaper and requires less effort. As per estimates, Punjab, Haryana and Uttar Pradesh today burn amongst the highest volumes of crop residue in the country - close to 20 million tons, 10 million tons and 11 million tons respectively⁶ (see photo 1 for the locations of the burning⁷).

Impact of crop residue burning on the environment

The Indian Agricultural Research Institute⁸ study estimates that in 2008-09, crop residue burning released 149.24 million tons of carbon dioxide (CO₂), over 9 million tons of carbon monoxide (CO), 0.25 million tons of oxides of sulphur (SO_x), 1.28 million tons of particulate matter (PM) and 0.07 million tons of black carbon. Their analysis shows that PM emissions from crop burning in one year is more than 17 times the total annual particulate pollution in Delhi from all sources—vehicles, industries, garbage burning, etc. Similarly, the total national annual emission for CO₂ from crop residue

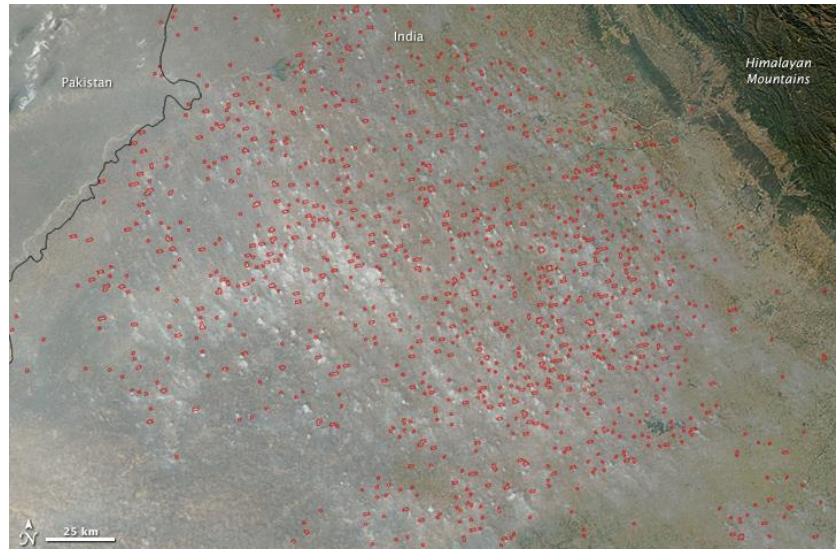


Photo 1: Red outlines show the approximate locations of active burning. October 2014.

burning is more than 64 times the total annual CO₂ pollution emission in Delhi. For SO₂, the total national annual emission from crop residue burning is about five times the total annual SO₂ pollution emission in Delhi. This can lead to a number of health problems. A study by the Institute for Social and Economic Change, Bengaluru, has estimated that people in rural Punjab spend Rs 7.6 crore every year on treatment for ailments caused by stubble burning. Moreover, climate scientists have already linked fine particulate matter in the haze to the melting of Himalayan glaciers.

Apart from humans and animals, residue burning also adversely contributes to loss of biodiversity of agricultural lands, and the deterioration of soil fertility⁹. Burning one ton of rice straw accounts for a loss of 5.5 kg of Nitrogen, 2.3 kg of Phosphorous, 25 kg of Potassium and 1.2 kg of Sulphur in the soil. Heat from burning straw penetrates 1 cm into the soil, elevating the temperature to as high as 33.8-42.2 °C¹⁰. This accounts for the loss of organic carbon, nitrogen, and other nutrients, which would otherwise have retained in soil. Additionally, this kills the bacterial and fungal populations critical for a fertile soil. Estimations show **that the monetary cost, of burning to Punjab's farmers, is** around Rs 800-2,000 crore every year in terms of nutritional loss and Rs 500-1,500 crore in the form of government subsidies on nitrogen, phosphorus and potash fertilizers.

⁶ Sarma, S. D. Paddy Residue burning: drivers, challenges and potential solutions. The Energy and Resources Institute, 2018. Ministry of New & Renewable Energy, Govt. of India, New Delhi, 2009

⁷ <https://earthobservatory.nasa.gov/images/84680/stubble-burning-in-northern-india>

⁸ Emission of Air Pollutants from Crop Residue Burning in India, Niveta Jain*, Arti Bhatia, Himanshu Pathak, Centre for Environment Science and Climate Resilient Agriculture, Indian Agricultural Research Institute, New Delhi, India, 2013

⁹ Loan, S.K.; Jat, H.S.; Yadav, A.K.; Sidhu, H.S.; Jat, M.L.; Choudhary, M.; Jyotsna Kiran, P.; Sharma, P.C. Burning issues of paddy residue management in north-west states of India. *Renew. Sustain. Energy Rev.* 2018, 81, 693–706.

¹⁰ By Jitendra, Shreeshan Venkatesh, Ishan Kukreti, Kundan Pandey, Deepanwita Gita Niyogi, Polash Mukerjee, June 2017 available at <https://www.downtoearth.org.in/coverage/india/river-of-fire-57924>

Initiatives from the Indian side

The Ministry of Agriculture and Farmers' Welfare, Government of India, proposes several mandates to the Indian states, the central administration and regulatory bodies, to address the paddy residue problem. It describes them in the National Policy for Management of Crop Residue, 2014 (NPMCR)¹¹, and they are as follows:

- *Diversified crops or use of crop residue* for various purposes like charcoal gasification, power generation, as industrial raw material for production of bioethanol, packing material, paper/board/panel industry, composting and mushroom cultivation etc.;
- *Control of burning* of crop residue to prevent environmental degradation and loss of soil nutrients and minerals by promotion of in-situ management (incorporation in soil, mulching, baling/binding for use as domestic/industrial fuel, fodder) of crop residue;
- *Capacity building and awareness* about ill effects of crop residue burning and its effective utilization and management; and
- *Formulation and implementation* of suitable law and legislative/policy measures to curb burning of crop residue.

The open air burning of crop-residue persists

As the previous section outlines, the Government of India promotes lots of alternatives to burning, but all have their problems. Considering the *Diversified use of crop residue*, paddy straw is not nutritious enough to make good animal fodder, and its high concentrations of silica can damage traditional farming equipment¹². As rice is typically grown in small fields, it is not always possible, or affordable to use the high-powered machinery necessary to till the straw deep into the soil prior to planting wheat. Those who want fodder have to get the stubble removed manually or use other specialized machines to do the job. But that is costly. For every 0.4 ha of wheat crop, the cost of renting a combine harvester is just Rs 800. Once the machine has harvested, the cost of getting the stubble removed is Rs 3,500/ha. So, the value of fodder is discounted, and at the end it is more economic for the farmers to just burn and clear the fields. Therefore, the high cost of these implements means that in spite of subsidies, only a small number of farmers have access to these implements at the moment.

In addition, there are major problems and constraints in crop diversification, mainly due to various reasons. Among some of them are, the fact that 66 percent of the cropped area in the country is completely dependent on rainfall and the inadequate supply of seeds and plants of improved cultivars.

Other solutions like using straw for biomass power require lots of new infrastructure. Straw is already collected and baled today in a few of Punjab's farms, and other areas near biomass power plants. But baled straw is difficult to handle, and bulky to transport and store. But also, establishment of a larger number of biomass-based power projects utilizing greater amounts of paddy straw is needed¹³. Currently, operational and planned projects in Punjab cumulatively utilize just 0.94 million tons of paddy straw against estimated 19-20 million



Photo 2: In situ stubble burning after harvesting of crop

¹¹ NPMCR available at http://agricoop.nic.in/sites/default/files/NPMCR_1.pdf

¹² Berry, R. & Sagi, A. S. How to fix India's burning issue- turn unwanted straw into bio-energy pellets. Phys.org, 2017.

¹³ Mukerjee, P. Crop burning: Punjab and Haryana's killer fields. DownToEarth, 2016.

tons of production. Punjab will have to expedite the construction of plants in progress and plan new one. Haryana has no operational biomass-based power projects presently.

Paddy straw burning is illegal but, since the alternatives are either impractical or expensive, most farmers still do it (Photo 2¹⁴). It is evident, that irrespective of government policy and wider environmental considerations, any solution must give a good incentive to farmers not to burn in the future.

¹⁴ Singh, J. Paddy and wheat stubble blazing in Haryana and Punjab states of India: A menace for environmental health. *Environmental Quality Management*, 28(1), 2018.

4. Project approach and outputs

The previous chapter shows that despite the existence of policy mandates, their adoption has been low and burning of crop residue persists. Even more, according to the satellite data from NASA (VIIRS), there was an increase in open fire counts during October and November in 2018 compared to the previous year¹⁵. So the question remains what the solution might be that will give the incentive to the farmers not to burn. Against this background, the current project is developed. The project follows an approach that is set out in three phases: identification, consolidation and formalization. These phases will be described, as well as the outputs per phase.

PHASE 1: IDENTIFICATION

(December 2018 – January 2019)

This phase focused on understanding the supply chain of the different crop residues in India. During a mission to India, that took place in December 2018, MVO Nederland analyzed issues like the availability and the quality of paddy straw, bamboo and sugarcane. (see annex 1 for a summary of the meetings during the first mission). Below, an overview is given of the potential of paddy straw, bamboo and sugarcane in the states of Punjab and Haryana.

Paddy straw

In India rice is grown in 43.86 million hectares of land, the production level is 104.80 million tones, the productivity is about 2390 kg/ha and India generated 105 Mt of rice in 2012-2013¹⁶. This makes India the second largest producer of rice worldwide. Paddy and wheat cropping are a widespread farming practice in northwestern parts of India, primarily in the riverine plains of Haryana and Punjab. These fertile lands are well known for extensive agricultural fields; however, they are equally infamous for the burning of paddy and wheat straw and stubble by farmers after the harvesting season.

In India, it is reckoned that 22,289 gigagrams (Gg) of paddy stubble biomass is generated annually, and of this 13,915 Gg (62.42%) is set ablaze in the agricultural fields. Haryana and Punjab alone produce 48% of the whole straw production in India, which is openly burned in situ¹⁷. The highest contribution to the amount of residue burned on the farm is from the states of Uttar Pradesh, followed by Punjab (20 Mt) and Haryana (10 Mt)¹⁸. Over 25% of the total crop residues were burnt on the farm. Among different crop residues, the cereals crops generated 58% of residue while rice crop alone contributed 53% and wheat ranked second with 33% of cereal crop residues (Figure 1)¹⁹. Eighty percent of the crop residue burning took place during the post-harvest period of April-May and November-December.

¹⁵ <https://earthobservatory.nasa.gov/images/144181/smokier-and-smokier-skies-in-india>

¹⁶ National Food Security Mission, A status Note on Rice in India, 2016.

¹⁷ Singh, Jabrinder. Paddy and wheat stubble blazing in Haryana and Punjab states of India: A menace for environmental health. Environmental Quality Management. 2018.

¹⁸ Bhuvaneshwari, S., Hettiarachchi. & Meegoda, J. N. Crop residue burning in India: policy challenges and potential solutions. International Journal of Environmental Research and Public Health. 2019, 16, 832.

¹⁹ Burning issues of paddy residue management in north-west states of India Shiv Kumar Lohana, H.S. Jatb,*, Arvind Kumar Yadavc, H.S. Sidhud, M.L. Jatb, Madhu Choudharyc, Jyotsna Kiran Petere, P.C. Sharmac, Elsevier, Renewable and Sustainable Energy Reviews 81 (2018) 693–706

The intensive farming practices of Indo-Gangetic Plains in Punjab and Haryana include the burning of 30 million ton paddy straw, as it is the easiest and most economical option to get rid of it during the short period available between the rice and wheat crops (as explained in the problem analysis). This burning is the main cause of air pollution in Punjab and Haryana. This is of grave concern since it results in GHG emissions, with grave health risks. But it also causes the removal of nutrients from the soil in the burned areas.

It is therefore important further to investigate the avoidance of field burning, and instead the paddy **straw's** removal. Since that will enable faster replanting. It will enable field sanitation, since there can be benefits by recycling nutrients back to soil. And there may be benefits in terms of circularity, as well. Overall the farm output and productivity will increase.

Earlier research²⁰, in Haryana state, identified a Dutch technological solution that can transform the paddy straw to valuable application. For example, ECOR technology can transform paddy straw to panels, that can be used for furniture, gift boxes, doors, kitchens, displays etcetera. Other circular products, identified in the course of this project, that could be made from the potentially removed paddy straw from the farm are packaging, paper and silica extraction. From the one hand, the processing of the paddy straw, because of its high amounts of silica remains a challenge. From the other hand, it is generally known that the extract of silica from the paddy straw is viable, and it may be used in the production of car tires and solar panels (see also section 2c).

The above applications create opportunities for the farmers, who struggle to find alternatives to not burning. Still though the feasibility for the farmers of removal and selling the paddy straw for the identified applications, versus burning needs to be calculated. And together the potential social and economic benefits to the farmers, for trading the paddy straw. Benefits in term of extra income generation, rural development, employment and local value added. Form the other side, also several costs need to be calculated, like the costs of collecting, and delivering the residues from the land to the pulp processing plant, as well as their operation costs. Least but not last, the benefits from the environmental pollution reduction need also to be taken into consideration. These calculations, among others, need to be assessed, so to determine the applications' viable commercial value.

Bamboo

India, China and Myanmar have 19.8 million hectares of bamboo reserves which represent 80% of the world's bamboo forests. India represents the global bamboo growing landscape with 136 species, 23 genera spreading over 10 million ha, which makes it the second largest bamboo growing country in the world after China²¹. Assam area (Figure 2²²) produces the largest amount of bamboo in India, as most of its forests are throbbing with bamboo plantation of various species. Bamboo is an important non-wood forest product used in furniture, construction, shoots as food, pulp and paper industry and handicrafts. This fast growing plant has the capacity to substitute wood in the near future. Bamboo from the Assam area is mainly used in the paper manufacture in the state itself. Besides that, bamboo is not burned, not even as fuel wood in the kitchen, due to an Indian Hindu tradition.



Figure 1: Residue burned on the farm is from the states of Uttar Pradesh, followed by Punjab and Haryana

²⁰ Alternatives to straw burning in Punjab and Haryana, India SMP 18011, Wolter Elbersen & Edwin Keijsers, Wageningen, 2019

²¹ India State of Forest Report 2017 is a biennial publication of Forest Survey of India, Ministry of Environment Forest & Climate Change of India

²² Source <https://www.mapsofindia.com/answers/india/state-largest-producer-bamboo-india/attachment/which-state-is-maximum-in-the-production-of-bamboo-in-india-2/>

There are initiatives to grow bamboo in India because of the future demand in the furniture sector. One of these initiatives is IKEA India. Nevertheless, IKEA bases its strategic sourcing in China, where plantations have been cultivated 5-15 years ago²³. China is the number one supplier of Bamboo for IKEA.

Since bamboo is not cultivated in the state of Haryana and Punjab, its availability, environmental risks or benefits from its cultivation, harvesting operations were not further explored in the context of this project. For the same reasons neither attention was given to identify if, from the one hand it generates residue streams; and from the other hand if they may have viable commercial value. Further research is clearly required on the above areas, if the geographical focus will be shifted to the Assam state.

Sugarcane

India has the largest sugarcane growing area in the **world and it is the world's second largest producer of sugarcane**, besides Brazil. India produced around 352 million tons of sugar in 2015-16. Largest sugarcane producing state of India is Uttar Pradesh, which has 38.61% share in overall sugarcane production as per 2013-14 figures.

Interviews with various stakeholders reveal that the by-products from sugarcane business is “well” organized, meaning that all the by-products are almost completely used. The processing of sugarcane generates bagasse, molasses and press mud.

Bagasse is the dry pulpy fibrous residue that remains after sugarcane stalks are crushed to extract their juice. It is not burned in the open air. Even if may be used in the manufacture of pulp and building materials, it is not preferred because it is a difficult material to work with. Its properties make bagasse very stringy, with a consequence to make it particularly problematic for paper manufacture. And it is more expensive per ton than paddy straw. However, almost all sugar mills in India are traditionally using cogeneration by using all their produced bagasse as a fuel for the production of the sugar. For example, large commercial players like Godavari bio refineries are using this production chain²⁴. Godavari bio, and a governmental owned sugarcane company, both create a stream of agriculture feedstock in bagasse and sugarcane leaves. This stream is a reliable source of energy, because the amount of 140.000 tons bagasse provided by Godavari is continuous, has a well-organized logistic system and it is enough for being used as a fuel for the sugar production. Molasses, is another by-product of the sugar industry. It is used in the manufacture of ethyl alcohol, Indian made foreign liquor (IMFL), as a table syrup and Food Flavourant. It is also used as feed for farm animals and in the manufacture of several processed tobaccos. Molasses can be boiled again in an attempt to crystallize out some of the rich sucrose content of this liquid. However this process is not economical.²⁵

Concluding, bagasse is not open-air burned, and it is not seen as waste. Instead, mostly all sugar mills involve cogeneration system which use bagasse as fuel in order to meet power and steam requirements of their production process. Any excess is sold back to the grid. So there is already a well-established market for the bagasse. Sometimes in India the price of the bagasse reaches as much as the commodity itself. What is more, the Indian government has promotional policies for the



Figure 2: Assam, the largest producer of bamboo in India

²³ Interview with Peter Nilsson, Head of bamboo product within IKEA Global

²⁴ Godovari is one of the 16 signees of the Memorandum of Understanding on the 'Biomass For All', May 24, 2018

²⁵ S.S. Shree Harsha Kumar*, G. Prakasha, D.C. Hanumanthapa and Sharanappa Kuri, Diversified Use of Byproducts of Sugarcane and Cotton - A Review Department of Agronomy, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India, International Journal of Current Microbiology and Applied Sciences, ISSN: 2319-7706 Volume 7 Number 03, 2018

cogeneration and other biomass based power projects. As for example, the Indian Renewable Energy Development Agency (IREDA) provides loan for setting up biomass power and bagasse cogeneration projects. And the Ministry of New & Renewable Energy (MNRE) GoI, has been supporting the cogeneration power projects by giving back ended subsidy.

Often the final decision is based on economics. If we want to create another business model based on bagasse, we should calculate the option to possible run the sugar mill with other kind of energy; and free up the bagasse as a source of fiber for pulp production, and further down the production process possible to turn the pulp into ethanol. **We didn't do the calculations, but many studies around the world** have identified sugar mill cogeneration as an attractive low-cost power option. In case of Indian is all subsidized by the government. Then the inevitable conclusion is that the sugar mills are better off burning bagasse than selling it for pulp production and down-stream for bio-ethanol production.

Conclusions on crop residue

The main mission findings can be summarized as following:

1. There are enough partners to **create a structural quantity of a “fixed” quality of paddy straw.**
2. The supply chain is less organized than within the sugar cane industry, but the needed quantities (more than 100.000 tons) can be well organized by Farm2energy, Farm solutions or Haryana Agriculture University. The university can serve as a hub to reach more organizations.
3. The burning of 20 million ton of paddy straw in the Haryana and Punjab states is the main cause of air pollution. In contrast, bamboo and sugar cane feedstock are not being burned and they are therefore not contributing to air pollution. Since one of the goals of this project is also to reduce air pollution, the most logical choice is to focus on paddy straw.
4. Income wise, the support to the paddy straw farmer is most welcome. All farmers struggle, but in the sugar cane business the organization rate of the business is already further ahead than in the paddy straw business.
5. Besides paddy straw, rice husk is another interesting feedstock stream that is linked to rice. Rice husk will be researched to understand the potential of the cellulose fibers.
6. The processing part of paddy straw is more complicated, because of the high amounts of silica the feedstock contains. In practice this means that there are less applications and therefore less interest of the industry. Nevertheless, Dutch technologies can work with the high amounts of silica.
7. For more detailed information on paddy straw in the states Punjab and Haryana, the WUR report is a good source of information. Based on the WUR report and the findings of the mission, we can conclude that it is possible to obtain the needed amount of paddy straw for the project.

Based on the above findings the focus of this project will be on paddy straw, instead of bamboo or sugarcane. Therefore, we chose to focus at the feedstock with the highest potential, the paddy straw that gives value to waste, and most importantly we focus on the one where we identify companies that commit themselves to work together and to calculate the business case.

However, these crops do have some potential but in relation to paddy straw they are of lesser interest. Below a small overview presents the main conclusions per each crop residue. In case other companies are interested in other feedstocks, they could get in contact with us, because of the network we build up, we could link them with interesting parties.

Paddy straw	+ many applications possible (packaging, paper, panels, silica)
	+ there are enough partners to create a structural quantity of a “fixed” quality of paddy straw
	+ India is a big producer of paddy straw
	+potential social and economic impact will be bigger to the rice straw farmers

Paddy straw	+Dutch companies have the solution on working with high amount of silica
	+not only paddy straw but also rice husk might have potential applications
	+ Indian government focusses at paddy straw burning
	- paddy straw is being burned in situ and is the biggest reason for smog out of crop burning
	- GHG emissions
	- affects farmer's income
	- processing is difficult due to the high amount of silica
Bamboo	+ capacity to substitute wood in near future
	+ India is a big producer of bamboo
	+ bamboo is not being burned
	- culturally not acceptable to burn bamboo
	- bamboo is not present in Haryana and Punjab state
Sugarcane	+ India is a big producer of sugarcane
	+ India has a well-organized sugarcane business
	+ bagasse as valuable by-product, is not seen as waste
	+ bagasse has several applications (fuel e.g.)
	+ cogeneration possible
	+ Bagass a residue of sugarcane is used for boilers and so for energy
	+ sugarcane is not being open burned
	- more expensive per ton than paddy straw
	- Big sugarcane companies as Godavari are much better organized than in the rice straw area so small famers of paddy straw will benefit more than for example sugarcane farmers

PHASE 2: CONSOLIDATION

(February – March 2019)

The second phase builds on the decision that paddy straw is the focus; and on the knowledge that Dutch innovative solutions exist on transforming paddy straw to circular products. MVO Nederland aimed, during a second mission to India, that took place in February 2019, to understand which supply party, distributor, and market player could be matched with each other, regarding each identified circular product (see annex 3 for a summary of the meeting during the second mission). The identified circular products are packaging, paper and panels. The 16 partners of the MoU were the main envisioned stakeholders, but in order to make suitable connections, MVO Nederland did not limit itself to these 16 partners. The most important aspect was finding suitable partners who could form a successful business chain together. MVO Nederland did that by identifying and linking **suppliers to the market to create business “connections”**. In this phase, through discussions with all stakeholders – both in the Netherlands and in India – all dots were connected (see annex 2 for a summary of the meeting in the Netherlands).

First, the identified Indian partners involved in the collection and storage of paddy straw will be highlighted (2a). Secondly, the Dutch partners with technology for the identified applications are illustrated (2b) and finally the business connections will be presented, for packaging, paper, panels and energy (2c).

2a. Indian parties involved in the collection and storage of paddy straw, in the area of Punjab and Haryana

MVO Nederland identified Indian parties who were able and willing to partner to investigate if paddy straw is of economic value for a new production chain. Through interviews with various stakeholders during the first mission in India (see annex 1), MVO Nederland concluded that

currently, there is no uniform mechanism to collect, store, or transport paddy residue. However, there are enough **partners to produce a structural quantity of a “fixed” quality of paddy straw**. The supply chain of paddy straw is less organized than the sugar cane industry, but the needed quantities, more than 100.000 tons, can be well organized and stored by Farm2energy, Farm solutions or Haryana Agriculture University. Enterprises, such as paper plants, confirm that they can recycle paddy residue. However, to run economically, a plant needs residue from 60-70 acres of land daily, along with six months of storage infrastructure.

The following parties assured that they have the ability to organize the supply chain and to provide the industry with the necessary quantities (see annex 1). They were willing to join forces with Dutch partners.

- *Farm solutions- Chandigarh*: Farm solutions is a company based in the area of Chandigarh. Farm solutions offer services, training, and financial services to 200-300 farmers. They collect data and based on this data, they advise and support the farmers. Farm solutions could act as a contractor, to supply paddy straw. That means they will serve as an intermediary between the farmers producing the paddy straw and the companies using it as raw material. And they will be in the position to improve the economic position of those individual farmers. Prices, including transport, are 2500 Rupees per ton in an area of 50 kilometers. This price was confirmed in other meetings as well, for instance in the meeting with Haryana Agriculture University.
- *Farm2Energy- Chandigarh*: Farm2energy is a real contractor which collects 5000 tons paddy straw on four different spots. They are an interesting organization to work with, because they understand the collection process, transportation and the processing of paddy straw. The processing of paddy straw is difficult, because of the high silica content.
- *Haryana Agriculture University – Hisar*: The Haryana agriculture university (HAU) invited MVO Netherlands to give a presentation about the Indus paddy straw project to the board of directors. The university with 5000 students and 1600 teachers, is specialized in biomass. Besides the main campus at Hisar, it has research and extension centers throughout the state of Haryana. Recently, it has established an Innovation Centre for Agri Waste Management. The management, especially the dean and the vice counselor were supporting the idea of collaboration. HAU served as a hub to reach more organizations.

2b: Identified Dutch companies with innovative solutions to transform paddy straw to circular products

Subsequently to the first Indian mission, MVO Nederland, in the context of its New Year Event, on the 29th of January 2019, organized a workshop to inform Dutch companies on the outputs of the first mission to India, and to explore their interest on joining efforts in discovering if the paddy straw is of economic value for a new production chain (see annex 2 for a summary of the meeting). The circular products that they could made from paddy straw are the following: packaging, paper, panels and silica extraction. A Malaysia company working together with a Dutch one, Free the Seed and Bio4Pack respectively, has great expertise on extracting the silica from the paddy straw.

Below, an overview of each application, that could be made from paddy straw, and the Dutch company with expertise in it.

Circular product	Dutch company
Packaging	Dutch technology from Bio4Pack, Paperwise, ECOR and Free the Seed
Paper	Dutch technology from Paperwise
Panels (for furniture, gift boxes, doors, kitchens, displays etcetera)	Dutch technology from ECOR
Silica extraction ²⁶	Expertise from Free the Seed (Malaysian company working together with Bio4Pack)

²⁶ it is important to mention that paddy straw is considered as a potential raw material for preparing high-value products like silicon composite. A B D Nandiyanto *et al* 2016 *IOP Conf. Ser.: Mater. Sci. Eng.* 128 012040

Next, the questions and difficulties per Dutch company are presented, which were discussed during the workshop on the 29th of January 2019 (see annex 2).

- *Bio4pack*: is interested to join efforts. They work with a company from Malaysia, Feed the Seed, on producing sustainable packaging materials based on paddy straw. They need help from MVO Netherland and the Netherlands Embassy in India to back up their practices, and to start operating in new markets. Bio4pack, through their partner, Free the Seed, has experience with removing silica from paddy straw. They bring their partner Feed the Seed based in Malaysia into the project. They suggest contacting an end user, such as the COOP Supermarket.
- *PaperWise*: is interested to join efforts. They know that they can produce sustainable paper based on paddy straw. The question they have concerns the extraction of silica out of paddy straw, because it is difficult to work with it and they have no experience with it. Besides that, PaperWise needs a paper mill to manufacture the paper. A mill that is open for innovation and wants to buy pulp. PaperWise wants to explore to work with papermills in India.
- *ECOR*: is interested to join efforts. They know that the currently burnt paddy straw has huge potential. ECOR Living Factories can turn the material into non-toxic, biodegradable and re-usable panels that are suitable for the furniture industry, amongst others, thereby crafting a circular value chain that creates additional income for Indian farmers, reduces air pollution and combats deforestation. ECOR has the possibility to manufacture boxes for packaging purposes, as well. Their technology is ready for upscaling in India. They are looking for potential clients for furniture and display market to complete the whole supply chain.

It is interested to mention After the new Year Event, discussions took place with COOP Supermarket and with Mars Uncle Ben. In the first place, both companies expressed interest to explore the possibility on joining forces. COOP Supermarket, decided to consider the option of joining in a later stage.

2c: Presentation of the business connections

Below, an overview is presented of the production chains and the stakeholders involved with a description of their company/organization and role. Besides that, potential stakeholders who are not fully committed in any value chain are being discussed.

1. Sustainable packaging production chain

Company/organization	Role	Description
Haryana University	Supplier	The Haryana University (HAU) has a lot of expertise about paddy straw. They have 3000 ton of paddy straw in their own possession and a large network of farmers with their own paddy straw supply. HAU aims to support research on paddy straw regarding how to source paddy straw in a sustainable way; how to get a contract in which quantity, price and quality are guaranteed over time for rice straw and how to arrange an exclusive zone in the area of the factory. Besides that, they could provide a pilot project with the correct infrastructure of energy and it is based close to the Delhi market.
Grameena Vikas Kendram Society for Rural Development Visapathnam (GVK)	Supplier	GVK Society is an Indian based, new generation non-profit organization that blends entrepreneurship with social responsibility. GVK knows the paddy and cotton farmers from

		<p>firsthand. They can help get in contact with rice mill owners and possible contractors for rice straw, cotton and other crop residues streams. GVK strives for the upliftment of small and marginal farming communities, tribal and women in India while regenerating their environment. They design and implements community driven initiatives that optimize value for peasant farmers and other rural households by nurturing producer organizations, value addition, infrastructure, up marketing and perpetual innovation. GVK models propel collectivism, collaboration and co-creation to build futuristic value chain communities.</p>
Indian Institute of Packaging	Buyer	<p>The Indian Institute of Packaging (IIP) advises the government and companies in sustainable packaging and educates young adults who would like to work in the packaging industry. The role of IIP is market player.</p>
Bio4Pack	Buyer	<p>Bio4pack is specialized in the development and production of compostable and sustainable packaging. Their wide array of products complies with multiple stringent regulations and standards. Bio4pack, through their partner, Free the Seed, has experience with removing silica from paddy straw.</p>
Free the Seed	Technology solution provider	<p>The companies green, circular economy initiative is implemented in the northern region of Malaysia and involves 1.300 paddy smallholders. The post-harvesting waste of paddy straws are purchased directly from the paddy farmers. Then converted to biodegradable packaging products using Free The Seed's innovative biotechnology process utilizing protease serene enzymes, delignified cellulose fibers and enzymatic gratification methods to produce biodegradable packaging products. These products compost organically in 180 days for the global market and in compliance with current sustainable packaging initiatives. As these waste stockpiles deplete, so does the incidence of open burning while the readily compostable nature of the end product ensures no further addition of harmful waste material to the environment.</p>
Paperwise	Buyer	<p>PaperWise produces high-quality packaging out of agricultural waste.</p>
ECOR	Technology solution provider	<p>ECOR Living Factories can turn paddy straw into non-toxic, biodegradable and re-usable boxes for packaging purposes. Packaging that could be made out of panels are for example gift boxes. Trident and Parson Packaging were investigating what the possibilities are related to packaging.</p>

		However, final specifications and cost price are needed to create a successful business case.
UNIDO	Coordinate Research in India	United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. Though their Inclusive and Sustainable industrial Development which foresees an industrial transformation towards factories fit for the future. UNIDO India came on board and wanted to join forces. Rene van Berkel, representative at UNIDO, participated in the second day of the MVO Nederland third mission to India, and was eager to join forces; to be the linking pin among the various knowledge partners in the Netherlands and in India; and to share with the partnership agreement's partners the projects' research results from different countries and from various types of biomass, that UNIDO participated in.
Mars Uncle Bens	Supplier/Buyer	Mars Uncle Bens is an American privately held company and worldwide manufacturer in food processing. Since they founded in 1911, they expanded its range of confectionery products. Uncle Ben's Rice is the brand name for parboiled rice and a variety of related food items. First marketed in 1943, it has been later acquired by Mars. In light of Mars' global operations in the food manufacturing and packaging industries, its collaboration is highly relevant. Mars Uncle Bens is a producer and they try to improve the supply chain.
LT Foods	Supplier/Buyer	LT Foods is a big food company producing rice and they work with companies such as Mars Uncle Bens. The aim of LT Foods is to increase the income of their farmers. They already ask their farmers not to burn the straw. They have the same role as Mars Uncle Bens.

These organizations **wanted to join forces and work together to develop the business “connection”**, towards the circular production of sustainable packaging based on paddy straw. They all signed the partnership agreement (see annex 9). The signing of the partnership agreement and the process after this, will be explained further in phase 3, the formalization of the project.

2. Sustainable paper production chain

Company/organization	Role	Description
Paperwise	Byuer	PaperWise produces high-quality paper out of agricultural waste. Next to contributing to the circular economy, PaperWise takes their (social) responsibility within their product chain very seriously. Their production facilities in Colombia and India have a positive impact on local

		communities, with investments in education, infrastructure and healthcare.
Haryana University	Supplier	The Haryana University (HAU) has a lot of expertise about paddy straw. They have 3000 ton of paddy straw in their own possession and a large network of farmers with their own paddy straw supply. HAU aims to support research on paddy straw regarding how to source paddy straw in a sustainable way; how to get a contract in which quantity, price and quality are guaranteed over time for rice straw and how to arrange an exclusive zone in the area of the factory. Besides that, they could provide a pilot project with the correct infrastructure of energy and it is based close to the Delhi market.

A missing gap in the paper production chain is an Indian end user. Potential stakeholders are Trident and Shreyans Industry Limited. Trident is a manufacturer and supplier of high-quality wheat-straw based paper. Shreyans Industry Limited has two paper manufacturing units located at Ahmedgarh (Distt. Sangrur) & at Banah (Distt. Nawanshaher) in the state of Punjab. They both use wheat-straw to produce paper. Research is needed to investigate if paper can be produced using paddy straw and if it is a valuable business case. Read more about this needed research in the follow up chapter.

3. Panels circular production chain

Panels circular product chain is the third **business “connection”**. During the second mission to India (see annex 3), MVO Nederland explored the possibility of converting paddy straw into composite board in India, by assessing global experiences, existing technology by ECOR and having discussions with various key stakeholders. Though the use of paddy straw for the production of composite boards and panels has been considered in India²⁷ and the technology is available,²⁸ commercialization has not taken off yet. Industry experts believe this has been due to a combination of techno-economic and logistical factors.

The ECOR panels can be used in a variety of applications. In this research the focus was on:

- Furniture
- Plain panels to complete with MDF

Furniture panels

ECOR got in contact with Wiseart, Pepperfry, Ikea, Wipro, Fab India, Cedar DECOR and Godrej Interio (see the list below with potential stakeholders) to discuss furniture panels. All the companies showed a huge amount of interest in furniture made from paddy straw. However, the price is more expensive than the existing price levels. Instead, Godrej interior is exploring the possibility to lease furniture, even though this is new in India. Leasing could be an opportunity to create a business case, instead of making new material.

Plain panels

To investigate the possibility of plain panels ECOR had several meetings with Greenply, Ceintury ply and Merbok (Sri Lanka). Greenply seemed very interested but stopped the process after the innovation manager was fired. Ceintury ply showed interest in a readymade product, therefore they are only interested if the factory is up and running and could act as a distributor. Merbok, which delivers a lot of panels to India is still on board.

Below, an overview is presented with stakeholders involved in the panels production chain, including a company description of their potential role. Given the fact that the panel circular **production chain received FMO’s support, from December 2018, to elaborate a feasibility study,**

²⁷ Pandey & Sujatha D. (no date)

²⁸ IPIRTI (2018a)

MVO Nederland and the Netherlands Embassy in India decided that this circular production chain can advance forward without their active support further on.

Company/organization	Role	Description
ECOR	Technology solution provider	ECOR Living Factories can turn paddy straw into non-toxic, biodegradable and re-usable panels that are suitable for the furniture industry, amongst others, thereby crafting a circular value chain that creates additional income for Indian farmers, reduces air pollution and combats deforestation. Their technology is ready for upscaling in India. They are looking for potential clients for furniture and display market to complete the whole supply chain.
Grameena Vikas Kendram Society for Rural Development Visapathnam (GVK)	Supplier	GVK Society is an Indian based, new generation non-profit organization that blends entrepreneurship with social responsibility. GVK knows the paddy and cotton farmers from firsthand. They can help get in contact with rice mill owners and possible contractors for rice straw, cotton and other crop residues streams. GVK strives for the upliftment of small and marginal farming communities, tribal and women in India while regenerating their environment. They design and implements community driven initiatives that optimize value for peasant farmers and other rural households by nurturing producer organizations, value addition, infrastructure, up marketing and perpetual innovation. GVK models propel collectivism, collaboration and co-creation to build futuristic value chain communities.
Haryana University	Supplier	The Haryana University (HAU) has a lot of expertise about paddy straw. They have 3000 ton of paddy straw in their own possession and a large network of farmers with their own paddy straw supply. HAU aims to support research on paddy straw regarding how to source paddy straw in a sustainable way; how to get a contract, and in which quantity, price and how the quality can be guaranteed over time for the paddy straw; how to arrange an exclusive zone in the area of the factory and how to treat paddy straw, so it will be ready for the applications. Besides that, they could provide a pilot project with the correct infrastructure for energy and that could be based close to the Delhi market.

Potential stakeholders

A short description is presented below of the potential stakeholders, who are not fully committed in the value chain yet.

Company/organization	Role	Description
Fab India – Delhi	Buyer	<p>Fab India is a young retail organization with 300 stores. MVO Netherland had a meeting with Giandaniele Asquini, the head of furniture. Fab India wants to be a sustainable brand. There were two options to explore working together with the partners of MVO Netherlands:</p> <ul style="list-style-type: none"> • Replacement of MDF in their products. The clients do not like the MDF in the products of Fab India, because it feels like sheeting, but they want solid wood. Fab India thinks that if they replace it for eco boards they have a great story, which will fit into their philosophy. • New interior design for their stores with panels. This year the plan is to build 30 new stores.
IKEA - Delhi	Buyer	<p>A meeting at IKEA in Delhi took place with Helene Davidson, Rakesh Jetil and Arthur Rozalski. They are the IKEA sustainability and buying team. MVO Netherland presented a short history of the project, about combining paddy straw with knowledge from ECOR to produce furniture made of boards in India. The first step would be a pilot project with full evaluation of conditions for feasibility. In the meeting the following points were discussed with Ikea:</p> <ul style="list-style-type: none"> • Ikea is interested in buying local produced wood and flat line ready products in India. • Ikea has one store in Hyderabad, so volumes that are needed are very limited. • Ikea is not looking and will not participate in investment plans to build and produce boards in India, at least in today's circumstances. • It is hard to imagine that Ikea will commit to any partner to buy 100% of output of board factory.
Wipro	Buyer	<p>Wipro is a large Indian company in many branches. MVO Netherland met Ajay Kumar Manager of the furniture business of Wipro. This is a 150 Cr business specially in B2B market focused at governmental organizations. Wipro believes that in order to succeed and start a factory at HAU “as soon as possible” the demand side is the most crucial part at this moment. According to HAU and Wipro, signing a partnership agreement is not helping this process. Instead, they believe that creating demand should be the first priority.</p>
Centuryply and Greenply – Calcutta	Buyer	<p>Century ply and Greenply are companies that produce particle board, MDF and they have</p>

		huge sales channel throughout India. Century ply is three times bigger than Greenply. Both companies see an opportunity for Eco boards. The development team of Century ply looked at the project from a buying perspective and they were not willing to set up a factory with this technology. In contrast Greenply supports the idea of making board of farmers crops residues.
Wisart studio Mumbai	Buyer	Wisart studio is an organization that designs furniture and interiors for the business to business markets. They also produce themselves, so they can oversee the complete value chain. Therefore it is an ideal customer partner to work with. The background of the founder of Wisart is farming, he still has a farm and is in the process to start a cooperation. The owner supported the concept of turning waste into panels.
Pepperfry – Mumbai	Buyer	Pepperfry is an online retailer in furniture. The focus is at B2B and in this market sustainability is not an issue at this moment. However, the margins Pepperfry makes furniture are between 45-50%, which is a big difference with Ikea who are making less margin.
Indian industry paper mills	Buyer	Indian industry paper mills, big and small ones were interested in a collaboration. According to the paper mills owners, present in the sessions during the second day of the third mission of April 2019, they said: “ there is no concern if the market players have interest on the sustainable packaging/paper. However, we need to calculate costs and figures of the new technologies we might need to invest. Then we could advance in the actual production of packaging/paper based from Indian paddy straw.” This is an important confirmation of the potential of the business case, and its impact on the private sector development of both countries.
Cedar Décor	Buyer	Laminate facture
Godrej Interio	Buyer	Home and office furniture store
Merbok	Buyer	MDF Panels
Spin	Buyer	Potential partner in launching for using ECOR panels

4. Energy production chain

In addition to the above business connections, paddy straw can also be used to produce biogas, bioethanol, or bio-CNG. There are several state initiatives to create biofuel supply and demand. For example, the Punjab government has entered into agreements with companies (like Hindustan Petroleum Corporation, Indian Oil, Verbio, and Rika Biofuel Development) to produce these biofuels. Hindustan Petroleum targets the use of about 500 metric tons of paddy straw daily for generating 100 kiloliters of bioethanol. Similarly, Verbio targets the use of 300 metric tons of paddy straw daily to produce 33.23 metric tons of bio-CNG. The state government formulates a policy to set up the infrastructure to create biofuel supply and demand²⁹.

MVO Nederland in the context of this fourth business “**connection**”, brought together the below companies. Farm2Energy and Farm Solutions, expressed interest to organize the paddy straw supply chain and were willing to be involved in energy production. More information on these two companies were given in the previous sections of this report (2a). Another company that could play an important role in energy production is Rika Biofuel. Rika Biofuel signed the MoU in May 2018, and they were invited for the third mission to India in April. In addition, there is a partnership between ECOR and Rika Biofuel. The ECOR factory needs a massive amount of energy. The heat which comes free of the paddy straw in the process of turning it into biogas, is an interesting byproduct. Besides that, Rika Biofuel has a technology to use the paddy straw and to take out the nutrients. This is positive news for ECOR, because they do not want nutrients in the furniture they will manufacture. Unfortunately, Rika Biofuel did not participate in the third mission to India. Therefore, they did not sign the partnership agreement.

MVO Nederland is of the opinion that this fourth **business “connection” belongs to the linear economy**. Simply put, once burned, biomass no longer fits inside the circular economy equation. **MVO Netherland’s new strategy promotes the circular economy. Consequently, MVO Nederland will not actively facilitate further this business “connection”.**

PHASE 3: FORMALISATION

(April – May 2019)

Partnership agreement

MVO Nederland with the Netherlands Embassy in India, by the end of the second mission, reached the conclusion that two of the four **identified business “connections”** could be supported to be further formalized. The role that MVO Nederland took was to facilitate matchmaking and to generate actual commitment, regarding the sustainable packaging and paper. Therefore, MVO Nederland organized a third mission to India, for the Dutch companies that were part of the packaging and **paper business “connection”**. **This mission took place from 1-3 April 2019** (see annex 5 which organizations participated in the third mission). It consisted of in-person and group discussions to initiate a partnership and to join forces creating circular production of packaging/paper in the future.

Through this mission, the parties met in person, and identified their roles and responsibilities in the circular production chain of sustainable packaging and paper (see annex 6 for the discussed roles and responsibilities). At the end, they formalized their ambitions by signing the partnership agreement (see annex 9). HAU, GvK, Feed the Seed, Mars Uncle Ben, LT Foods, ECOR, PaperWise, and Bio4Pack sealed the partnership agreement, on the 3rd of April 2019, in a signing ceremony at **the Netherlands Ambassador’s residence in India**.

Process after signing

During the third day of mission in April, a meeting was held among the partnership agreement partners to discuss their roles and responsibilities for the first three months of their collaboration. They named it a roadmap with concrete actions they committed to realize until July 2019 (see annex 6). This was added to the partnership agreement, they signed the same day. Besides that, MVO Nederland conducted a CSR risk check (see annex 4), that summarizes the most common potential risks in India in general, in the production of rice, due to the use of chemicals on rice fields, in pulp mill machine plant and during transport. The partnership agreement takes into consideration the CSR challenges in India, and commits its signees to address them, in their future joint activities.

The partnership agreement **partners’ ideal situation is captured and revealed by the document itself**. The partnership agreement states:

“With this Agreement, through the Indo-Dutch Sustainability Forum ‘INDUS’ an initiative of the Embassy of the Kingdom of the Netherlands in India and CSR Netherlands, we, the supply chain actors, experts, solution providers, and market players enter in a Partnership, to reduce the negative environmental, health and social impacts of the open-air burning of paddy straw, while valorizing the paddy straw, to create a new circular value chain, to produce sustainable paper and packaging materials, and generate sustainable livelihoods.”

The same partnership agreement expresses the way towards sustainability by expressing the overall purpose:

“Our goal: we will have established the first successful circular business model for paddy straw upcycling in India. We opt for circular system solutions, where we transform agricultural waste, in the form of crop residue (paddy straw), into new products, as sustainable paper and packaging materials based on paddy straw, that will maximize value addition, reduce air pollution, soil degradation and deforestation.”

The partners identified the following requirements to achieve their ambition and to guarantee continuity:

Circularity: To use agriculture waste, in the form of crop residue (paddy straw), as feedstock for new products, as sustainable paper and packaging materials.

Accessibility: To produce paper and packaging materials, for both the mainstream consumer and the corporate market, with a guaranteed competitive pricing.

Human resources: Production takes place in India, under distinctive Corporate Social Responsibility (CSR) conditions, and creates fair and extra income for farmers and local rural communities. To particularly endeavor women empowerment in all the phases of the value chain.

Environmentally friendly Production: To avoid any negative environmental impact as much as possible.

Transparency To be transparent about products and production conditions, following the UN **Sustainable Development Goals. The aim is to ‘objectivate’ as much as possible, identify risks in the new value chain, monitor results in a measurable and quantifiable way.** Communication will be open, proactive and secure.

Scaling & co-creation Other organizations are strongly invited to hook up. By stimulating far-**reaching environmental and CSR measures in the partners’ organizations, to reach the final** desired scale.

The PA partners asked and expected from MVO Nederland, in follow up activities, to undertake a coordinator role to stimulate the continuation of the partnership (see annex 7 for the minutes of the meeting). Hence, MVO Nederland initiated and coordinated a sequence of discussions, either in bilateral or group meetings and teleconferences. MVO Nederland enhanced this by assuming a monitor role on the agreements made on the 3rd of April. The Dutch and Indian partners, shared information on the actions they agreed on the 3rd of April, to produce win-win situations. MVO Nederland shared this information among the consortium.

During these encounters, partners often revealed that they find it important to have a follow up activity, where they could join forces in a concrete way, within a demonstration/pilot project. They wanted to plan and implement a pilot project where a paper mill is able to produce, with Indian paddy straw, sustainable packaging/paper in a small scale. To bring new products in the market, in a competitive price and self-sustaining manner and in addition give value to the by-products of the pulp. They strongly believed that such a pilot project would allow them to calculate the costs of organizing the supply chain; of using suitable biorefinery techniques; of introducing new machineries in the paper mills; of calculating the improvement of the air pollution of not burning **and of calculating the improvement of the farmers’ income.** A pilot project is seen as the priority number one follow up activity, which gives continuity to the partnership agreement, and brings the social, economic and environmental benefits to the farmers. However, the partnership agreement partners agreed that a required factor to secure sustainability of such a pilot project, is to secure a certain amount of funds. MVO initiated many meetings with various organizations, for example with representatives from DGGF, NL works, Rabobank, Wageningen University, Radboud University, among others, to discuss possibilities of new alliances and support. Eventually, MVO Nederland started to work with the Wageningen University. Further information about this development is to be found in the next chapter (see section TKI proposal).

5. Conclusions and follow-up

Conclusions

The first objective of this project was to explore which crop residue (paddy straw, bamboo and sugarcane) is the most suitable for setting up a circular production chain in Punjab and Haryana state. After assessing the suitability of the three crops residues, paddy straw, bamboo and sugarcane, the paddy straw was chosen to be the most appropriate one. Paddy straw is available in Punjab and Haryana state. It has many applications, that create several circular production chains. These productions chains will provide alternatives and potential social and economic benefits for the farmers. Benefits in terms of extra income generation, rural development, employment and local value added. Since paddy straw is being burned in the two states, creating a large amount of air pollution, its removal from the land, versus burning, will additionally contribute to air pollution reduction. However, several costs need to be calculated, like the costs of collecting, and delivering the paddy straw from the land to the pulp processing plant, as well as the **plants'** operation costs. These calculations, among others, need to be further assessed, so to determine **the applications'** viable commercial value.

The second objective was to understand which supplier, technology solution provider, and buyer could be matched together to create circular production chains. Four circular applications based on paddy straw were identified, packaging, paper, panels and energy.

Three of these applications were linked to a different Dutch company:

- Packaging (Bio4pack, Paperwise, ECOR)
- Paper (Paperwise)
- Panels (ECOR)

These Dutch companies were linked with Indian partners. In April 2019, The Dutch and Indian partners signed a partnership agreement (see annex 9), to define concrete next steps towards the sustainable packaging and paper production chain. The partners are: HAU, GvK, Feed the Seed, Mars Uncle Ben, LT Foods, ECOR, PaperWise, and Bio4Pack.

MVO Nederland believes that the “From burning to buying: creating a circular production chain out of left-over crop residue from India farm **land**” is an initiative that could enable the Dutch and Indians to cooperate more closely, in tackling **India's** challenges regarding open air burning of crop residues, creating new circular production chains. Already via this project, MVO Nederland succeeded to be the initiator on building a partnership of both Dutch and Indian entrepreneurs, **NGO's** and public sector organisations to develop an integral concept for the processing crop residue into bio-based products such as packaging, flooring, furniture, and much more (Annex 10).

Follow- Up Steps

To provide a more full picture the below section outlines the important current political developments in India; presents the next steps regarding the three identified circular production chains; the feedstock and the pulp; and the Top Sector Agri & Food proposal (TKI) (see annex 8) proposal.

Political developments in India

Of great importance of the project were the election results. Prime Minister Narendra Modi's BJP won India's general election. While financial markets have reacted positively, many are worried about the rise of nationalism and the future of India's democracy. After news of the BJP victory broke, the Sensex index of the Bombay Stock Exchange reached 40,000, prompting analysts to

predict good times for India's economy. "This is a big mark. The markets will be more buoyant in the coming months and a stable government is good news for us. We saw this in the last term of BJP, and I am sure it will be the case this time," said Romesh Tiwari, research chief at CapitalAim, an Indian financial analysis firm³⁰.

In his victory speech, Mr. Modi said there were only two castes in India now. "The poor and those who want to work to bring them out of poverty. We need to empower both."

Growing unemployment and fears of a recession, will provoke demands for Mr Modi to provide jobs for the millions of young people entering the labor market in coming months. Also farmers in India hope that he will prioritize the agricultural industry, after a crop glut and commodity prices declining.

Therefore, the timing is very appropriate to support the efforts of the Governments of Punjab, Haryana, Uttar Pradesh and NCT of Delhi to address farmers hopes and tackle air pollution. In this context, on the 9 September a National Conference on Crop Residue Management took place. Shri Parshottam Rupala, Union Minister of State for Agriculture & Farmers Welfare, requested further support and ideas from the farmers to ensure zero burning in all the villages. Next to these dynamics in India, we see that there are significant opportunities for closer and stronger cooperation **on the identified business "connections", as described in the** previous chapters.

MVO Nederland with this project succeeded to build a broad network of contacts in India, with almost all the parties contacted ready to build on the enormous momentum gained over the last months **from the elections results, that will likely be positive for the country's growth, according to** economists and investors.

Panels circular production chain

Within this circular production chain the next step is to create the business case for applications like furniture, packaging and plain panels, to replace MDF. Currently ECOR is realizing a feasibility study, where a 50% of it is financed by FMO. The feasibility study results are to elaborate an entrance strategy in India, to define a clear potential impact, that can be realized by the ECOR technology, and to calculate the business case. Merbok, Trident, Cedar DECOR and potentially Godrej interior, will support the calculation of the business case, by providing data (see page 17-19 for more information about these stakeholders). For ECOR to create a financially successful business case the following data is needed:

1. Feedstock, quality, quantity and consistency
2. How to create pulp with the best economics (yield etc.)
3. Costs of operating a factory (labor, energy, land, building etc.)
4. Earnings and what the current market prices of applications are
5. The current costs of operation
6. The financial costs, equity versus loan
7. Information about the CAPEX of the factory
8. Certifications and specifications (water resistance, fire retardant)

It is estimated that the ECOR feasibility study will be completed within 2020. ECOR will share its results with the partnership agreement partners. MVO Nederland will not play any role further on this circular production chain development.

Sustainable packaging and paper chain (Bio4pack, Paperwise, ECOR)

The packaging solutions of Bio4Pack and Paperwise are primarily positioned in the food sector. Therefore, retailers who will be contacted are Jumbo, Albert Heijn and Eosta. The first next step for this value chain is to succeed in the European market. To succeed they need competitive prices by controlling the price of pulp. This is the reason why they will join the TKI together with Wageningen (see more information about this proposal further below). The second next step is to investigate the interest of end users in India. In October 2019, a trade mission will be organized to India. During

³⁰ <https://www.dw.com/en/india-election-narendra-modi-faces-big-challenges-after-victory/a-48847611-0>

this mission companies such as Unilever and Coca Cola will be contacted to explore possibilities for cooperating in calculating the business case. The role of MVO Netherlands is to facilitate the process and link the technology solution providers and buyers from the Netherlands with paper mills owners and end users in India.

Feedstock and pulp

Parties like HAU, Farm Solutions, Farm2Energy can provide adequate data regarding the biomass (paddy straw). Trident has also the interest to cooperate and to investigate further the paddy straw and the pulp made from it. It will, in the first place, focus at their current paper waste stream, which is in itself consistent in quality and quantity. Besides that, the pulping process is crucial. The cost of pulping, the yield and the success of the pretreatment will determine the final price of the feedstock. To get the maximum out of the feedstock, and understand the best way of pulping technology, MVO Netherlands started to work with WUR (the Top Sector Agri & Food), on a project exactly to do research on the above themes. Further, MVO Nederland will explore possibilities for cooperation also with the Center of Paper and Pulp in India and UNIDO India.

TKI proposal

This current project, with RVO financial assistance, provided the first steps towards alternative uses of paddy straw, that can be profitable to farmers, and thereby to be able to avoid the field burning. This initial period was important to explore technical feasible scenarios, identify and match relevant parties and explore possibilities to achieve sustainability and continuation of the progress made.

Subsequently, MVO Nederland with Wageningen University submitted a concept note, for funding by the Top Sector Agri & Food (TKI³¹, see annex 8). See below for more information and background about TKI. The proposal aims to develop a small scale pre-pulp production from paddy straw, within a clean production system that is economical at a scale of 20.000 to 35.000 tons dry matter per year, that can recycle nutrients locally and generates a pulp that can be used directly for more crude uses or can be transported to a more remote large scale factory for upgrading into added value products.. The deadline for the final proposal was the 31st of August 2019. Therefore, on the 2nd of July 2019, HAU and MVO Nederland co-hosted a meeting through a teleconference, with the PA members. The PA members agreed on a set of actions in order to be able to write the full proposal, by the 31st of August (see annex 7). The concept note is approved.

In the positive scenario that the TKI project is approved, then the vision of the partnership agreement members will be met. **And the project's** scope will be expended, by both providing answers to technical questions, and calculating the business opportunities for the involved Dutch and Indian partners. The TKI project, will be the next step towards the feasibility and usefulness of specific techniques. The TKI will try out different approaches, develop evidence-based strategies, collect and identify good practices and even provide guidance for future similar initiatives in other countries. By doing this it will contribute to the **improvement of the Indian farmers' livelihoods, and to Indian's** private sector development, and possible to other countries as well.

³¹ The Top Consortium for Knowledge and Innovation (TKI) coordinates the development of the Knowledge and Innovation Agenda of the Top Sector Agri & Food, takes care of the research programming and advises the Top Team Agri & Food on agreements to be made with the Minister of Economic Affairs and Climate <http://topsectoragrifood.nl/kennis-en-innovatie/>

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