INTERNATIONAL RICE RESEARCH INSTITUTE

Project: Scalable straw management options for improved livelihoods, sustainability, and low environmental footprint in rice-based production systems

Inception Workshop

Conducted at DARD, Can Tho, Vietnam, 3-4 March 2016

prepared by

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IRRI

March 2016

Funded by:

BMZ Federal Ministry for Economic Cooperation and Development

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I. ACRONYMS and ABBREVIATIONS

AWD	Alternate wetting and drying
BMZ	German Federal Ministry for Economic Cooperation and Development
BRIA	Better Rice Initiatives Asia
CCAC	Climate and Clean Air Coalition
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CLRRI	Cuu Long Rice Research Institute
CORIGAP	Closing Rice Yield Gaps in Asia with Reduced Environmental Footprint
DANIDA	Danish International Development Agency
DARD	Department of Agriculture and Rural Development, Vietnam
GHGE	Greenhouse gas emissions
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HTC	Hydro thermal carbonization
HU	Hohenheim University, Germany
IAE	Institute of Agricultural Environment, Vietnam
IRRI	International Rice Research Institute, Philippines
LA	Learning Alliance
LAAEC	Long An Agricultural Extension Center, Vietnam
LCA	Life cycle assessment
MAFF	Ministry of Agriculture, Forestry, and Fisheries, Cambodia
NARES	National agricultural research and extension systems
NLU	Nong Lam University, Vietnam
PhilRice	Philippine Rice Research Institute, Philippines
RS	Rice straw
SIAEP	Sub-Institute of Agricultural Engineering and Postharvest, Vietnam
UN	United Nations
ZES	Zeigler Experiment Station, IRRI

II. Contents

III. Rationale

In intensive rice systems of Southeast Asia, rice straw burning in the open field has been one of several common practices to dispose of rice straw after traditional harvesting practices, but most of the straw was either incorporated or used for other purposes such as for mushroom production or to feed animals. This situation has changed drastically with the ongoing structural transformation in rice production characterized by labor shortage, consolidation of farms, and further intensification and mechanization of harvesting. As a consequence, field burning became more rampant, causing increased air pollution and greenhouse gas emissions (GHGE). Economically, straw burning constitutes a loss of potential income from rice straw.

The rapid introduction of combine harvesters is a game changer because they leave the straw spread on the field. Manual collection is unprofitable because of the high labor cost. Incorporation in the soil is also not possible in systems with two to three crops per year because the turnaround time is too short for decomposition. All stakeholders involved (from farmers to policymakers) have only limited knowledge on (1) alternative management options and (2) the negative effects of burning on health, climate, and soil nutrition. Existing legislation prohibiting field burning is usually not enforced by governments because of a lack of political will or power to implement unpopular measures.

Another reason why farmers burn the straw is that they cannot capture value-adding opportunities from selling straw or straw products despite emerging market potential. Also, knowledge about other potential straw products is limited and value chains for straw or straw products are rudimentary. In addition, farmers waste nitrogen when burning rice straw compared with field incorporation of the straw.

The detrimental impact of open straw burning on human health is an increasing concern of policymakers and scientists. The smoke contains a wide range of pollutant gases and black carbon that collectively impair air quality and visibility. In Southeast Asia, the haze caused by straw burning has often been reported as a threat to health. Although this is an important issue, limited empirical data and documentation are available to help further understand the impacts of straw burning on GHGE.

Although several research activities have focused on component technologies and management practices and some greenhouse gas emission measurements, no comprehensive effort has been made yet to compare different straw management options with regard to GHGE, energy balances, economics and value-adding opportunities, and agronomic implications using a holistic approach in the context of fostering more sustainable rice production.

A new three-year collaboration between IRRI and the German Federal Ministry for Economic Cooperation and Development (BMZ) launched the project *Scalable straw management options for improved farmer livelihoods, sustainability, and low environmental footprint in rice-based production systems* to improve the livelihoods of farmers through a holistic approach on sustainable rice straw management, which will also target adding value to their rice crop and reducing the environmental footprint from rice production systems. The project aims to (1) assess different straw management options, including their value-adding potential and environmental footprint; (2) provide information and training to farmer intermediaries, including national agricultural research and extension systems (NARES), for encouraging and advising farmers to use best straw management practice; and (3) provide information to policymakers for creating an enabling environment for best-practice straw management. With these new and exciting opportunities to examine rice straw management-related issues, an inception workshop was conducted to tackle the following objectives:

1. Provide an overview of the new rice straw project and entry points where it can fill the gaps or enhance current initiatives,
2. Share the current research and development initiatives on rice straw management by different institutions, and
3. Develop action plans for 2016 and areas for collaboration.

IV. Field trips before the workshop

Some of the workshop participants joined field trips on 1 March and participated in a national seminar on rice straw collection and processing organized by CORIGAP, Cuu Long Rice Research Institute, Can Tho DARD, and Nong Lam University, and a visit to a farmer who produced mushrooms on 2 March.

Binh Minh Cooperation is a cooperative that owns 20 balers and processes straw into high-density bales using a stationary hydraulic press, and into pellets in a feed mill with 20-t/day capacity for sale for different purposes. The hydraulic baler compresses three to six small round bales of 10–20 kg each into one larger bale that can be transported more easily (easier stacking of rectangular bales) at lower cost (density).

The straw baler and combine harvester contest/demonstration was conducted by CORIGAP with Vietnamese partners. Straw collectors from four different companies were demonstrated in the field. Three were self-propelled ones, of which two were round balers and one just collected the straw in bulk, and one was a tractor-drawn round baler. All the balers make small round bales of the same size. A bale weighs from 10 to 20 kg depending on the moisture content of the straw. The bales we saw in the field were about 13 kg. In another field, two YANMAR combine harvesters equipped with straw choppers and spreaders as well as *Trichoderma* sprayers were demonstrated (Figs. 1 and 2).

Fig. 1. Rice straw baler from STAR.

Fig. 2. Rice straw baler from Phan Tan.

A half-day national CORIGAP-sponsored seminar on straw collection and processing conducted at Cuu Long Rice Research Institute with co-funding and participation of the National Extension Center and provincial representatives from 30 provinces focused on existing technologies and recent research findings from Vietnam on rice straw management. This seminar was high-profile and chaired by Dr. Phan Huy Thong, the director of the National Extension Center. Martin Gummert gave a welcome address on behalf of IRRI and highlighted the collaboration IRRI has with Vietnam also in CORIGAP and VNSat, not only in straw management. Dr. Phan Huy Thong repeatedly stressed the importance of climate change, health, and pollution, and suggested that rice straw management should be included in the VNSat project.

The discussions after the lectures were very informative and showed that support for improved straw management is in flux. Researchers complained that the problems of straw burning are known and solutions exist but that no support policy is in place yet. The vice director of Vinh Long DARD, on the other hand, said that policy is in place and that subsidies of up to 30% for straw-processing equipment are already available as long as the price is below VND 200 million.

A visit to a farmer mushroom producer showed that this farmer used the traditional method of producing mushrooms in the open and he had been doing this for 16 years. He represented the traditional practice farmers use in the Mekong Delta.

A visit to Can Tho University's biogas demonstration site encountered different biogas technologies mostly targeting the farm level.

V. Welcome remarks and introduction to the project

Dr. Duong Duy Dong, Vice President, Nong Lam University

Dr. Dong stressed the importance of collaboration with IRRI to serve agriculture. NLU was very happy about the activities developed, which were very practical, always aiming to understand the most pressing problems of the farmers and the people involved in agriculture and using practical ways to develop strategies to address concerns such as rice straw management. He also acknowledged the support of BMZ and confirmed that NLU will continue to collaborate with IRRI and partners.

Nguyen Thi Kieu, Deputy Director of Can Tho Department of Agriculture and Rural Development

Rice production in Can Tho improved because of collaboration with organizations such as IRRI. This collaboration also enhanced the contribution to increase the yield of farmers by 5% in the spring season and by 10% during the summer-autumn season. However, an issue that still needs to be examined is by-products such as rice straw, which can cause GHG emissions and harmful environmental impacts. Can Tho Province produces 1.3–1.4 million tons of milled rice per year, and about the same amount of rice straw. Rice straw can be used in many ways—mushroom, biochar, and organic fertilizer, which can bring increased income to farmers. Kieu hoped that the new project would provide more options to use rice straw in order to thoroughly reduce the environmental footprint and increase farmers' income.

Reiner Wassmann, IRRI

Reiner's welcome remarks highlighted the importance of having more research initiatives on rice straw. Most of the research at IRRI focuses on crop technologies and rice varieties. The workshop will provide a fresh perspective in looking at rice straw issues from different angles and at different scales, such that problems and the effects of mechanization can be seen from the farmers' level. Policy implications can also be assessed as many farmers are burning rice straw. He emphasized that the project can help promote options to farmers to find other productive uses for rice straw. Rice straw management can also be looked at in the context of climate change. When it comes to rice production, farmers look only at practicality to decide whether they plow the straw under, burn it, or use it for other purposes, but the link to climate change is obvious. Reiner closed by acknowledging the outstanding partnership between IRRI and partners, that is, NLU and other institutions in Vietnam, Cambodia, and the Philippines.

Introduction to the project

The welcome remarks were followed by an introduction of the participants (see Appendix 1). To set the scene for the following presentations, Martin Gummert explained why it is important to use a systems/value chain approach to identify sustainable rice straw management options as alternatives to open field burning of the straw. He used an example from Europe, where straw chopping to improve incorporation moved from an individual machine with its own power source to combine harvesters, with the result that fuel consumption of the combine increased by around 40%. However, this move eliminated the additional process of straw chopping using separate equipment and therefore cut emissions and the energy requirement for this operation that now became integrated into the combine. However, legislation regarding emissions of machines did not take this into account and years of development of combine harvester performance were lost because development teams had to focus on reducing emissions of the combine rather than increasing harvesting efficiency. It therefore does not make a lot of sense to look at component technologies only. The new project gives us for the first time the chance to look at straw management holistically from rice production to the marketing of rice straw products, and doing comprehensive sustainability assessments for the different options. He then presented the rationale, goal, purpose, outputs, and expected outcomes of the project.

- The **goal** of the project is to improve the livelihoods of farmers by fostering sustainable rice straw management that adds value to their rice crop and to reduce the environmental footprint from rice production systems.
- The **purpose** is to (1) assess different straw management options, including their value-adding potential and environmental footprint; (2) provide information and training to farmer intermediaries, including NARES, for encouraging and advising farmers to use best straw management practice; and (3) provide information to policymakers for creating an enabling environment for best-practice straw management.

Five project outputs will be produced by different working groups:

1. Innovative **technologies, management options,** and **farmer business models** for rice straw management
2. **Carbon footprint analysis** of alternative rice straw management against baseline GHGE from straw burning, at the field level
3. Carbonization of straw (biochar) as a pioneering approach for lowering footprints and increasing income
4. Methodologies for and results from **sustainability assessments** for promising rice straw management options
5. **Communication strategies** for dissemination

For details, refer to the presentation (https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4Ojk5NzI4ZWYwMGQzZTQ2ZQ), the project document, and the logical framework in Appendix 2.

Martin stressed the importance of the participation of the private sector for developing and piloting business models. The project does not have a lot of funding for capital items, so, in order to do field demonstrations, collaboration with technology providers needs to be sought to source prototypes, and economically viable business models need to be developed to encourage contractors and other technology users to invest in the equipment. Therefore, engaging with companies that have equipment such as balers and sprayers for *Trichoderma* application, etc., and encouraging their contributions will be essential to successfully conduct technology and business model pilots.

Another objective of the workshop was to identify business models for rice straw management that are already existing or are in an advanced stage of development so that they can be considered for piloting through IRRI technology verification platforms such as CORIGAP, national programs such as the Five Reductions, One Must Do or Small Farmer, Large Fields programs in Vietnam, and at the BRIA pilot sites. One example could be contract services for rice straw collection. Initial business models using balers for collection and densification of rice straw into bales for sale to rice straw markets are already visible. So far, these are entrepreneurial business models: the baler owners buy the straw from the farmers for USD 30–40/ha, collect it, and then sell the bales in the market. Collection is a necessary operation for any further off-field use of the straw, so this business model has clear boundaries, data on costs and benefits, and the market for bales can be easily established. So, this constitutes a “low-hanging fruit” in terms of a business model.

VI. Country status

Vietnam

Dr. Nguyen Thanh Nghi from Nong Lam University and Dr. Pham Van Tan from the Sub-Institute of Agricultural Engineering and Postharvest (SIAEP) presented the current initiatives on rice straw research and development in Vietnam. Dr. Nghi reported on previous activities funded by CORIGAP on piloting balers and measuring GHGE in mushroom production. Dr. Tan presented some of his studies also conducted as part of CORIGAP comparing indoor and outdoor mushroom production. The indoor setup prevents chemical use for disease control, saves land (minimum use of area), and can increase cycles for mushroom production. The price is also higher for indoor mushroom and the net profit is higher. He showed a slide on the economics for indoor mushroom production.

For details see the presentation:
https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjUwYzViNTNlZTJjMGQwY2UCambodia

Dr. Pyseth Meas and Mr. Walter Zwick explained the situation of rice straw use in Cambodia. Their presentation highlighted the use of straw to improve soil conditions in Cambodia. Rice straw is incorporated into the soil at a shallow level (5–10 cm) to improve soil conditions, as most of the soil in Battambang Province where the Don Bosco demo farm is located is compacted, and thus devoid of oxygen. Much of the rice crop in Cambodia is harvested during the wet season. Harvesting is done by combine harvester and stubbles are cut high. The stubbles are used as feed for cattle that are brought to the field after harvesting. After two weeks, ratoon stems emerge and a fungal species infects the new green leaves. The total value of nutrient contained in the straw is USD 35.77/ton based on fertilizer cost in the market. The organic matter in the soil has to be maintained by incorporating the straw. After incorporating straw at 5–10-cm level, the farmers spray it with liquid urea at the rate of 1 kg per 100 kg of straw. The UN convention on soil conservation was also tackled in this context, as a global initiative, which the government of Cambodia fully supports. The Ministry of Agriculture, Forestry, and Fisheries assigned Pyseth as the focal person for this initiative.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjI5ZGY5NTU2NDNlNWEwNjQ

VII. Technical presentations

Participatory multistakeholder processes

Reianne Quilloy presented a range of activities that started from the establishment of multistakeholder processes. A Learning Alliance (LA) was established in Vietnam to organize and monitor groups with shared interest and explore best practices for rice straw management. The LA was described as “a series of meetings with clear-cut action steps in between meetings” or “meetings plus action” by a Vietnamese project collaborator in the 2013 Project Review in contrast to many other meetings that are held with different stakeholders but are not followed up by action.

LAs are characterized by learning cycles that promote progressive situated learning at different scales, and encourage regular assessment of technologies and management options being promoted. A learning cycle is characterized by members planning and then acting and successively reflecting on what actually worked and what can be done better next time. The LA also facilitates documenting and sharing learnings. Some key outcomes reported were the involvement of women in decision-making, initiating collective action, and engaging the private sector for co-funding. A possible opportunity for the group is to adapt the platform with CORIGAP activities, and establish community-based groups to try rice straw management options (identify technologies and actors to be involved and pilot sites).

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjUxZmIxNTExMWVlNzkzMGE

Greenhouse gas emissions from different rice straw management options: IRRI's past and current activities

Bjoern Ole Sander, from IRRI's Climate Change group, presented rice straw-related activities of the group and gave an overview of the status in terms of measuring greenhouse gas emissions from rice straw management. Methane (CH_4) and nitrous oxide (N_2O) are two major GHGs in agriculture. CH_4 is produced in anaerobic conditions of 10–100 mg/m^2 per day and increases with organic amendment to the soil, while the N_2O produced is a by-product of denitrification and is not a large source. It is negligible, but increases with nitrogen fertilization (increased application of N). CO_2 in the context of rice straw management is not considered as a GHG contributing to climate change since all the carbon released from rice straw during straw use was previously accumulated in the rice plant from the atmosphere, so there are no net emissions of carbon.

Greenhouse gas is measured using the closed chamber approach and eddy covariance system, which detects CO_2 and CH_4 fluxes over approximately a 1-hectare area with continuous data recording. Ole presented results on CH_4 emissions on soil with biochar added showing no significant difference from soil without biochar. Another study on life cycle assessment (LCA) for carbon compares carbon turnover in residue incorporation against biochar. Ole also presented the current activities related to identifying emission factors from rice straw burning: a field experiment on LCA of different straw management options in which very high GHG emissions were observed in the treatment incorporating straw on the soil. Another experiment comparing different water management options showed a significant reduction in CH_4 emissions by draining water at 1 to 7 days after transplanting.

The Climate and Clean Air Coalition (CCAC) to reduce short-lived climate pollutants is one of the major partners for scaling out efforts on mitigation in rice production. The partner countries are Vietnam, Bangladesh, and Colombia. CCAC supports national plans on reducing emissions by providing evidence-based information that can help influence policy recommendations related to reducing CH_4 emissions from rice.

Planned activities within the BMZ-funded straw management project include (1) using the eddy covariance system to measure emissions from straw burning; (2) using extended measurements from different on-field straw management options with biochar and including different ways of incorporation; (3) measuring GHG emissions from alternative uses of straw for LCA such as mushroom production; and (4) improving national data on straw management.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjcyMTc5MjA2NzRhMjI4OWM

Q&A:

Walter Zwick: How many days does draining take in order to reduce greenhouse gas emissions from crop production (referring to the time interval between letting the soil dry and the next irrigation in alternate wetting and drying)?

Ole Sander: It depends on the soil condition. We usually have a tube placed in the rice field and observe the water level inside. If the water level is 15 cm below the soil surface, then it is time to irrigate.

Rice straw management in Vietnam

Vu Duong Quynh from the Institute of Agricultural Environment presented his rice straw-related activities in Vietnam. He showed how to produce biochar through pyrolysis in 2 hours. The pH of biochar from rice straw is higher than from rice husk and the amount of carbon is also higher. He also presented an experiment on GHG emissions during passive aeration composting of manure and digestate typical of small-scale livestock farmers in Vietnam. Quynh also presented results from a study on different manure, biogas digestate, and crop residue management affecting GHG emissions from paddy rice fields. Results of his experiment revealed that biochar has no significant effect on grain yield; rather, the effect is more on the increase in organic carbon and increase in pH. There are still limitations on technology development in biochar production. Current initiatives are using biochar for cooking.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjMyZDNiMDE1OGRhZjRkYWM

Q&A:

Pham Van Than: The experiment using biochar with rice straw showing that biochar can reduce GHG emissions is very good. If you want to scale out and apply this to production, we should understand the weakness such as biochemical reactions. Do you think we should conduct more experiments to find out which chemical is produced and understand the biochemical reactions so that we could apply this in farmers' fields?

Quynh: In my opinion, microorganisms are inhibited because of the high pH of biochar. A good pH for microorganisms is 6–7, but the high pH in biochar can inhibit microorganism reactions.

Rice straw as biofuel: barriers and solutions in South and Southeast Asia

Craig Jamieson explained the three major barriers to why rice straw is not fully used as fuel: composition and properties (very loose form compared with that of fossil fuel), logistics (not easy to transport), and nontechnical (commodification, farmers' cooperation, subsidies to fossil fuels). He presented the strengths and weaknesses of each of the challenges. He showed some cases of using rice straw for energy in India for power generation using observations from field visits and analyzed their strengths and weaknesses.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjdhZjI3NzY0ODBjNTBhYmE

Biogas project in Can Tho University

Tran Sy Nam from Can Tho University presented his study on the Super ProM project on rice straw for biogas, which is supported by DANIDA. He talked about the study he conducted on using rice straw for biogas using different sizes of digester, pretreatments used, etc. The suitable mixing ratio is 50–70% for rice straw and pig manure. Using the optimal rice straw cut size of 1 cm–20 cm had no significant effect on biogas yield after 60 days.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjRiZDkzOTk5NTY4N2Y1ODg

Carbonization of straw (biochar) as a pioneering approach for lowering the footprint and increasing income

Simon Munder from Hohenheim University described initiatives on carbonization and composting with a range of options for processing rice straw using modern machinery in Germany. Hohenheim University has conducted a number of studies partly in cooperation with IRRI on rice straw use such as densification through briquetting, a baseline report on rice-based straw-based systems for energy generation, basic research on hydro thermal carbonization (HTC), and an ongoing study on steam explosion. Biochar is not a universal solution to the world's problem, but it presents good opportunities, that is, using it as a carbon sink. Compost is a product of anaerobic decomposition of organic matter that can be used for soil amendment. Biochar is not always equal. If processed in the wrong way, it can even have negative impacts on soil fertility and crop health.

In producing rice straw biochar, crystobalite, a human health hazard, is emitted (at >600 ^{o}C). The effect of composting biochar is a significant increase in surface of the carboxylic group (which we want) and a decrease in the phenoxylic group (which we don't want). Planned activities of the carbonization component of the project will involve five phases: (1) laboratory—rice straw charring under controlled conditions; (2) construction of a low-cost process and integration in a semi-automatic reactor; (3) operation of a reactor at the IRRI Zeigler Experiment Station (ZES); (4) upgrading—mixing with a fresh windrow/rice straw; and (5) use trials on the IRRI ZES to verify agronomic benefits.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjY0MWJiZTNiMDE1ZDc2MmQ

Market for rice straw products: evidence from India

Matty Demont discussed the concept of rice straw in value chain upgrading, which is composed of five stages: (1) process upgrading, (2) product upgrading, (3) functional upgrading, (4) channel upgrading, and (5) inter-sectoral upgrading. The use of rice by-products such as rice straw is part of the inter-sectoral upgrading, which is already an advanced category of upgrading. Exploring by-product use connects to new value chains, and thus new markets.

Matty also discussed the types of drivers for by-product market development:

(1) Supply: productivity, economies of scale/scope—farmers, by focusing on rice straw, have two outputs, grain and straw; technology—combine harvesters and balers.

(2) Demand: rice straw consumers would value energy, nutrient, and fiber contents, and driving factors for change would be urbanization and the accompanying diet change, for example, increased consumption of meat products.

Matty presented the case of rice straw use in Odisha, India, where little incidence of burning was found because rice straw is used as cattle feedstock, for mushroom production, and as fuel for cooking. The quality of rice straw is being rewarded in the market through higher prices. Matty's team elicited the perceptions of farmers about the importance of rice straw quality for rice breeding programs. Farmers identified triple priorities for rice breeding: grain quality, agronomic stress tolerance, and by-products. He presented the results of a study on eliciting farmers' triple preference in trade-offs between male and female farmers in different seasons. In India (West Bengal and Odisha), farmers will invest only 2% in straw digestibility; farmers mostly will invest in stress tolerability. Farmers prefer to invest more for their food security (and income from paddy sales) and less for animal feed security.

Matty suggested preliminary activities on rice straw: collecting monthly rice straw prices in four countries; compiling and analyzing existing datasets on straw usage; doing a benefit-cost analysis of current and alternative management practices; and doing a demand analysis on drivers and future trends.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjRkZGRlZGE2NjNlZGViOGE

Q&A:

Duong Nuyen Khang (of NLU): In the Mekong Delta, rice straw is used for cattle, but the problem is management, not only where to collect it and transport it to the site, but also its quality in the field. The quality of rice straw varies in different seasons, and we are thinking about how we can optimize its quality for cattle and how to transport it and reduce the cost of transportation and labor. Storing rice straw is another problem. We are thinking about how to optimize its use in the Mekong Delta up to southeast of Ho Chi Minh City, where cattle production flourishes.

Sustainability analysis

Nguyen Van Hung presented IRRI's current initiatives on life cycle assessment, as a tool to identify best practices for sustainable rice straw management. The LCA is a tool used to analyze environmental impact from the cradle to the grave. The project will combine the LCA conducted for different rice straw management options with economic and social criteria and combine these three aspects into a "sustainability assessment" under Output 4.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OjE0MTFjNDViODIyNjA0MGI

VIII. Rice straw initiatives from other sectors

Better Rice Initiatives Asia

Juejan Tangtermthong, regional officer of GIZ in Thailand, explained the concept of BRIA and its project countries—Thailand, Vietnam, Indonesia, and the Philippines—from 2014 to 2017. BRIA has an overall steering committee and country-based steering committees. BRIA aims to reach 10,000 to 4 million farmers. BRIA also introduces rice seeding technology, which improves the net profit of farmers by more than 124% based on a study. In Thailand, John Deere donated a combine harvester to BRIA, which is currently used to develop and pilot a combine harvesting business model for a farmers' group. A study conducted by the Deutsche Bank concluded that the purchase or rental of combine harvesters could lead to an efficiency gain of more than 50%. BRIA's potential areas of interest with the new project include efficiency of using by-products (rice husk and straw) and harnessing potential income for farmers through business models.

In 2014, BRIA Thailand conducted a study on sustainable rice straw use, which revealed that rice straw is sold at USD 1 per heap (25–30 kg).

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OmY5OGNhM2EzNTEzNTM0OQ

Q&A

Martin Gummert: Are the 71,000 tons of straw potential based on production or the amount of straw used?

Juejan Tangtermthong: It's based on rice production.

Walter Zwick: Is the farm becoming smaller or bigger? But the farmers are becoming older and fewer are younger, so we would assume that small farms get consolidated into bigger ones.

Juejan Tangtermthong: I have not presented land trends but, yes, there farmers are increasingly aging.

Phan Hieu Hien: Are farms becoming bigger and bigger in Thailand?

Juejan Tangtermthong: No, because farmers are distributing land to their children, which makes the farms smaller, but they are not really distributing the title.

Private-sector presentations

Loc Troi (former AGPPS) group.

Duong Van Chin gave a presentation on behalf of the Loc Troi group. Loc Troi is funding its own research center, which Duong Van Chin is heading, and one of the research topics in the last few years has been rice straw management. He promoted the baler brand, Phan Tan, which was identified in their work as the best rice straw baler. For using rice straw for animal feed, he talked about the preparation procedures in preserving feeds in polyethylene (PE) bags: rice straw is sprayed with 4% urea and kept in a PE bag. They observed that this practice improves the condition of the stored feed after 7 months of storage. For carbonization, about 2 hours of burning/pyrolysis are needed to produce biochar. He also mentioned that they cooperate with YANMAR and use YANMAR combine harvesters with a straw-chopping mechanism and a built-in *Trichoderma* sprayer to speed up incorporation and decomposition and thus produce in-field organic fertilizer. He also showed a 4-wheel- and 2-wheel-tractor-based option, which is spraying *Trichoderma* while plowing the straw into the field. Then, they proceeded to conduct flush irrigation after plowing. Then, they buried the rice straw and irrigated using the alternate wetting and drying technique and that reduced greenhouse gas emissions. They found the combine harvester with chopping and built-in *Trichoderma* sprayer to be very useful during the wet season. Chin said that, after five seasons of applying 5–6 tons of rice straw into the soil, this improved its condition.

Loc Troi is very interested in working with the project. They think the combine with straw chopper and *Trichoderma* sprayer is a mature technology ready for outscaling, and would be interested in using the project to initiate outscaling of the technology. Loc Troi also produces *Trichoderma*; the capacity of the plant is 600 t/year but they are currently producing only 50 t/year.

Chin also claimed that in their work they showed that applying carbonized by-products can increase the yield of rice by 2%.

Note: During the field visit, we saw two combines with different power ratings, both with straw choppers and *Trichoderma* sprayers. The straw is chopped into particles a few centimeters in length and spread very evenly, suggesting that incorporation will be much easier than when the straw is on windrows. The combines had the same performance/capacity as the Kubota DC60 with 60 hp but more powerful engines. The smaller one had 72 hp and was considered under-motorized for continuous operation at full capacity, whereas the larger one had 86 hp, 26 hp more than the comparable DC60. This confirms the statements of CLAAS that adding a straw chopper to a combine leads to a 20–40% higher power requirement.

Note 2: As observed during the field day with the combine harvesters, the *Trichoderma* is applied to the straw very unevenly in the combine harvesters basically through two tubes dripping the liquid into the chopper. Loc Troi has not done any research on how more even distribution of the chemical would affect straw decomposition.

Bui Van Ngo

Nguyen The Ha presented for the Bui Van Ngo group, which consists of a rice milling equipment factory making world-class milling equipment, a furniture manufacturer, and some food business. For years, Bui Van Ngo has been working on an integrated business model with a large-scale rice-processing plant and a total of VND 1 trillion in investment, which also includes farmers as stakeholders. This includes not only rice but also husk and rice straw as additional products.

More than 30 years ago, Mr. Ha was also a mushroom producer, and he mentioned an example of the benefits of using rice straw. According to him, the financial benefits from mushroom production could be twice those of rice production from the same rice field area. Similar benefits were also confirmed by a mushroom producer during our site visits to Can Tho City of Vietnam. Farmers can obtain an additional VND 17–18 million by investing their own labor in rice straw gathering and mushroom production from 1 ha of rice field.

He also said that cattle raising is better than mushroom production, because of the yield of rice straw. Only around 3% of the rice straw is used to produce mushrooms, whereas the potential to use it as cattle feed is much higher. But, he suggested using the rice straw harvest for mushrooms and cattle, depending on the opportunity in the area. He also suggested incorporating rice straw into the soil if the area is conducive to neither cattle raising nor mushroom growing. Bui Van Ngo plans to invest in processing rice straw to use it properly; they do not want to treat straw only as a by-product, but they see it as another product equally important as paddy grains.

Binh Minh Cooperation

Note: Some participants of the group had visited Binh Minh Cooperation on the way from HCMC to Can Tho. It is a cooperative and it processes rice straw into bales and into pellets in a large feed mill.

Mr. Le Minh Anh presented options for gathering straw and reducing the collecting cost. The Binh Minh company is now gathering, storing, and processing rice straw into high-density rectangular bales for transport to HCMC and other locations and into pellets. They purchased 15 units of a self-propelled baler from Phan Tan to be used in Long An and Dong Thap provinces. The company owns five units of the tractor-driven Z557 baler. The self-propelled baler can decrease labor by 50% compared with the tractor-driven baler because the tractor-driven baler drops the bales in the field, which then have to be collected separately. The self-propelled baler collects the bales on a platform and drops them at the side of the field. They also bought two units of a 250-ton loader to transport straw. Current total field capacity is 10,000 bales per day.

In other uses of rice straw, Binh Minh supplies straw to cattle and pig production companies; produces wet straw with urea; produces pellets from rice straw for fuel; produces straw-husk pellets, using the same heating value as for rice husk; and produces ground rice husk and supplies it to Heineken Beer Company for the fluidized bed furnace. About 220 kg of pellets are needed to produce 1 ton of steel, which costs VND 330,000. If we use fuel oil, the cost Is VND 560,000 per ton of steel, which is more expensive than pelletized straw.

Anh enumerated some challenges encountered during rice straw processing: (1) the very short turnaround time (7 days) for farmers before establishing the next crop after harvest so farmers tend to burn rice straw in the field; (2) small fields, and storing of straw at high moisture content is difficult, therefore making it difficult to process straw into more high-value products.

Straw is bought at VND 500,000 per hectare or VND 200,000 per t in farmers' fields. Rice straw is also used for mulching dragon fruit plantations. It can also be used as construction material and beds for cattle raising.

Suggestions were made to researchers and business sectors for more initiatives on gathering and processing rice straw to reduce its price and add value.

Ways to dry rice straw for longer storage are being explored with NLU.

For details see the presentation:

https://docs.google.com/a/irri.org/viewer?a=v&pid=sites&srcid=aXJyaS5vcmd8cG9zdGhhdmVzdC11bml0fGd4OmNkYTMwMTlmYmViMzJiMw

IX. Day 2

To start the group work of day 2, Martin summarized some of the key points that were discussed the previous day:

- There have been many new developments since we wrote the proposal. Some of the assumptions need to be re-assessed and new research findings, developments in the private sector, and emerging business models, for example, for straw collection, need to be taken into account.
- Plenty of research done in Vietnam by different actors, including the private sector, on technologies and management options are more advanced than in the Philippines and Cambodia. In those two countries, we could start with a subset of activities, for example, by demonstrating balers.
- Lots of component technologies are being commercialized or are under evaluation:
  - Straw collection, mushroom production, pelleting, chopper on combine, *Trichoderma*, biogas….
  - "Will not come up with one solution that fits all."
- Some new technologies still need to be researched:

    - Carbonization + composting.
- There are some needs for clarification and data gaps exist, such as for carbonization:
    - Vu Dong Quynh: Applying a carbonized product leads to a yield increase when 1.5 t/ha is applied, but larger application does not further increase yield.
    - Duong Van Chin (Loc Troi): No yield increase with 1 t/ha, but an increase with 2 t/ha.
    - Data about benefits and potential hazards of biochar, in particular cristobalite, which is as cancerogenous as asbestos.
    - Baling works well in the dry season but not in the wet season. Drying straw is also a problem in the wet season.
    - Biogas on a larger scale is moving toward commercial applications; on a small scale, it targets the farm level. It is cheap but competes with other family activities. Is it really the best solution? Rice straw alone for biogas does not seem to be an option.
    - From Cambodia, we saw an economic assessment of the value of the nutrients removed with the straw. We need to look at the whole system, not just the components.
    - Markets for rice straw and rice straw products are not understood well (Vietnam) or don't exist yet (Cambodia, Philippines?). Market trends are not understood either. Prices can change very quickly and render assumptions for business models invalid very quickly. For example, the price for rice straw in Vietnam increased from USD 20/t to 80/t within a few years. We need to get a handle on that.
- We could use the already existing CORIGAP rice straw Learning Alliance in Vietnam and adapt that to the project needs.

Based on the observations during the field visits and the discussions and presentations of the previous day, Martin then also presented a list with potential business models that exist already or are outlined sufficiently so that they could be included for verification already in year 1 (low-hanging fruits). They could be characterized as contractor service provision (C), individual farmer business model (F), or entrepreneurial business model (E) (Table 1). He asked the audience for comments and further suggestions, but the table was not discussed in more detail. Reiner suggested that discussion of business models is too early and should happen at a later stage of the project when all the data gaps are filled. There are, however, simple models such as a contract service for straw baling that are so straightforward and already exist so they have only to be documented in order to start working with them.

Table 1. Potential business models extracted from observations during field visits and from presentations.

Business model	Type	Status of development/verification	Project action
Rice straw collection using balers	C	Already implemented in Vietnam	Initial BM for outscaling?
Mushroom production	F, E	Already implemented in all countries	Initial BM for outscaling?
Biogas	?	Part of SUPERGEN project; Projects in Vietnam	Still at research stage?
Mushroom + biogas	F, E	SUPERGEN project, research stage	
Composting	F?, E	Already implemented	Initial BM for outscaling?
Carbonization/C sequestration	?	Projects, question about monetary benefits for farmers	
Carbonization + composting	E?	Output 3 of BMZ project, first results in 2017	
Combustion + carbonization	E?	Initial results from furnace at IRRI, questions about quality of carbonized rice straw	

Martin then presented an overview of the five outputs and the corresponding activities as defined in the project document. He stressed that the project proposal was written one year ago and that in particular many developments have occurred with respect to rice straw management, in particular in Vietnam, and that therefore some of the assumptions in the project document have to be re-assessed.

X. Group discussions for proposed activities

For the group work, the participants were grouped into three: Group 1—innovative technologies and business models (Project Output 1); Group 2—upstream research to verify rice straw technologies and fill data gaps (Project Outputs 2 to 4); and Group 3—outscaling (Project Output 5).

Group 1: Innovative technologies and business models

Activity	Data/ information gap/ problems	Location/ sites	Potential	Research needs	Partners, who else needs to be on board	Project action, potential co-funding
DEMAND						
Rice straw for building materials (low-density fiber)		Vietnam	Large-scale private company capacity	Demand, quantity, quality	Private company, DARD	Study
Livestock feed	Chopper for feed	Vietnam (Can Tho DARD)		Demand, quantity, quality (MC for wet straw, effect of pesticide on straw quality; dirt, variety)		Research
Compost	Applied research (Indoor mushroom production)	Thailand Vietnam		Efficiency Modify indoor mushroom production to improve technology Outscale business models in the Mekong Delta, link to markets Organic fertilizer/*Trichoderma*	BRIA SIAEP SIAEP	Research
Mushroom*	As additional income only Sticky rice variety is best for mushroom production	Philippines Vietnam (Can Tho) Le Minh Anh (Binh Minh group)		Systems approach with collection and management options	PhilRice	Business models, outscaling
SUPPLY						
Straw supply chain	Transportation cost is high Densification	Philippines Vietnam (Can Tho) Vietnam		 Pressed straw on boat	PhilRice Straw trader Binh Minh	

Activity	Data/ information gap/ problems	Location/ sites	Potential	Research needs	Partners, who else needs to be on board	Project action, potential co-funding
Transportation**	Densification, more compact bales; balers Pellets for cattle feed (5 t/ha), briquettes		Pellets for cattle feed (5 t/ha)		Nguyen Van Hieu, Tien Giang University Binh Minh Animal Nutrition	Continue research on rice straw pellet production
Energy, gasification, biogas	To power irrigation pumps for vegetables (after rice) Cooking Biochar	Philippines Vietnam	For central Vietnam	Systems approach with collection and management options	PhilRice Research on kilns (biochar)	Research
Business models for rice straw value chain (collection, chopping, baling, marketing), making machines, for wet straw, animal feed	Lack of feasibility study	Vietnam	Technology, know-how, feasibility study		Bui Van Ngo	Business models

Activity	Data/ information gap/ problems	Location/ sites	Potential	Research needs	Partners, who else needs to be on board	Project action, potential co-funding
Improving chopping, *Trichoderma*, incorporation			Field trial (for *Trichoderma*): temperatures in field are different every season Demonstrated BM for baling in central Vietnam		Vietnam	 BM
Drying straw business model			Research on straw-drying technology		Central Vietnam	

** ranked as the most important issue; * ranked as the second most important issue.

General comments

- Do we have ready technologies for business models? Maybe it is worthwhile to tackle business models at the end, to know where something can work and how much we can generate; BMs should not be at the forefront.
- It might be better to provide comparative options for different options. Business models should not be automatically attached to each of the technologies. They might even come in combinations of different technologies. I suggest that they should not be considered at the start of the project.
- The future of straw use involves livestock raising and the incorporation of rice straw as main activities—90% of the straw will be used for these purposes. For mushrooms, slightly less than 2% of the rice straw will be used and, yet, the group prioritized mushroom production and related activities. More straw is used if it is incorporated into the soil. Reconsider the priority activities in terms of optimizing the use of available straw.
- Prioritize activities for this output, and look at the economic and technical feasibility of the identified technologies.

Group 2: Upstream research

Activity	Data/information gaps	Locations/sites	Partners, who else needs to be on board	Project action, potential co-funding
GHGE + LCA of different practices of rice straw Incorporation	Available data: incorporation of rice straw ➔ Upgrade with more scenarios/ verification	IRRI		Available instrument
Eddy covariance measurements on straw burning		IRRI		Available instrument at IRRI
Carbon footprint and LCA of using rice straw for cattle feed	Available data (GHGE) for nonrice straw feed (NLU) ➔ Review ➔ apply for rice straw	NLU IRRI		NLU: cow farm, instrument BMZ: labor, feedstock, consultant, analysis IRRI: staff time of scientist
GHGE for mushroom production	Ongoing research	Vietnam (Mekong River Delta)	IRRI, NLU, and CTU	Low priority if budget limited
Energy balance, carbon balance, and LCA of carbonization ➔ compost	Piloting activity: HU ➔ Compost can be used for other crops	HU and IRRI (ZES and CESD)	Simon Munder, Ole Sander, James Quilty, Hung Van Nguyen	Budget: Outputs 3 and 4
Country data on specific treatments (e.g., *Trichoderma*)	Potential opportunity in Vietnam	CLRRI, Loc Troi, Hue University, and IAE	Hue University for analysis of samples	Country data on specific treatments (e.g., *Trichoderma*)

General comments

If composting is really a farmers' practice, it should be mechanized from removal to transportation to a more high-value market.

Biochar is not a miracle product. We should measure GHG emissions during biochar production and during the process in reactors. Then, we can conclude on the value of biochar. Biochar can also have negative effects on soil fertility and crop health, and polycyclic aromatic hydrocarbons become concentrated in the soil water with the application of biochar. This needs to be understood better.

A composting experiment will be conducted at the IRRI ZES in Year 3 after the carbonization research is done.

Walter Zwick: If we incorporate rice straw in the rice field, we obtain more GHG emissions. Draining the field is interesting for fertilizer and pesticide application. What is the most optimum drainage?

Ole Sander: Yes, you are very right. We will include that in the experiment. We did not include that here in the work group because that is not part of the deliverables within this project. We already have some data on that and, yes, we will still include that in our experiment.

Vu Duong Chin (Loc Troi): If we incorporate rice straw into the field, we want to increase fertilizer, but, if we continue to irrigate the field, then methane will increase. I believe that, if we want rice straw for mushroom and feedstock, still a majority of the farmers will burn it in the field, instead of using *Trichoderma* and incorporating in the field. I suggest that IRRI conduct an experiment comparing flooding (with a high amount of rice straw) continuously versus AWD and measure emissions in the field.

Ole Sander: We have done experiments on AWD and still conduct an experiment now and we are willing to conduct an experiment with Loc Troi and compare our results with on-farm results.

Reiner Wassmann: We should really measure CH^4 at different points. But let's not forget the policy side. Vietnam is promoting Small Farmer, Large Fields (SFLF). There could be a chance for improved straw management because management of straw is difficult for a very small farm. So, let's look for synergies. We can see that there are more benefits for mitigation. On top of that, in combination with the ongoing mechanization, the policy is going in the direction that fields are becoming bigger now.

Phan Hieu Hien: Since SFLF and AWD were mentioned, I would suggest another factor: whether the field is leveled or not leveled. Because I believe that AWD will not work well with a nonleveled field.

Ngo Dang Phong: We should also consider seasons because Vietnam has three seasons but other countries have only two seasons. I think that the hydrologic conditions are different in different locations.

James Quilty: I guess that, in all that we are doing, we have to consider seasonal fluctuation. We cannot have one scenario. Consider the most common scenario. The opportunity from Loc Troi is that the work can be done there. For the wet season, we can apply *Trichoderma*. It would be good to look at location-specific research happening but we have to look at budgets. Biochar is really aimed at increasing the productivity of soil. From the presentation yesterday, biochar can be beneficial, if it's incorporated into a soil with high pH, and it will have the opposite effect if used in a fertile soil because the carbon from biochar might remove nutrients from the soil. So, it's not really a one solution for all problems.

Group 3: Outscaling

Activity	Data/information gaps	Locations/sites	Partners, who else needs to be on board	Project action, potential co-funding
Develop and use existing ICT platforms	Cambodia: appropriate format of ICT/dissemination platform for rice straw management options	Cambodia, Vietnam, Philippines	PhilRice Bac Lieu, Hau Giang (CCAFS Project) Don Bosco Farm	Outscaling
Develop training modules for extension/farmers Adaptation of training modules in Cambodia and the Philippines	Further enhance mushroom production (MC and temperature control for indoor production) Use national document on mushroom cultivation (translate into English, Khmer, or any local language)	Vietnam, Cambodia, Philippines	Supergen (biogas): second half of 2016 Long An Agricultural Extension Center (LAAEC) National AEC SIAEP	Training, outscaling
Develop training materials for using rice straw as animal feed based on best practices	Best practice from farmers in Vietnam	Vietnam, Cambodia	NAEC	Training
Conduct of training (farmers, extension agents/ToT) in farming communities in identified provinces		Cambodia, Vietnam, Philippines	MAFF, DARD, BRIA	Training
Demonstration of combine harvesting, baling, *Trichoderma* application, land preparation, indoor mushroom, and best practice on straw management in field	Soil fertility data; biochar effects on soil (Loc Troi)	Vietnam (An Giang Province, Long An, Can Tho, Bac Lieu) Cambodia Philippines	CORIGAP Long An AEC Loc Troi Group Bui Van Ngo DBFS (Battambang), Kubota PhilRice	Field demo and outscaling

General comments

Suggestion to work with YANMAR; the company is already a partner of Loc Troi and Cuu Long Rice Research Institute and is also willing to partner with the project team. YANMAR machines are the best.

Martin Gummert: IRRI is an honest broker. We can work with any company but cannot guarantee exclusiveness and we don't promote certain products or companies. We work with the private sector and welcome its contribution to promote a principle, for example, combine harvesting, but not the product as such. Everybody is welcome to work with us.

This is a work in progress. The next step is to consolidate the documents and come up with an action plan. I would invite you to look at it when we share it and see if everything is covered and then we start working on the action plan.

Asrul Iman: If we want to do something in Indonesia, whom can we liaise with?

Martin Gummert: We have CORIGAP projects in Sumatra and Yogyakarta working with the Indonesian Agency for Agricultural Research and Development as the principal partner and in particular the Indonesian Center for Rice Research in Sukamandi, which is also a BRIA partner, and with the BPTPs in the two provinces. We also work with Balai Besar for mechanization in Serpong and the Postharvest Institute in Karawang. But, you could also contact us directly.

XI. Discussion and next steps

Points raised during the discussions are captured in the previous section as feedback to the outputs of the working groups.

Martin then outlined the next immediate steps for the project, which include the following:

- Submission of workshop report (March)
- Conduct smaller, regional workshops in Cambodia (MAFF) and the Philippines (PhilRice) to discuss the needs and activities in those two countries
- Nomination of contact person at BRIA (at IRRI, Paolo Ficarelli)
- Include a rice straw subpage on the Learning Alliance website (a work in progress)
- Contact a scientist for each output package:
  - Martin Gummert for coordination; Reiner for mentoring
  - Dr. Nguyen Van Hung for Output 1 and Output 4
  - Dr. Ole Sander for GHGE studies (Output 2)
  - Dr. Matty Demont for markets (Output 1)
  - Reianne Quilloy for Learning Alliance (for cross-cutting, link to CORIGAP)
  - James Quilty for supporting experiments at the IRRI ZES
  - Caling Balingbing for technical topics on mechanization, postharvest
  - Simon Munder from Hohenheim University will lead Output 3

The workshop ended with thanks to the host, Can Tho DARD, the organizing team from NLU and from IRRI, and to the participants for their valuable contributions.

Appendix 1: Participants' List

	Name	Institute
Academic or research sector		
1	Dr. Phan Hieu Hien	Nong Lam University (NLU), HCMC
2	Dr. Duong Duy Dong	Nong Lam University (NLU), HCMC
3	Dr. Duong Ngyuen Khang	Center for Science and Technology Transfer, Nong Lam University
4	Dr. Nguyen Thanh Nghi	Center for Agricultural Energy and Machinery, NLU
5	Dr. Pham Van Tan	Sub-Institute of Agricultural Engineering and Postharvest Technology
6	Mr. Nguyen Thanh Long	Hue University of Agriculture and Forestry
7	Mr. Nguyen Van Hieu	Tien Giang University
8	Mr. Nguyen Van Xuan	Center for Agricultural Energy and Machinery, Nong Lam University
Government sector		
9	Dr. Ngo Dang Phong	NLU-IRRI
10	Dr. Nguyen Thi My Phung	Department of Agriculture and Rural Development, An Giang
11	Dr. Vu Duong Quynh	Institute of Agricultural Environment
12	Mr. Le Minh Duong	Department of Agriculture and Rural Development, Bac Lieu
13	Mr. Nguyen Thanh Tung	Long An Agricultural Extension Center
14	Ms. Dinh Thi Phuong Khanh	Department of Agriculture and Rural Development, Long An
15	Ngo Van Day	National Center for Agricultural Extension
16	Nguyen Thi Kieu	Department of Agriculture and Rural Development
17	Phan Thi Minh Hieu	Department of Agriculture and Rural Development, Can Tho
Private sector		
18	Dr. Duong Van Chin	Loc Troi, Inc.
19	Mr. Le Minh Anh	Binh Minh Group (Nam Anh Tien Giang)
20	Mr. Nguyen Hong Tien	Tu Sang Enterprise (baler manufacturer)
21	Mr. Phan Tan Ben	Phan Tan Machinery Enterprise (Dong Thap)
22	Mr. Vo Ngoc Vui	Mushroom Farm (Can Tho)
23	Mr. Vo Thanh Can	Cow Farm (Long An)
24	Mr. Nguyen The Ha	Bui Van Ngo Co. (HCMC)
Other institutes		
25	Asrul Iman	BASF, Indonesia
26	Caesar Tado	Philippine Rice Research Institute
27	Carlito Balingbing	International Rice Research Institute

	Name	Institute
28	Craig Jamieson	International Centre for Research in Agroforestry
29	Dr. Juejan Tangtermthong	GIZ, Thailand
30	Gerald Hitzler	International Rice Research Institute
31	James Quilty	International Rice Research Institute
32	Martin Gummert	International Rice Research Institute
33	Matty Demont	International Rice Research Institute
34	Meas Pyseth	Department of International Cooperation, Cambodia
35	Ambros Dotzer	GIZ , Vietnam
36	Sieu Trinh Vi	GIZ, Vietnam
37	Nguyen Van Hung	International Rice Research Institute
38	Ole Sander	International Rice Research Institute
39	Reianne Quilloy*	International Rice Research Institute
40	Reiner Wassmann	International Rice Research Institute
41	Simon Munder	Hohenheim University
42	Walter Zwick	Don Bosco Technical School, Battambang, Cambodia

Appendix 2: Logical framework matrix of the project

LOGICAL FRAMEWORK MATRIX				
PROJECT DESIGNATION: Scalable straw management options for improved farmer livelihoods, sustainability, and low environmental footprint in rice-based production systems DATE: 31 March 2015				
	Intervention Logic **Narrative Summary**	**Objectively Verifiable** **Indicators (months)**	**Sources or Means of** **Verification**	**Major Assumptions**
IDO Contribution	Increased profitability of farmers and affordability to consumers (IDO 2) and increased sustainability and reduced environmental footprint (IDO 4)	Income of farmers managing straw according to best practice increased by 10%. Greenhouse gas emissions from straw management reduced by 50%.	Impact assessment after 10 years	Policy recommendations implemented by governments
Overall Objective	Improved farmers livelihood by adding value to their rice crop through either using straw in the field or selling straw products. Increased sustainability of rice production by reducing its environmental footprint.	Farmers at pilot sites (75 communities in three countries) reduce field burning by 10% per year. Number of farmers at pilot sites either selling rice straw products or applying best-practice management increases by 10% annually.	Farmer diaries at CORIGAP sites with project pilots Project reports	Incentives for farmers for environmental protection to reduce burning. Markets for rice straw or rice straw products. Availability of BRIA sites for pilots Risk: Legislation prohibiting field burning is not implemented.
Project Purpose	Provide NARES partners with sustainability assessment methodologies (economic, social, and environmental) to assess different straw management options, disseminate the results, and train farmers on best-practice straw management. *Provide policymakers (agriculture) with the information needed to create an enabling environment for best-practice straw management.*	One NARES partner in each country using sustainability assessment (36). Training of farmers by one NARES partner in each country (36) At least one policy recommendation released in each country (36).	Policy recommendation documents National rice strategy documents Reports on sustainability assessments	NARES have resources and mandate to advise farmers on sustainable rice production. National governments include sustainable rice production and environmental protection in their agricultural strategies.

Outputs	Output 1: Innovative technologies, management options, and farmer business models for conventional rice straw management	At least two straw management options evaluated per target country (36). Two different business models for farmers for adding value from their straw piloted (36).	Project reports Publications Technology pilots	Technologies and management methods adapted to local conditions
	Output 2: Carbon footprint of conventional straw management options under different mechanization levels of harvest/postharvest operations.	Emission data established for use in sustainability assessment from IRRI trials (24) and from partner countries (30)	Project reports Publications	No extreme climate events during the field trials
	Output 3: Carbonization of straw (biochar) as a pioneering approach for lowering footprint and increasing income	Process parameters and GHGE data for carbonization established in laboratory (12) and in pilot at IRRI (18).	Project reports Publications Technology pilot at IRRI	
	Output 4: Methodologies for and results from sustainability assessment for promising rice straw management options	Protocols and methodologies for LCA and economic and social assessments developed and tested (12) Best-practice policy recommendations developed (30)	Project reports Assessment reports Spreadsheet models Publications	
	Output 5: Communication and outreach strategies for dissemination of results	Training of trainers conducted on methodologies (18) and on most-promising technologies in target countries (30). Policy recommendations included in national rice strategies (36). Information on methodologies and technologies available online and disseminated in print (30).	Training materials developed Reports on training courses prepared Web pages (e.g., RKB)	Online platforms (RKB, Rice Crop Manager) continue to operate. National stakeholders include project outputs in their programs.
Activities		**Major Milestones for key activities**	**Brief summary of resources required; major sources of funding**	**Assumptions referring to Activity to Output level**
	1.1 Determine future market prospects for rice straw and rice straw products in the context of the structural transformation of rice value chains. 1.2 Baseline study on straw management options and technologies that are readily available or in the research pipeline. 1.3 Assess the technical feasibility and economic viability of most-promising on-field straw management options in the form	1.1 Study conducted in all three countries (6) and potential rice straw product markets prioritized (12) 1.2 Baseline study conducted in the Philippines, Vietnam, and Cambodia (6)	Personnel 10% of Matty Demont's time in 2016, 5% in 2017 and 2018 100% for 4 months of PDF (Nguyen Van Hung), (in 2016, 25%, co-funded by SUPERGEN) 60% of assistant scientist (straw management)	Existing technologies can be adapted to local conditions Risk: IP issues with some available technologies Finding partners who are willing to invest for piloting business model implementation

	of field trials supplemented by cost-benefit analysis. 1.4 Verify/adapt technology options for operations identified as bottlenecks in off-field straw management in areas where suitable technical solutions adapted to rice agriculture in the tropics are not yet available, for example, for collection, densification, and pre-processing. 1.5 Conduct a feasibility study on energy use of straw derived from a comprehensive SWOT analysis of technical options in different rice environments and time horizons. 1.6 Facilitate information exchange with research groups working on other non-energy options for straw use. 1.7 Conduct value chain analysis for selected straw use options and develop business models for farmers' value adding.	1.3 Field trials for straw incorporation and mulching conducted at various sites (IRRI, NARES, and BRIA) (18) Results verified in farmers' fields in target countries (24) 1.4 Four field trials for collection and experiments for densification conducted at IRRI (12). One field trial/experiment at various sites (IRRI, NARES, and BRIA) conducted (24). 1.5 At least one study for energy from rice straw application available (12) 1.6 Workshop with ILRI conducted (24) 1.7 At least one farmer business model for straw use options in each country developed (24) and tested (30)	<u>Capital items</u> USD 45,000 for prototypes, instrumentation <u>Travel and workshops</u> Travel to pilot sites and workshops (travel budget under Output 5) One workshop with ILRI in Year 2	
	2.1 Replicated field experiments for GHGE measurements of different practices of straw incorporation into the soil at IRRI's experiment station. 2.2 Field experiments on GHGE from straw	2.1 Replicated GHGE experiments at IRRI's ZES conducted (24) 2.2 GHGE from straw burning in selected	<u>Personnel</u> 10% of Ole Sander in 2016, 5% in 2017 and 2018 100% Sr. Associate Scientist 100% Researcher (NRS support)	Field equipment for GHGE measurements is not damaged by natural catastrophes (e.g., typhoons).

	burning in farmers' fields 2.3 Measurement of GHGE from nonenergy options of straw treatment, for example, mushroom production	farmers' fields in the Philippines (30) 2.3 Field experiments on GHGE from nonenergy options vs. straw incorporation into the soil conducted in farmers' fields in two countries (30)	Partner subcontracts (USD 266,037) (together with Output 1) Travel, supplies Travel to pilot sites, workshops (travel budget under Output 5)	
	3.1 Investigate the thermal degradation of rice straw (loose cut, briquetted, untreated) to coal 3.2 Construction of a semi-automatic TLUD reactor for larger quantities at IRRI. 3.3 Conduct experiments with different straw properties and reactor process conditions at IRRI ZES. 3.4 Conduct char activation trials via composting and determine straw fractions as a function of mean residence time. 3.5 Conduct an experiment at IRRI ZES to determine GHGE from biochar during crop growth and assess the agronomic benefit of composted biochar.	3.1 Model on optimum straw-charring conditions developed (6). Data on process efficiency and emissions for LCA established (6). 3.2 Pilot reactor constructed (18). Char for activity 3.3 available (24). 3.3 Optimum operation parameters determined (18). 3.4 Data from composting trials available (24). 3.5 GHGE from biochar during crop growth available (36).	USD 166,037 for subcontract with Hohenheim University Including: Two years for project scientist Travel cost (project scientist and students) Instrumentation Reactor and composting device	
	4.1 Adapt methodologies and tools for life cycle assessment (LCA) and economic and social assessments. 4.2 Build best-practice recommendations based on results from economic, social, and environmental assessment.	4.1 Methodologies for LCA and economic and social assessments developed and tested (12). 4.2 Best-practice recommendations developed for each country (30).	Personnel 100% for 4 months of PDF (Nguyen Van Hung), (in 2016, 25%, co-funded by SUPERGEN) 60% of Assistant Scientist (straw management) Travel, supplies Travel to pilot sites, workshops (travel	National stakeholders provide the information needed for the sustainability indicators.

			budget under Output 5)	
	5.1 Enhance existing ICT platforms to increase dissemination 5.2 Develop training modules on best-practice straw management options and on decision support tools for direct clients. 5.3 Training delivery (training of national direct clients/training of trainers) 5.4 Use field pilots in all countries as demonstration sites for the dissemination of information about best management options. 5.5 Provide policy recommendations based on results of sustainability assessments and best-practice recommendations.	5.1 Platforms enhanced (30), tested, and used in training (36). 5.2 Modules developed (24). 5.3 Training delivered for project partners (12) and direct clients (36). 5.4 At least one best management practice piloted and demonstrated in each country (30). 5.5 One policy dialog event held in each country (36).	Personnel 10% of Martin Gummert's time in 2016, 5% in 2017 and 2018 100% for 4 months of PDF (Nguyen Van Hung), (in 2016, 25%, co-funded by SUPERGEN) Consultant for web interface Travel and workshops Inception workshop Two project coordination workshops	NARES stakeholders and outscaling platforms (BRIA, SRP) are supporting the pilots. Policymakers are willing to engage in dialogue.

XII. Appendix 3. Documentation of the event

IRRI News: Innovative technologies turn rice straw from waste into productive uses

(http://irri-news.blogspot.com/2016/03/innovative-technologies-turn-rice-straw.html)

CAN THO CITY, Vietnam—Farmers were able to see firsthand the latest technologies that turn rice straw from waste into a useful and renewable resource during a field demonstration at Cuu Long Rice Research Institute (CLRRI) on 1 March.

Although the use of combine harvesters has been a game changer in rice productivity, it leaves behind enormous amounts of rice straw, especially in fields using intensive cropping systems. Each year, about 26 million tons of rice straw are left in vast areas of Can Tho after combine harvesting. Most farmers burn the straw because it is the easiest and quickest method of disposal so that the field can quickly be prepared for planting the next crop.

To give farmers better disposal options, the Postharvest group at the International Rice Research Institute (IRRI), through the Closing Rice Yield Gaps in Asia (CORIGAP) project, initiated a farm demonstration featuring technologies for gathering rice straw for productive uses. The event was conducted in collaboration with Nong Lam University and the Vietnam National Extension Center.

"We are pleased to see the progress of mechanized rice production in Vietnam," said Professor Nguyen Hong Son, director of CLRRI. "This initiative that IRRI started also resonates with our vision to make rice farming environmentally sustainable while helping more farmers."

Through the demonstration, participants learned more about straw balers, which are machines that collect rice straw scattered across the field. They were able to observe the performance of three locally manufactured balers and one imported brand. They saw how much straw each baler could collect and how many laborers each baler required.

A multi-sectoral forum about rice straw management initiatives in the Mekong Delta was held the next day (2 March). It was locally organized by Vietnam's National Extension Center, led by its director, Phan Huy Thong.

The aim was to discuss how research breakthroughs and extension efforts on rice straw technologies could be improved. The forum attracted extension staff from more than 30 provincial branches of the Department of Agriculture and Rural Development and extension centers in Vietnam. Representatives from IRRI, private institutions, academe, and research institutes in Cambodia, Germany, the Philippines, Thailand, and Indonesia also attended the forum.

Another group attending the forum represented the private sector, including local manufacturers, feedstock company owners, and farmers. Members of this sector saw potential areas for improvement being mushroom production technologies, feedstock, organic fertilizer, and equipment subsidies.

According to Thong, the forum is in line with the country's policy direction on the elimination of rice straw burning in the field.

CORIGAP initiated the rice straw collection business model in 2013, which has led to more rice straw-related activities and the establishment of a rice straw management Learning Alliance in Vietnam.

IRRI News: Proper rice straw management may increase Southeast Asian farmers' income

http://irri-news.blogspot.com/2016/03/new-project-on-rice-straw-management-to.html

CAN THO CITY, Vietnam—A new German-funded project on using rice straw in an environmentally sustainable way could bring income opportunities for farmers.

In Southeast Asia, rice straw is a major rice by-product that is usually burned in the field, a practice that has detrimental effects on the environment and human health.

A new project, Scalable straw management options for improved farmer livelihoods, sustainability, and low environmental footprint in rice-based production systems, has been launched in the Philippines, Cambodia, and Vietnam. It aims to provide a holistic approach to identify and promote environmentally sustainable options to manage rice straw while improving livelihoods of smallholder farmers.

The International Rice Research Institute (IRRI) and the German Federal Ministry for Economic Cooperation and Development (BMZ) held an inception workshop on 3-4 March in Can Tho City to lay the groundwork. The workshop brought together major public and private stakeholders from the three target countries and project partners from Germany and project satellite countries such as Indonesia and Thailand. They provided updates on the latest rice straw management research activities and initiated the project's strategic collaborative activities.

According to Martin Gummert, IRRI senior scientist and project coordinator, the project's main activities involve (1) assessing different straw management options, including value-adding potential and environmental footprint; (2) building capacity of farmer intermediaries on providing advisory services for best straw management practices; and (3) providing policymakers with information on creating enabling environments for best practices on rice straw management.

Gummert added, "Engagement with the private sector is important to develop business models on how farmers can make use of the equipment to the most benefit."

These activities will be carried out through interlinked outputs focusing on innovative technologies, management options, and business models; the carbon footprint of mechanization; new technologies such as carbonization of straw that produces biochar; sustainability assessment; and outreach strategies.

The Mekong River Delta produces about 10 million tons of rice straw, 10% of which comes from the rice fields of Can Tho Province, according to Nguyen Thi Kieu, deputy director of the Department of Agriculture and Rural Development: “Hopefully, this project will come up with practical solutions to manage rice straw as well as increase farmers’ income,” he said.

To initiate outreach, the project links to IRRI’s existing consortia and projects such as the Closing the Yield Gaps in Asia with Reduced Environmental Footprint (CORIGAP), national initiatives such as the One Must Do, Five Reductions in Vietnam, and Better Rice Initiative Asia.

Prior to the workshop, Nong Lam University and Cuu Long Rice Research Institute (CLRRI) organized a rice straw baler demonstration and a straw collection and management seminar at CLRRI on 1-2 March. Through these events, workshop participants were able to see the equipment in action and exchange views on currently available rice straw management technologies. The field demonstration and seminar were supported by CORIGAP.