

**LOW CARBON AGRICULTURAL SUPPORT PROJECT
MANAGEMENT UNIT (LCASP)**

INCEPTION REPORT

**RESEARCH ON EFFECTIVE UTILIZATION OF CROP WASTE BY
VALUE CHAIN**

(Work package 28)

Submit to

**LOW CARBON AGRICULTURAL SUPPORT PROJECT
MANAGEMENT UNIT**

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(LCASP)**

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(Package 28)

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PART I. OVERVIEW

1.1. Low Carbon Agricultural Support Project (LCASP)

The Low Carbon Agricultural Support Project (LCASP) was signed in 2013 between the Asian Development Bank (ADB) and the Socialist Republic of Vietnam. The Project impact is expected to increase the uptake of climate smart agriculture waste management practices (CSAWMP) as indicated by the increased use of clean biogas energy and organic bio-slurry fertilizers. The project also strengthens the capacity of various stakeholders by disseminating skills and knowledge of good practices to beneficiaries. The objectives of the Project are to (i) Improve management of livestock waste, slurry or biogas; reducing environmental pollution; creating clean energy, bio-organic fertilizer generating incomes from Clean Development Mechanism (CDM), (ii) Increasing the application of CSAWMP that are effectively certified; greater use of renewable energy and bio-fertilizers from agricultural waste; replicating pilots application of CSAWMP in order to reduce greenhouse gas (GHG) emissions, improve livelihoods and life quality of rural people, and (iii) Capacity building of stakeholders and disseminating knowledge and skills of good CSAWMP to beneficiaries.

The project is being implemented in 10 provinces of Bac Giang, Ben Tre, Binh Dinh, Ha Tinh, Lao Cai, Nam Dinh, Phu Tho, Soc Trang, Son La and Tien Giang during 6 years (2013-2018).

1.2. Consulting services

Package 28 will target the development and demonstration of new technologies for crop residues recycling. Calculation from agricultural statistics (2013), the amount of residues from the main crops (rice, corn, sugarcane, peanuts, soybeans) is 77 million tons, in which 54 million tons of residues originated from rice production (rice straw and husk), 12 million tons from sugarcane and nearly 10 million tons from corn (stems, leaves, corn cob). According to the survey in the 10 participating provinces, the amount of rice straw being burned in the field accounted for 42%, where the Son La in the upper end burned 76%; the amount of residues used for composting for organic fertilizer only accounts for 5.5%. This is a huge loss of nutrient sources since rice straws contain 0.5-0.7% N; 0.07-0.12% P_2O_5 and K_2O 1.17-1.68%; If the amount of nutrients is used for organic fertilizer production, more than 30% of inorganic fertilizer consumption can be saved the soil fertility can be significantly improved.

Further, crop residues (especially rice straw) burning is directly resulting in potentially serious pollution risks leading to increased greenhouse gas emissions.

From rice straw can create new value chains such as production of compost, biochar, activated coal, fuel briquettes, feed for animal, mushroom substrate, bedding material for animal, etc. However, today only very little of the crop residues are recovered, though there is good options for creating income and at the same time reducing greenhouse gas emissions by carbon sequestration in soil through biochar and saving of chemical fertilizers. At the same time the production of compost by mixing crop residues with bio-slurry or liquid manure can help pig producers to produce a valuable organic fertilizer, that can be used in crop cultivation.

To solve the above mentioned problem, the CPMU of LCASP has identified and signed a consultancy contract with the Research Institute for Agricultural and Rural

Planning which is legal and qualified consultancy agency with appropriate experience to implement Package 28 "**Research on effective utilization of crop waste by value chain**" to develop and demonstrate new technologies for crop residues recycling (rice straw and corn cob) with main contents as follows:

Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes

Research output 2: Research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice rice straw with high heating capacity

Research output 3: Research on technology for animal feed production from crop residues (rice rice straw and corn stover) and storage

Research output 4: Research on technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling of used substrate to produce bio-organic fertilizers

Research output 5: Research on the technology for on-field rice straw decomposition and production of bio-organic fertilizers

Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologies that link advanced pellets /briquettes, activated coal, biochar production, on-field fast rice straw decomposition and production of bio-organic fertilizer from rice rice straw

Research output 7: Policy recommendations for the uptake of crop residues (rice rice straw and corn stover) recycling

PART II.

APPROACHES AND JUSTIFICATION OF RESEARCH OBJECTIVES

2.1. Approaches:

*** Ecological approach:**

- The chemical composition of rice straw is calculated by the dry weight including cellulose: 7.08%, hemicellulose: 42.41%, lignin: 6.48%, ash: 12.76%. In rice straw, nitrogen content accounting for 0.7% of total dry matter; similar to phosphorus, potassium is 0.23% and 1.75% respectively. If calculated by elements then carbon (C) accounts for 44%, hydrogen (H) accounts for 5%, oxygen (O) accounts for 49%, Nitrogen accounts for about 0.92%, a very small amount of phosphorus (P), sulfur (S) and potassium (K). Burning rice straw causes the almost complete loss of N. The amount of P lost about 25%, K lost about 20% and S lost from 5 - 60%. However, if all rice straw and stubble volume is treated as fertilizer, it will be great benefit to agricultural production, especially recently, the amount of manure applied to the field is very small, mainly using inorganic fertilizers and pesticides. This practice has hardened the soil, changed the composition of soil substances, the soil lacked organic matter, reducing the coherent, so the ability to absorb water and fecal matter is poor. On the other hand, the source of microorganisms in the field is increasingly exhausted, therefore rice straw, stubble and other residues decompose slowly, causing toxins that affect the growth of rice, reducing the yield at the end of the crop.

- Corncobs: This is an abundant and cheap food source that can be used to fatten cows to bring about significant economic and environmental benefits. Use this residues is one of the measures to address the existing food shortage for cows. On the other hand, corn cob is a nutritious material suitable for production of edible and medicinal mushrooms. However, the collection and processing of corn cob for production still faces difficulties because collection and chopping works are required to produce micro-organic fertilizer.

- According to Department of Crop Production, mushroom development target of the Ministry of Agriculture and Rural Development will reach 1 million tons by 2020, accordingly waste after growing mushrooms will be about 1 million tons. Mushroom growing residue with high content of minerals, phosphates and porosity has a very good regulatory effect for the soil and is a source of fertilizer to stimulate seed germination.

- Agricultural residues are also a source of raw materials to create energy. The biofuel rod is called as "black gold" for its applications in agriculture and the environment. High carbon content along with the natural porosity of the biofuel rod helps the soil retain water and nutrients, while protecting the bacteria live in the soil, against the adverse effects of weather and soil erosion and also increases crop yields.

* Socio-economic approach:

- The economic analysis shows that the cost of fertilizer in rice and maize production accounts for 30-35% of the investment value. Currently, in large agricultural production areas, there is a shortage of manure. Farmers know the great role of organic fertilizer, but they are difficult to access because of cost factors, they do not know what kind of fertilizer to buy, where to buy and how the quality is, etc. Proactively produce an organic fertilizer from available raw materials, provided on site for local people will contribute to creating an organic fertilizer which is stable quality, affordable price and suitable to the majority of people.

Each hectare of rice straw, stubble can provide soil 35 kg N, 11,5 kg P_2O_5 and 87.5 kg K_2O , respectively 76 kg of urea, 72 kg of superphosphate and 178 kg of potassium chloride fertilizer; In addition, organic matter and microelements that mineral fertilizers cannot obtain. If an additional 10 tons of manure is applied, the sum from these two sources can provide the soil is 120 kg of urea, 290 kg of super phosphate and 280 kg of potassium chloride - higher than the total average amount of chemical fertilizer that farmers in the Provinces in the project area are currently using.

- Demand for cheap fuels is a great demand of many people in the country. Biofuel rod is quite effective, with cost of 7,000 VND/1 kg that can cook for up to 2 hours without being as dangerous as gas or having odor like conventional coal.

- Cattle raising is one of the strengths in economic development of the mountainous provinces. The buffalo and cow herds not only provide traction and fertilizer for agriculture but also provide an abundant and important food source for the local people. However, in recent years, the situation of cattle and buffaloes dying due to extreme cold and food shortages ... has been quite common. The main reason is that people have a practice of free-grazing livestock, lack of food, leading to inadequate resistance to cattle, sickness and death, greatly affecting the economic development of localities.

- According to the Department of Crop Production, the mushroom development target of the Ministry of Agriculture and Rural Development will reach 1 million tons

by 2020 and reach USD 1 billion in export. Investing in mushroom cultivation is not so big as other products. Economic efficiency is quite high per area unit: 450 - 600 million VND / ha. Production of edible and medicinal mushrooms is suitable for all regions and areas of the country. Millions of rural workers will have jobs, employments, stable incomes, contributing to economic, political and social security development.

*** Horizontal approach:**

The majority of Vietnamese farmers wish to apply technical advances, but only a few are truly pioneering. These can be considered to be the core nucleus to ensure the success of the project and most importantly these are the "vital propagandists" for the replication of the model results. Based on the actual situation and needs of each task in the component package, the project will select the appropriate households to participate in building the model.

*** Approach through the Association level:**

In rural areas, some associations are effectively operating because they really bring many benefits to members, among them are the Women's Union, the Veterans' Association and Gardening Association. Members of these three associations are also responsible for the development of their organization. When the project is implemented, some work will be integrated with the activities of these 3 associations to ensure the benefits for both parties.

*** Top - down Approach:**

When the project is officially approved, the consulting service will set up a project management board at different levels, each level will have specific roles and functions in implementing the project's contents.

*** Inheritance approach:**

Selecting previously published research results of domestic and international authors, especially FAO guidance documents on the fast processing of rice straw into organic fertilizer, producing biofuel / activated coal, producing animal feed and mushroom cultivation.

*** Visual approach:**

Through a field survey of emissions of rice straw and maize stalks after harvesting rice and maize; Existing collection and recycle of agricultural waste residues sources in localities; Demand for animal feed in winter and dry seasons in the Northern Upland region; Demand for fuel to replace gas for poor and marginal poor households; Demand of farmers for using organic, mineral and micro-organic fertilizers to improve soil, improve the efficiency of mineral fertilizers and reduce production costs; Demand for consumption of edible and medicinal mushrooms of people in the country as well as in the world.

*** Community-based approach:**

- Based on the critical need, which has existed for many years but has not been thoroughly and effectively addressed by the community, livestock farmers on a model of agricultural residues recycling (especially corn stems and leaves) as animal feed in the winter and dry seasons in the northern mountainous provinces.

- Besides, there is a high demand for quality organic, microbiological and organic mineral fertilizers with traceability, cheap price, etc. of the crop producers.

- Moreover, the requirement of a clean and smokeless environment due to rice straw

burning after harvest of the people also requires an appropriate method to use rice straw and corn leaves. The use of bio-fuel pellets / activated coal processed from agricultural residues helps to reduce burning of rice straw while reducing daily living costs.

- In addition, the issue of clean agricultural products is a hot issue. Edible mushrooms as well as medicinal mushrooms have begun to gain a foothold in the market. People began to choose mushrooms more often for family meals. The edible and medicinal mushrooms are mainly grown on substrate of agricultural residues.

* Participatory technology development

Vietnamese farmers are skeptical about the quality of products when they do not know the origin, do not make such products themselves, especially those related to agricultural products, fertilizers, due to the chaos of fertilizer market. Witnessing organic fertilizer, animal feed, agricultural products (mushrooms) or activated coal / fuel pellets directly or indirectly created will make farmers more confident.

* Multi-disciplinary and interdisciplinary approach

- Agricultural residues in Vietnam can be recycled for producing edible mushrooms / medicinal mushrooms, fertilizer, bio-fuel pellets or activated coal. For the Northern Uplands, when winter comes, the demand for green feed for cattle is very critical but satisfaction of this demand is difficult. Fresh corn cobs and rice straw can be processed into animal feed through the process of silage before storage.

- Recycle crop residues effectively in the Vietnamese context requires interdisciplinary coordination, with the involvement of animal nutrition sector (when processed into animal feed stored for winter and dry seasons), energy industry, materials (when processing fuel pellets/biochar), agro-biotechnology (when processing into biochar, organic fertilizer, microorganism organic and organic minerals or cultivating edible mushrooms, medicinal mushrooms), farming/agricultural economics.

2.2. Interpretation on research objectives

2.2.1. Rice straw collection method and technology

- Red River Delta (RRD) region is featured by fragmented farming areas, averaging 8.6 plots / agricultural household. In provinces like Nam Dinh, the level of fragmentation is found with 5.7 plots/household. Each plot area varies widely from 100 to 5,800 m². After the policy of land consolidation and exchange, in major rice production province, number of plots has decreased from 8.5 plots/household to 3 plots/household (respectively 59.8%), the production area is expanded from 294 m²/plot to 579 m²/plot (an increase of 1.96 times). Accordingly, with one harvest, the average rice straw yield is about 100-150 kg/plot, in these areas, it is recommended to use small rice straw collection machines that can be easily moved, low productivity.

Currently, there is almost no rice straw market in the Red River Delta, the collection of rice straw is mainly operated on a small scale, households scale, some households collect rice straw on their own, dry and heap up. To introduce mechanization of rice straw collection into this region is a long-term step, associated with the planning of animal husbandry and mushroom growing. At present, it is necessary to test and assess mechanized collection of rice straw, transport to consumption places which are concentrated cattle ranching areas, and then evaluate the economic efficiency to replicate the model.

- Mekong River Delta is the largest rice growing area in the country, with a field size of 1,000 - 2,000 hectares; Each plot of land is from 1-5 ha. The number of land plots size from 0.5 ha with a length of over 200 m is accounting for 60% of the total area of the region. In terms of scale of use, the average land per households is also quite large, an average of 3-5 times higher than that in the RRD. With 1 harvest, the average amount of rice straw is about 1,000-1,500 kg/plot. However, in order to facilitate the transportation of rice in these areas, each rice threshing point can thresh about 1 ton of rice (about 500 kg of rice straw) and then move to another place.

In the Mekong River Delta, there is an increasing demand for rice straw as a mushroom growing material. The existing collection method is mainly based on households who have demand to use for mushrooms production. These households buy threshed and dried rice straw from farmers (mainly in the summer-autumn crop) and then transport to the place of use. There have been households specializing in rice straw trading, forming rice straw buying and selling markets.

- From existing issues, the Package proposed research outputs as follows:

(1) *Improve the process and equipment for collecting rice straw appropriate with each ecological region of the project.*

(2) *Complete the process and equipment for collecting rice straw appropriate with each method of using rice straw.*

(3) *Develop a rice straw collection model appropriate to each ecological region and method of using the rice straw (used for producing fuel pellets/briquettes, biochar, making animal feed or producing edible and medicinal mushrooms, producing organic and bio-organic fertilizer).*

2.2.2. Technology for producing fuel pellets/briquettes, activated coal and biochar from rice straw

Vietnam is an agricultural country with two large deltas namely Red River Delta and Mekong River Delta, thereby Vietnam has great potential in transforming biomass - agricultural residues into energy such as rice straw, coffee husk, coconut fiber but the direct use of biomass - agricultural residues as rice straw is very limited due to many reasons such as low calorific value, low density, high humidity, difficult transportation, large transportation costs, especially is air pollution when burned directly, ...

- When using pellets pressed from agricultural residues, there are advantages compared to burning agricultural residues because:

- Volume reduced by more than 5 times.

- Favorable for storage, transportation and mechanization, automation for fueling the incinerators.

- Has same composition as traditional energy.

- There is high calorific from 3500 ÷ 4500 kcal / kg.

- Cost is only equal to 50% of coal.

Agricultural waste residues include rice husks, sawdust, peanuts shells, cashew shells, bagasse, rice straw, wood chips, etc., in agricultural production, rice straw is the largest residues with 1.1 ÷ 1.2 times of total gained food output.

Using rice straw fuel pellets from agricultural residues is a new practice in the Mekong River Delta, there are five rice husk power plants with capacity of 55 MW have been installed and scattered in Tien Giang, An Giang and Can Tho, 02 power plants are allowed to build with a capacity of 13 MW powered by rice husk. The issue of agricultural waste residues research was also mentioned in the project "Researching on producing fuel pellets from Biomass" of the Danang Congress in 2008 but the research only stopped in the form of sawdust pellets applying low-pressure piston pressing type, not being widely used.

Equipment: Minh Quang Group in Yen Bai province has imported 01 German production line pressing fuel pellets from wood branches, wood tops, sawdust and some units have imported equipment but have not yet put into operation.

About the device for pressing fuel pellets from rice straw - there is still no suitable technological equipment associated to the pressing machine like a crusher, because the rice straw contains a high fiber content (31 ÷ 45%) and when is being evenly crushed, the cost of pressing energy can be reduced 3 times. The current crushing equipment still uses hammer mill for granular material when putting into grinding rice straw, crushing efficiency is low due to its porous, light and different from the grain, accordingly to press the rice straw pellets, it is required a specialized rice straw milling machine suitable for the physical properties of rice straw. Therefore, to take full advantage of the abundant domestic rice straw raw materials to reduce environmental pollution and to complete the technology of rice straw fuel pellet production equipment, contributing to replacing the increasingly exhausting fossil energy source and create new technology in processing of agricultural residues, the research for designing and manufacturing rice straw milling machine used in the production line of fuel pellets is an urgent issue.

From existing issues, the Package proposed the following research outputs:

(1) Select suitable method and equipment to produce bio-fuel pellets/briquettes and biochar.

(2) Research and complete the technological process to produce quality bio-fuel pellets/briquettes and biochar with low energy pellet pressing cost.

(3) Research to complete the rice straw milling machine in order to improve the product cost effectiveness.

(4) Research and complete technology for producing biochar from fuel pellets/briquettes made from rice straw and corn cobs.

(5) Formulate an application model to produce fuel pellets/briquettes from rice straw and corn cob with the selected technology and development.

2.2.3. Technology for producing animal feed from crop residues (rice straw, corn cob) and preservation

According to statistics, Vietnam has about 10 million cattle heads; including 2.5 million buffaloes, 5.5 million cows, and over 1.5 million goats, accordingly, on average, each buffalo or cow will eat about 20-30 kg of raw food/day, annually, demand of raw food for cattles is about 40-60 million tons. Especially in recent years, the movement of beef cattle development has sharply developed, especially fattening (domestic and imported cattle from abroad for fattening), thereby refined feed is and will be an urgent need.

However, livestock industry in Vietnam is still small-scale, scattered and less sustainable; ranch farming is still spontaneous, lack of planning and management and quality control of animal breeds and animal feed are still weak and inadequate. At present, the cattle livestock (buffaloes, cows, goats) is mainly taking advantage of the available food, while the industrial processed food accounts for a very low rate, while annually a very large amount of agricultural residues (rice straw, corn stovers, sweet potatoes ...) must be discarded, causing waste and environmental pollution. Due to lack of food and cold weather, during past 10 years, about 60-70,000 cattle and buffaloes died in the Northern mountainous provinces. The above information shows that the need to use rice straw, corn cob, corn stovers and other agricultural residues as cattle-feed is very urgent.

According to the livestock development strategy approved by the Prime Minister, development goals: By 2020, the animal husbandry industry will basically shift to farm scale and industrial production scale to meet quality food demand for both domestic consumption and export. The proportion of animal husbandry in agriculture reaches over 42% by 2020. The potential for livestock development in Vietnam is great.

From existing issues, the Package proposed the following research outputs:

(1) Survey the needs and conditions for application of silage technology for animal feed from rice straw and corn cobs in the project area.

(2) Complete the technology of silage for rice straw, corn cob to make animal feed for each ecological region of the 10 project provinces.

(3) Research to introduce a model for application of silage technology of rice straw and corn cob for animal feed suitable for each ecological region of the 10 project provinces.

2.2.4. Technology for producing edible and medicinal mushrooms from crop residues (rice straw, corn cob) and recycling substrates to produce bio-organic fertilizer

In the process of application and development of mushroom growing technology in the Red River Delta provinces, the harvested rice straw source has different hardness, the cutting stubble has physical property different from that of the rice straw which is soft due to threshing machine. All localities applied a same method to treat rice straw, creating uneven used mushroom substrate, unstable mushroom yield. Therefore, rice straw processing requires an appropriate fermentation technique and appropriate additives mixing to create a compost for growing button mushrooms with a proportion of nutrients C, N and balanced mineral elements that will generate high yield and stable mushroom quality. Moreover, there are few equipments for research, production, preservation and processing mushrooms, and there is no factory specializing in manufacturing and supplying to producers. The stages of mushroom growing such as handling raw materials (rice straw, sawdust, bagasse, corn stovers), tending and harvesting are all done manually, so the labour productivity is low, quality of commercial mushrooms is not high.

However, at present, the selection of mushroom varieties to be suitable for each ecological region, substrate for producing mushroom cultivars suitable for each type of mushroom, and the technological process of farming suitable for each domestic raw material is still limited and need to be improved. Therefore, in order to develop mushroom cultivation in general, and to develop mushroom cultivation in Son La and Nam Dinh

provinces in a sustainable way, it is essential to coordinate many synchronous solutions, in which the key contents need to be implemented in current stage is overview of existing international and national technologies of producing edible and medicinal mushrooms from crop residues, thereby proposing development orientations for Vietnam.

Existing market potential (size and type of products) of mushrooms and production orientations must be analyzed; complete the technological process for producing edible and medicinal mushrooms from crop residues suitable to ecological conditions, varieties, and farming practices according to household/farm scale; At the same time, it is necessary to develop a pilot model for producing edible and medicinal mushrooms from crop residues on a household/farm scale in Son La, Nam Dinh to create standard central models/satellites to exchange, study, provide seeds and purchase products for mushroom-producing households in the whole province. In addition, it is necessary to open training courses for trainees in the area to benefit from the results of the project, in order to raise the awareness and technical level of mushroom production from raw material handling to tending, collecting, preserving and pests and diseases controlling, etc., thereby helping the mushroom cultivation industry in our country gradually stabilize with high effectiveness.

From existing issues, the work package proposed the following research outputs:

(1) Survey on the situation of using rice straw and corn cob to make substrate for growing edible and medicinal mushrooms in 10 project provinces.

(2) Research and develop mushroom growing technology based on substrates from rice straw and cob for different mushrooms, suitable to each ecological region of the project.

(3) Develop technologies for producing bio-organic fertilizer from used mushroom substrate.

(4) Develop a model for production of edible and medicinal mushrooms from rice straw and corn cobs suitable for each ecological region.

2.2.5. Technology for on-field rice straw fast decomposition and production of bio-organic fertilizer

❖ Buried directly into the soil and field

Burying rice straw in the soil, although the effect on the next crop's yield is not great compared to removing rice straw from the field, but in the long run the effect is obvious. Simultaneous combination of seasonally fertilizing for rice with the rice straw burying in the soil will ensure N, P, K and S nutrition for rice, and also increase the nutrient reserves for the field. Burying rice straw in wet soil will cause a temporary fixation of nitrogen (N) and increase the amount of methane (CH₄) released in the soil, causing greenhouse gas accumulation. Besides the benefits, burying rice straw in the soil has some disadvantages such as: additional costs, may cause some rice diseases, slow down growth and reduce rice yield.

The results showed that: Burying residues of agriculture has improved soil fertility (organic matter content, nitrogen, phosphorus and available potassium, absorbing capacity, texture, porosity, moisture, microorganisms total, cellulosic microorganisms, phospholytic microorganisms and nitrogen fixing microorganisms), increased productivity by 6 - 12% compared with no bury rice straw. Burying agricultural residues can replace the amount of manure that needs to be applied to rice

growing structure; reduce 20% of nitrogenous, phosphorus fertilizers and 30% of potassium fertilizer but productivity is not reduced compared with no residues burying. Economic efficiency is equivalent to fully manure fertilizing, mineral fertilizers NPK and 5% higher than only NPK fertilizer, profits increased by 5 - 12% compared with no buried residues.

Currently, the use of microbiological probiotics in processing of agricultural residues is to shorten the residues composting period, while improving the quality of compost to minimize the amount of chemical fertilizers and pesticides used in the process of agricultural production, towards sustainable agriculture, contributing to increase income for farmers. In particular, in addition to the concentrated processing rice straw into fertilizer (composting pile), the method of fast processing in the field is also concerned. This method of on-the-spot processing both uses available materials in the field (saving collection and transportation costs) and minimizes organic poisoning due to the residue of the previous crop.

❖ Composting as an organic fertilizer

Currently, due to the development of animal husbandry towards industrial level, plants are not used as food but are left in the field. The quantity of crop residues in Vietnam is very large, approximately 49.83 million tons of dry materials/year, of which rice straw accounts for 85.49% or 42.6 million tons of dry material/year. Therefore, the use of microorganism strains capable of breaking fibers to decompose rice straw, waste of vegetables and fruits into humus and recycling into organic fertilizer will improve the efficiency of using rice straw without leaving as waste and return annual lost nutrients to the land.

Vietnam is an agricultural country with a large and diverse source of post-harvest wastes, including rice straw, corn stovers, legume plants ... In the past, the crop residues were fully utilized such as composting, cooking, bedding material for animals or making animal feed. Nowadays, the rural life has been improved, cooking fuel pressure is not so serious, so the source of crop residues is mainly burnt in the fields, polluting the air environment, partly pouring into the ditches results to pollution of water sources, a part of which is left in the field causes growth of pests and diseases of plants. Meanwhile, perennial cropland is severely lacking in nutrients, is at high risk of degradation

Current trend is to develop sustainable agriculture - organic agriculture. It not only helps to clean and protect the environment but also creates a source of organic manure on site for plants, resolving the shortage of organic manure; at the same time reduce fertilizer costs for people. However, agricultural residues contain high cellulose content, so the natural decomposition time is long, causing loss of field area, affecting the ecological environment and landscape. Current orientation is to use probiotics in the processing of agricultural residues to shorten the residues composting time and at the same time improve the quality of compost, minimize amount of chemical fertilizers and plant protection chemicals used in agricultural production, towards sustainable agriculture, contributing to increased income for farmers.

Although our country has conducted researches on the use of rice straw as organic fertilizer and microbiological organic, there are still many shortcomings, so it is necessary to research the following contents:

(1) Research on appropriate technology to be developed to fast decompose rice straw to meet the production plan for the next crop.

(2) *Develop technology to fast decompose rice straw to suit the cropping seasons and the needs of the next crop.*

(3) *Develop a model of producing organic and bio-organic fertilizer that fast decomposes rice straw, suitable to each project area.*

2.2.6. *Formulate a pilot model of integrated technologies associated with production of fuel pellets/briquettes, activated coal, biochar, on-field rice straw fast decomposition and production of bio-organic fertilizer from rice straw*

Use of organic fertilizer or biochar produced from agricultural residues or spent substrate after mushroom production in agricultural production has been reported to be effective in some reports. However, the practical application is still very low, small scale and testing level; Farmers have not yet applied it in actual production.

Modeling is the way in which products applied and evaluated by the people themselves will prove the applicability and scalability of organic fertilizer or biochar, especially organic fertilizer or biochar is produced from agricultural residues or residues from mushroom cultivation in agricultural production. On the other hand, through the model, people will be visiting and learning. Therefore, if the model is good, it will be the most useful information channel to propagate and replicate in practice

Thus, formulating a model is mandatory so that people have the opportunity to learn, but it is necessary to choose the right subjects, reasonable organizational methods to ensure success.

From existing issues, the work package proposed the following research outputs:

(1) *Planning for build nga pilot model at each farm site*

(2) *Identify target areas, target crops and units / individuals to be coordinated in building the model*

(3) *Building an application model based on a combined fertilizer application formula for testing and production.*

(4) *Organize the implementation of the model: Establish an executive board, local steering committee, survey for pilot area selection, participating farmers, sign contracts and build models.*

(5) *Training farmers on the use of bio-organic fertilizer or biochar for selected crops and conferences, workshops on reviewing the model*

2.2.7. *Policy on future crop residues recycling (rice straw and corn stovers, corn cobs)*

- There are currently no policies to encourage the collection and processing of crop residues into organic fertilizer for business; policies to encourage the establishment of combined collection and recycling facilities associated with production areas to receive and use for different purposes; policies to support and encourage application of value chain of crop residues.

- There has been no review of effective value chain models on crop residues processing to be used as a basis for issuing legal documents to encourage development

- Institutional responsibilities and coordination among ministries, especially the Ministry of Agriculture and Rural Development and the Ministry of Natural Resources and Environment, among central and local governments in management and use of crop residues as well as responsibilities and coordination between agriculture and environment in the locality in managing crop residues are not clearly defined;

- No national technical standards and regulations have been issued yet for major organic products and identification of competent authorities for certification of organic products. Special national incentive programs should also be enacted to support the expansion of organic agriculture and export of organic products. .

From existing issues, the identification of the objectives and content of the research topic is directed to:

(1) Policy recommendations for recycling crop residues, animal feed production, mushrooms cultivation, biochar in accordance with each project province's conditions.

(2) Select policies to apply and expand the recycling of agricultural residues.

Therefore, implementation of Package 28 " Research on effective utilization of crop waste by value chain" is consistent with the current agricultural production practice (small and medium-sized farmers; large scale) to enhance the use of renewable resources and available materials; minimizing impacts on the ecological environment, reducing production costs and increasing income for farmers is very essential.

PART III

OBJECTIVES, OUTPUTS AND SCOPE OF CONSULTANCY SERVICES

3.1. Objective of the consulting services

3.1.1. Overall objective

Support creating new value chains for crop residues recycling and mitigation of greenhouse gas emissions.

3.1.2. Specific objectives

(i)- To conduct research methods and technology for collection and preliminary processing of crop residues that are most suitable for each specific target of using agricultural residues in different conditions

(a) Conducting a review of available international and national technologies for crop residues collection and processing for different application purposes;

(b) Assessing the operational and cost effectiveness of such technologies;

(c) Develop designs, cost estimates, test methods and technology for collection and preliminary processing of crop residues for different purposes; Proposing methods for crop residues collection and processing (rice straw in the plains and corn stover in mountainous areas), which are effective for processing for different purposes (animal feed, biochar/ activated coal; bio-organic fertilizer, used mushroom substrate).

(ii)- To conduct research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice straw with high heating capacity:

(a) Conducting a review of available international and national technologies for fuel pellets/briquettes, activated coal and biochar produced from crop residues, focusing on rice rice straw;

(b) Identify technologies and their efficiency and cost effectiveness from international equipment suppliers and manufacturers

(c) Develop designs, technologies improvement and production of fuel pellets/briquettes, activated coal and biochar from rice rice straw and from sawdust (for reference): Completing technology to produce synthetic fuel pellets from rice rice straw with a minimum capacity of 1 ton of product/hour, energy heating reach over 70% compared to fuel pellets from rice husk and activated coal production technology, continuous biochar from rice rice straw with a capacity of over 300 kg of coal/h; Tested to successfully produce 100 tons of fuel pellets and 50 tons of biochar;

(d) Identify the intellectual property rights and requirements attached to each technology

(iii) To conduct research on technology for animal cattle feed production and storage from crop residues rice rice straw and corn stover :

(a) Conducting a review of available international and national technology for animal feed production from crop residues;

(b) Develop technology for animal feed production from crop residues;

(c) Develop technology for animal feed storage during the dry and winter seasons; trial production of 100 tons of silage feed / nutrition powder / nutritious cake, effectively used for cattle in winter or dry seasons;

(d) Assessing the operational and cost effectiveness of such technology.

(iv) To conduct research on technologies for producing edible and medicinal mushrooms from crop residues (rice rice straw, corn stover) and recycling of spent substrates to produce bio-organic fertilizers:

a) Conducting a review of available international and national technology for production of edible and medicinal mushrooms from crop residues, focusing on rice rice straw;

(b) Using the PN1 oyster mushroom variety; A11 button mushroom variety; Ganoderma Ga2 to optimize the conversion of rice straw and corn cob sources into high value-added products by complete technological processes to build the model at household / farm scale in Son La, Nam Dinh; scale of 50 tons of substrate/site

c) Develop technology for producing bio-organic fertilizer from spent substrate of mushroom production, with a capacity of 10 tons of organic raw materials /site;

(d) Assessing the operational and cost effectiveness of such technology.

(v) To conduct research on technology for on-field rice straw fast decomposition and producing bio-organic fertilizers:

(a) Conducting a review of available international and national technology for on-field rice rice straw fast decomposition and producing bio-organic fertilizer from rice rice straw at different scales (farmer households / groups of households, factories);

(b) Develop technology for on-field rice straw fast decomposition (less than 25 days with decomposition rate of more than 80%);

(c) Assessing the operational and cost effectiveness of such technology.

(vi) *Using the outputs from (ii) (iii) (iv) and (v) above establishing pilot technologies including*

a) Pilot demonstration of using organic materials (compost and biochar) for carbon build up in soil and fertilization for crop production.

(b) Re-establishing fertilizer balance for crops by organic fertilizer incorporation from newly developed products

(c) Successfully formulate 10 models using organic fertilizer or biochar produced from agricultural residues, used mushroom waste, ... with scale 2 ha / model, increasing economic efficiency by 15% or reduce 15-20% of inorganic fertilizer use; contribute to safe agricultural production, VietGAP production and organic farming in 10 project provinces. Successfully organized 2 seminars, field visits and assessments for 80 participants to create basis for propagation and replication of the model

(vii) *Propose policy review for crop residues usage and propose*

(a) Policy recommendations for the crop residues recycling, production of animal feed, mushrooms, biochar suitable to each project provincial condition.

(b) Policy options for application and scaling up crop residues recycling

3.2. Expected outputs

3.2.1. . Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes

Expected outputs – with activities

(i) A report presenting the findings of the review of alternative method and technology of collection and processing of crop residues and their suitability for promotion in Vietnam. The report will present the findings of:

(a) A survey of existing methods and technology of collection and preliminary processing of rice straw for different purposes in Vietnam to understand the technical and management status and issues/problems - including a surveys of end-users / farmers, company managers, and local authorities in the agricultural sector. The survey will seek to provide insight into the following issues:

- i. Methods for collecting and preliminary processing of rice straw for different purposes (animal feed, composting, bedding material, mushroom production, cooking fuel and others) in the project provinces
- ii. Quantity/ percentage of rice rice straw to be collected;
- iii. Methods of preliminary processing applied;
- iv. Costs / benefits of different methods of collecting and preliminary processing including farmers perception
- v. Management issues;
- vi. Existing policies and subsidies;

- (b) Literature review and key informant survey of international methods of rice straw collecting and preliminary processing technology and costs, including a desk study of the comparative performance of different technologies
 - (c) A set of recommendations on new methods of collecting and preliminary processing technologies, that could be incorporated in the project provinces along with cost estimates;
- (ii) Design and documentation report on methods of collecting and pre-processing including design drawings and supporting specifications. This report will be developed from:
 - (a) Review of methods of collecting and pre-processing various scales both nationally and internationally;
 - (b) An assessment of alternative design including manufacturing / modification equipment that meet the different rice production scale and harvesting season's conditions;
 - (c) A review of methods of rice straw collecting and pre-processing needs under the range of conditions in the selected provinces;
 - (d) Development of cost estimates for application of methods of rice straw collecting and pre-processing;
 - (e) Development of design and performance standards;
- (iii) A technology performance review that provides the details of pilot testing of the preferred (and accessible) technology within each of the 3 provinces (representing 3 agro-ecological zones) with no more 1 site per province
 - (a) Proposed testing protocol and methodology that is approved by the MARD's science committee.
 - (b) A set of agreed testing parameters that include; design and manufacturing/fabrication equipment standards, operational standards, performance standards and environmental standards
 - (c) For each approved technology, provide a certified test report
 - (d) For each approved technology, provide a certified inspection report.
 - (e) A formal recommendation based on the pilot testing for (i) further methods and technologies development and or (ii) passing the technology option to PPMUs for the purpose of demonstration to the wider sector
- (iv) Draft technology standards provided to CPMU for each of the pilot technologies approved based on the pilot results
 - (a) Forming a working groups from rice farming stakeholders (households, farms, companies)
 - (b) Using the working group for developing an agreed scope and structure for the proposed standards.
 - (c) A consultative draft process that builds on consultants findings and the feedback from wider stakeholders consulted.

Implementing scale and location

- (i) Methods and technology improvement for a province at 1 site
- (ii) Pilots of technology at 1 site in the 3 selected provinces for a total of 03 pilot sites (100 ha / site of rice area).

3.2.2. Research output 2: Research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice straw with high heating

capacity

Expected outputs – with activities

- (i) Technology assessment report on:
 - (a) Technology identification and assessment frameworks that includes both Vietnam and internationally source technology solutions
 - (b) A literature review of technologies, production materials, technology performance data, technology and operating costs.
 - (c) Survey of key technologies to be high priority for detailed assessment including production materials, technologies, heating capacity, and perceptions of farmers.
 - (d) Development of appropriate technologies for fuel pellets / briquettes, activated coal, biochar production from rice rice straw and rice husk (for reference).
 - (e) A proposed testing protocol, testing methodology including the range of parameters to be tested.
- (ii) A workshop testing report for fuel pellets /briquettes, activated coal and biochar produced in Vietnam. The report will:
 - (a) Present the findings of the testing protocols and procedure in both workshop and field conditions.
 - (b) From user evaluation and assisted monitoring by the consultant conducted over a period of at least 3 months for using fuel pellets/briquettes, activated coal and biochar.
 - (c) Provide clear recommendations on the strengths and weaknesses of the technology including production technologies, raw material stability, heating capacity, cost/benefit and farmer perception.

Implementing scale and location

- (i) Fuel pellets / briquettes, activated coal and biochar manufacturing technology from rice rice straw (100 tons of fuel pellets / briquettes; 50 tons of biochar or / and activated coal per province)

Testing under field and workshop conditions for a total of 10 households / province (total 100 households) and / or 03 companies in the selected provinces

3.2.3. Research output 3 - Research on technology for animal feed production from crop residues (rice rice straw and corn stover) and storage

Expected outputs – with activities

- (i) A report the present the identification of appropriate technology for animal feed production from rice rice straw and corn stover and storage by:
 - (a) International literature, internet and literature research to identify technology being currently being used.
 - (b) Propose an appropriate technology that could be developed for different climatic conditions.
 - (c) A detailed comparative assessment with recommendations for preferred technology for workshop and field testing.
 - (d) The cost of technologies in Viet Nam conditions

- (ii) A technology testing report based on workshop testing of animal feed production from rice rice straw and corn stover and storage performance by:
 - (a) Application of animal feed production from rice straw and corn stover and storage under workshop conditions using a range of farm sizes and residue quantities.
 - (b) Application of feed for cattle under two field conditions (dry and winter seasons).
 - (c) User evaluations and assisted monitoring by the consultant conducted over a period of 1 cattle live cycle cycle (12 months) for technology application (2 sites / province, total 4 sites in target provinces).
 - (d) A technology applicability recommendation along with technical specifications and design guidelines.
- (iii) Piloting report based on animal feed production from rice rice straw and corn stover and storage performance:
 - (a) Application of the piloting protocols of animal feed production from rice straw and corn stover (50 tons / site, 02 sites/province, total 04 sites for 2 provinces) and storage (3 months in the same place where animal feed produced) under dry and winter conditions.
 - (b) Application of the piloting protocol of feeding cattle with animal feed produced from rice rice straw and corn stover and stored during dry and winter seasons

Implementating scale and location

- (i) Recommended animal feed production from rice rice straw and corn stover and storage technology tested in 2 provinces (dry and winter conditions)

Cattle feeding testing under field and workshop conditions for up to 10 households and /or 6 farms (5 households and / or 3 farms per province).

3.2.4. Research output 4: Research on technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling of used substrate to produce bio-organic fertilizers

Expected outputs – with activities

- (i) A report the present the identification of appropriate technology of edible and medicinal mushrooms production from crop residues (rice rice straw and corn cob) and recycling of used substrates to produce bio-organic fertilizers.
 - a) International literature, internet and literature search to identify technology currently being used to processing rice rice straw and corn cob for mushroom substrate production and technologies for production of bio-organic fertilizer from spent substrate.
 - b) Propose an appropriate technology that could be developed for different types of mushrooms.
 - c) Develop technologies for mushroom substrate production from rice rice straw and corn cob for different type of mushrooms.

- d) Develop technologies for bio-organic fertilizer production from used substrate.
 - e) A detailed comparative assessment with recommendations for preferred technology for workshop and field testing.
 - f) The cost of technologies in Viet Nam conditions.
- (ii) A technology testing report based on workshop testing of edible and medicinal mushrooms production technologies from crop residues (rice straw and corn cob) and recycling of spent substrates to produce bio-organic fertilizers
- a) Application of the testing protocols under workshop conditions using a range of substrate production scale.
 - b) The application of the testing protocols under up to two field conditions with selected mushroom types (2 types of edible mushrooms, 01 for medicinal mushroom)
 - c) From user evaluations and assisted monitoring by the consultant conducted over a period of 6-months for substrate technology production (1 site per province, total 2 sites) and 12 months for mushroom production using selected substrates (3 farms / province, total of 6 sites in 2 provinces).
 - d) A technology applicability recommendations along with technical specifications and design guidelines.
- (iv) Piloting report on edible and medicinal mushrooms production from rice straw and corn cob and storage;
- (a) Application of the piloting protocols of edible and medicinal mushrooms production technologies from crop residues (rice straw and corn cob) (50 tons of substrate/site, 02 sites/province, total of 4 sites for 2 provinces).
 - (b) Application of piloting protocols for producing bio-organic fertilizers from spent substrates (10 tons of organic fertilizers / site, 2 sites in 02 provinces).

Implementating scale and location

- (i) Recommended substrate technology production tested in 2 provinces (Son La, Nam Dinh): 4 sites in 2 provinces
- (ii) Mushroom production using researched substrate testing under field and workshop conditions for up to 4 farms (2 farms / province)

Bio-organic fertilizer production from spent substrate in 2 provinces (Son La and Nam Dinh), 2 sites in 2 provinces

3.2.5. Research output 5: Research on the technology for on-field rice straw decomposition and production of bio-organic fertilizers

Expected outputs – with activities

- (i) A report presents identification of appropriate technology for rice straw fast decomposition
 - a) Through international and national literature and key informants survey, conduct a literature search to identify technology currently

- being used for processing of rice straw on the paddy field after harvesting.
- b) Propose an appropriate technology that could be developed for fast decomposition meeting the next crop planting requirement.
- c) Develop technologies for fast rice rice straw decomposition suitable the cropping seasons next crop demand.
- d) A detailed comparative assessment with recommendations for preferred technology for workshop and field testing
- e) The costs of technologies in Viet Nam conditions.
- (ii) A technology testing report based on workshop testing of on-field rice straw fast decomposition and production of bio-organic fertilizers.
 - a) Application of the testing protocols under workshop conditions using on-field rice straw fast decomposition and producing bio-organic fertilizers technologies.
 - b) Application of testing protocols under field conditions for on-field rice straw fast decomposition (2 sites per season, 2 sites per province, total 12 sites per 3 provinces) and 2 sites for producing bio-organic fertilizers (1site for per province, in 2 provinces)
 - c) For user evaluations and assisted monitoring by consultant conducted over a period of 6 months for on-field rice straw fast decomposition technology and 12 months for bio-organic fertilizer production technologies using rice straw.
 - d) A technology applicability recommendations along with technical specifications and design guidelines.

Implementation scale and location

Application of testing protocols in field conditions for on-field rice straw fast decomposition (2 sites for 1 crop, 2 sites for each province, total of 12 sites for 3 provinces: Nam Dinh, Binh Dinh and Soc Trang) and 2 sites for bio-organic fertilizer production (1 site for each province, in 2 provinces).

3.2.6. Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologies that link advanced pellets /briquettes, activated coal, biochar production, on-field fast rice straw decomposition and production of bio-organic fertilizer from rice rice straw

Expected outputs – with activities

- (i) Pilot plan for each farming site - in the form of a management manual and plan outlining
 - (a) Responsibilities of the LCASP, consultant and property owner and manager,
 - (b) ownership of equipment and its maintenance;
 - (c) Fund allocation;
 - (d) scale and scope of liabilities associated with the pilot
- (ii) A signed pilot site arrangement for 1 site in each province (3 agro-zones) confirming the provisions detailed in the site management manual including access to site, awareness visit, data monitoring
- (iii) A detailed monitoring report that presents

- (a) The performance standards of the technology within a farming systems context;
- (b) A financial assessment of the adoption of a farming systems perspective including capital costs, operating costs and additional benefits;
- (c) An assessment of environmental benefits including rice straw processing with and without the technology;
- (iv) An analysis of potential user perception of the technology system based on
 - (a) Self-evaluation analysis of people visiting sites
 - (b) A demand assessment for wider uptake of the technology.

Implementing scale and location

- (i) Integrated systems field tested and piloted for the range of farms / household levels.
- (ii) Stakeholder awareness and a minimum of 02 technology exposure study field trip per site

3.2.7. Research output 7: Policy recommendations for the uptake of crop residues (rice straw and corn stover) recycling

Expected outputs - with activities

- (i) A policy issues report covering
 - (a) A review of the current crops residues recycling technologies, including on-field processing, fuel pellets /briquettes, activated coal, biochar, bio-fertilizers, animal feed and mushroom substrate production policy objectives and the status of the sector in relation to the policy target
 - (b) An assessment of future targets and strategies to achieve.
 - (c) An assessment of the linkages between environment, energy, agriculture and rural development goals, including externality effects and constraints of crop residues recycling goals.
- (ii) A workshop for crop residues recycling stakeholders covering the proposed policy issues to identify gaps and to develop agreed policy targets for 2025 and 2030.
- (iii) The policy options paper covering:
 - (a) The range of policy options to stimulate the adoption of technologies including:
 - i. Awareness raising,
 - ii. Regulations and compliance strategies,
 - iii. Market-based approach versus the use of incentives and subsidies.
 - iv. Sectoral financing options through credit lines, carbon-based financial support and green economy funds.
 - (b) Sector management responsibilities including State, Provincial, Private Sector and National Programs.
- (iv) A draft crop residues recycling policy documents to review by the sector and MARD.

Implementating scale and location

- (i) Sector-wide.
- (ii) Provincial policy case study using in the selected province
- (iii) National Policy.

3.3. Scale of service

The scale of this service will include the implementation of technological research with the following specific tasks

3.3.1. Determine the scale and methods for:

- i) Technology for rice straw collection;
- ii) Technology for producing biochar, fuel pellets/ briquettes;
- iii) Technology for producing animal feed from rice straw for cattle;
- iv) Technology for cultivating edible and medicinal mushrooms on the substrates from rice straw and corn cob;
- v) Technology for processing spent substrate after mushroom production, collected rice straws and rice straws in fields into bio-organic fertilizer.
- vi) Develop policies for the collection and use of agricultural residues (rice straw, corn cob) according to the value chain.

3.3.2. Determining areas to build models and crop objects

Coordinate with specialized units/individuals to build a pilot model of post-harvest rice straw processing technologies, using bio-organic fertilizer on rice and vegetables with high efficiency.

- Determination of locations: Priority will be given to key areas for rice, vegetables production, remote areas, ethnic groups and women.
- Identify rice and vegetables as the model building objects.
- Identify the implementation organization / model implementation coordination.

3.3.3. Training for farmers

Organize training and coaching on the technologies mentioned in section 3.3.1 above.

- Quantity: 6 classes, 30 trainees/class.
- Identify the target participants of the training.
- Develop plan and contents for the training.
- Identify training methods.
- Organization of evaluation and acceptance.

3.3.4. Model development

- Establishing a local steering and executing committee;
- Sign contracts, survey model sites, farmer households participating in the model;
- Select the site, farmer households and commitment to implementation;
- Model building: Deploying pilot model and simultaneous models;

3.3.5. Site visit and study tour

- Field visits, seminars: 02 visits / 4 provinces with model implementation;
- An analysis of the awareness of potential users of the technology system based on the self-assessment analysis of the participants involved in survey ; An evaluation of

technology replication demand. Quantity: 15 people / event.

- Propagating the results of model building: 02 articles were broadcast on the radio
- television system or published in local newspapers.

3.3.6. Plan to organize seminars

Contents	Scale	Venue
Seminar 1: Project kick-off workshop	LCASP, Consultant, Expert Group	Ha Noi
Seminar 2: Comments on the draft report "Assess the existing rice straw collection technology for high effective in Vietnam".	60 participants, including: LCASP representatives, consultants, experts, facilities selected to implement the model, representatives of PCMU of the provinces, representatives of DARD with pilot models	1 project province in the South
Seminar 3: Comments on the draft report on mushroom production on rice straw and corn cobs	60 participants, including: LCASP representatives, consultants, experts, facilities selected to implement the model, representatives of PCMU of the provinces, representatives of DARD with pilot models	1 project province in the North
Seminar 4: Comments on the draft report on the technology of rice straw processing in the field	60 participants, including: LCASP representatives, consultants, experts, facilities selected to implement the model, representatives of PCMU of the provinces, representatives of DARD with pilot models	1 project province in the Central region
Seminar 5: Comments on the proposed policies for the use of agricultural residues (rice straw, corn cob) according to the value chain in Vietnam.	60 participants, including: LCASP representatives, consultants, experts, facilities selected to implement the model, representatives of PCMU of the provinces, representatives of DARD with pilot models	1 project province in the North
Seminar 6: Project summary	60 participants, including: LCASP representatives, consultants, experts, facilities selected to implement the model, representatives of PCMU of the provinces, representatives of DARD with pilot models	Ha Noi

PART IV

IMPLEMENTATION PLAN

4.1. Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes

Table 1: Implementation plan of Research output I

No	Work items	Time	Outputs	Location
1	Investigation of collection stage in Nam Dinh, Bac Giang and Binh Dinh	8-9/2018	Select 3 technologies in each region to evaluate	Nam Dinh, Bac Giang, Binh Dinh
2	Research, design, manufacture and complete the machine model: + Rice rice straw/stubble cutting and stamping machines; + Microbiological products spraying part to be installed on rice straw-winding machine	9-10/2018	Machine model	Ha Noi
3	- Completing the process and equipment for rice straw collection in accordance with the Northern ecological region	9-10/2018	- Reports/ materials on collection and disposal methods - Design of the rice straw collection machine / tool suitable for the North	Ha Noi
	- Completing the process and equipment for rice straw collection in accordance with the Central ecological region	9-10/2018	- Reports/ materials on collection and disposal methods - Design of the rice straw collection machine / tool suitable for the Central region	Ha Noi
3	Conduct field tests of samples at testing workshops.	10-11/2018	Choose the machine model, practical evaluation and advantages and disadvantages of	Ha Noi

			technology in factory conditions	
4	Deploy model in the North	11-12/2018	Scale 30 ha	Nam Dinh
5	Deploy model in the South	2/2018-4/2019	Scale 100 ha.	Soc Trang
6	Deploy model in the Central region	2/2018-4/2019	Scale 50 ha.	Binh Dinh

4.2. Research output 2: Research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice rice straw with high heating capacity

Table 2: Implementation plan of Research output II

No	Work items	Time	Outputs	Location
1	Synthesis, analysis and evaluation of materials outlining technologies, materials for production of synthetic fuel pellets/briquettes, activated coal / biochar from rice straw in the world and Vietnam.	6 – 7/2018	<ul style="list-style-type: none"> - Type of commonly used input materials, - Method of producing bio-fuel pellets/briquettes from rice straw using fuel compression type by mechanical piston. - Method of producing bio-fuel pellets/briquettes from rice straw using fuel compression type by hydraulic piston - Method of producing biofuel pellets/briquettes from rice straw using fuel compression type by the screw. - Method of producing biofuel pellets/briquettes from rice straw using fuel compression type by winder 	Ha Noi
2	Orientation to identify technology for producing fuel pellets/briquettes and biochar from rice straw in Vietnam	8 – 9/2018	Select 2-3 technologies in each region to evaluate.	Ha Noi
3	SWOT analysis to assess the type of oriented technology	9 – 10/2018	SWOT analysis table shows the strengths, weaknesses, opportunities and challenges of each technology applied in the	Ha Noi

			area..	
4	Proposing technology for priority application and trial evaluation	10 – 11/2018	Each region proposes 01 suitable technology and 01 technology for the second choice	Soc Trang, Binh Dinh and Nam Dinh
5	Testing evaluation of some technologies for producing fuel pellets/briquettes from rice straw in Vietnam	11 – 12/2018	Each region evaluates 02 technologies Prototype production then evaluates the indicators including: Technology performance (production materials, technology), production costs, people's awareness	Soc Trang, Binh Dinh and Nam Dinh
6	Testing and evaluate some technologies of producing activated coal/biochar from rice straw in Vietnam	11 – 12/2018	Each region evaluates 02 technologies Sample production then assesses the indicators including: Technology performance (total carbon (TC,%); total organic carbon (TOC,%); N (%); P ₂ O ₅ (%); K ₂ O (%), production materials, technology, thermal energy), production costs, people's awareness evaluation	Soc Trang, Binh Dinh and Nam Dinh
7	Making decisions to choose appropriate technology.	1 – 2/2019	Each region 1 type of technology applied	Ha Noi
8	Improve technology (if necessary)	2 – 3/2019	Technology improvement diagram. Detailed drawings of the system to be improved	Ha Noi
9	Recommend applicable technology	2 – 3/2019	01 technology is recommended . Technology to ensure a minimum capacity of 5 tons of products/hour for synthetic fuel pellets / briquettes and 300 kg of products/hour for activated coal / biochar.	Ha Noi

10	Technology development in the locality (building models).	3 – 5/2019	1 model with a scale of 100 tons of biofuel pellets/briquettes. 1 model with a scale of 50 tons of biochar or / and activated coal	Soc Trang, Binh Dinh and Nam Dinh
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4.3. Research output 3 - Research on technology for animal feed production from crop residues (rice rice straw and corn stover) and storage

Table 3: Implementation plan of Research output 3

No	Work items	Time	Outputs	Location
1	Identify technologies in producing animal feed from crop residues that are suitable for different weather conditions	7-8/2018	Select 3 technologies in each region to evaluate	Ha Noi
2	SWOT analysis for assessing the appropriate technology	8-9/2018	SWOT analysis table for each technology applied in the area	Ha Noi
3	Proposing appropriate technology applied, evaluated and tested	9-10/2018	1 region proposed 1 applied technology and 1 technology for the 2nd choice	Ha Noi
4	Survey the actual test of recommended technology at the testing workshop.	9/2018	Provide a detailed evaluation of practical and advantages and disadvantages of the technology in the research workshop conditions	Ha Noi
5	Deploy model in the North	10-11/2018	2 model sites, scale of 50 tons / site	Nam Dinh
6	Deploy model in the South	12/2018-1/2019	1 model site, scale of 50 tons	Soc Trang
7	Deploy model in the Central region	2-3/2019	1 model site, scale of 50 tons	Binh Dinh

4.4. Research output 4: Research on technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling of used substrate to produce bio-organic fertilizers

Table 4: Implementation plan of Research output IV

No	Work items	Time	Outputs	Location
1	Review technologies on producing edible mushrooms, medicinal	6-7/2018	- Technological process of cultivating some edible mushrooms (oyster mushroom, lingzhi, rice	Ha Noi

	mushrooms from crop residues in the country		straw mushrooms, button mushrooms) is currently applied in Vietnam from material selection → raw material handling → Raw material disinfection (bag preparation, clonal packing, making beds) → transplanting cultivars → Raising mycelium → tending, collecting → Processing and preserving products.	
2	Review international technologies on producing edible and medicinal mushrooms from crop residues	6-7/2018	- Studies on the technologies of edible and medicinal mushrooms cultivation from crop residues in the world, achieved results	Ha Noi
3	Analyze current situation of market potential (scale and product types) of mushrooms and production orientation	7-8/2018	Report analyzing current situation of market potential (scale and product types) and orienting mushroom production in Soc Trang	Ha Noi
		10/9-30/9/2018	Report analyzing current situation of market potential (scale and product types) and orienting mushroom production in Son La and Nam Dinh	Ha Noi
4	Research, select technology of propagating and cultivating Ganoderma mushroom (Ga2)	6/2018-1/2019	<ul style="list-style-type: none"> - Technical process of propagating and cultivating Ga2 mushrooms on the most appropriate raw material substrate formula - This process was carried out on a small scale at Vietnam National University of Agriculture from June to September 2018 	Ha Noi
5	Researching and selecting technology for propagating and cultivating oyster mushroom (PN1)	6/2018-1/2019	- Technical process of propagation and cultivation of PN1 mushrooms on synthetic substrates of which corn cob is the main material.	Ha Noi

			<p>- Technical process of propagating and cultivating PN1 mushroom on synthetic substrate of which rice straw is the main material.</p> <p><i>(This process is being carried out on a small scale at Vietnam National University of Agriculture from June to December)</i></p>	
6	Researching and selecting technology process for propagating and cultivating rice straw mushroom (V2)	6/2018-9/2018	<p>Technological process of propagation and cultivation of V2 mushroom on the most suitable raw material environment</p> <p>(This process is being carried out on a small scale at Vietnam National University of Agriculture)</p>	Ha Noi
7	Researching and selecting technology process for propagating and cultivating button mushroom (A1)	8/2018-10/2018	This process is being carried out on a small scale at Vietnam National University	Ha Noi
8	Surveying and investigating in areas expected to launch models in Son La, Nam Dinh and Soc Trang provinces.	6-7/2018	<p>- Identify natural conditions (temperature, humidity, precipitation, ecoregions ...) in recent years.</p> <p>- Determine available volume of local materials (corn stem, corn cob, rice straw, etc.)</p> <p>- General socio-economic situation of the locality.</p> <p>- Positioning of specific model location</p>	Son La, Nam Dinh, Soc Trang
9	Building 4 models in 2 provinces of Son La and Nam Dinh with scale of 30 to 50 tons of materials of all kinds / 01 farm model / and 6 satellite producing households with 3 tons of raw material / 01	8/2018-4/2019	* In Son La: Growing Ganoderma mushroom and oyster mushroom on synthetic substrate, of which corn cob is the main raw material for two central models in Son La at different seasons of the year, including 02 farms and 03 satellite households with	Son La, Nam Dinh

	household model/01 type of mushroom		<p>dried Ganoderma mushroom yield of 20-30kg / 1 ton of dry raw material; oyster mushroom reached 600 - 700kg fresh mushroom / 1 ton of dry raw material.</p> <p>* In Nam Dinh:</p> <p>+ Growing button mushrooms, oyster mushrooms on 2 farms and 6 satellite households. Fresh button mushrooms yield achieved 250-300 kg / 1 ton of dry material; oyster mushroom reached 600 - 700kg fresh mushroom / 1 ton of dry raw material.</p> <p>+ Due to late model formulation, production of rice straw mushroom was not implemented (because rice straw mushroom is only cultivated from May to September) but replaced with oyster mushroom production in Nam Dinh.</p>	
10	Training and coaching techniques on cultivation, preliminary processing, preservation and consumption of Ganoderma and oyster mushrooms in Son La; oyster and button mushrooms in Nam Dinh.	10/2018 – 4/2019	<p>40 - 50 trainees trained and ensured to:</p> <p>+ Grasp mushroom cultivation, preservation and processing technology</p> <p>+ Grasp mushroom disease control measures</p> <p>+ Prepare production plan suitable with cropping seasons</p> <p>+ Actively growing mushrooms at home after the course.</p> <p>+ Can guide neighbouring people to participate in mushroom cultivation.</p>	Son La, Nam Dinh
11	Final report of research topic	5- 6/2019	- Scientific and technical summary report of the research topic	Ha Noi

			<ul style="list-style-type: none"> - Scientific and technical narrative summary report of research topic - Statistical report of research topic 	
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Processing mushroom waste into bio-organic fertilizer

No	Work items	Time	Outputs	Location
1	Review technology for producing bio-organic fertilizer from spent substrate after mushroom production in the world and in the country	6-7/2018	Overview report on the technology of producing bio-organic fertilizer from spent substrate after mushroom production in the world and in the country	Ha Noi
2	Investigating forms of management, using and proposing the technology to produce bio-organic fertilizer from spent substrate after mushroom production in Son La and Nam Dinh	6-7/2018	Report on the actual situation and propose the technology of producing bio-organic fertilizer from suitable spent substrate after mushroom production in Son La and Nam Dinh	Son La, Nam Dinh
3	Completing the technological process to produce organic fertilizer from spent substrate after mushroom production in Son La and Nam Dinh according to household / farm scale	6 - 12/2018	Technological process of producing organic fertilizer from the spent substrate after mushroom production	Son La, Nam Dinh
4	Model of bio-organic fertilizer production from spent substrate after mushroom production	10/2018 - 3/2019	<ul style="list-style-type: none"> - Location: - Producing 40 tons of bio-organic fertilizer from spent substrate after mushroom production in 02 provinces (10 tons of organic fertilizer / site, 02 sites for 02 provinces). - Quality meets the standards specified in Decree 108/2017 / ND-CP 	Son La, Nam Dinh,
5	Developing demonstration models of rice and maize cultivation using bio-organic fertilizer produced from spent substrate after mushroom production	01 - 5/2019	<ul style="list-style-type: none"> - Scale: 2 ha / model; - Requirements for evaluation: Productivity, yield bumper, fertilizer use efficiency and economic 	Son La, Nam Dinh

			efficiency of the model.	
6	Training on production of bio-organic fertilizer from mushroom residues and use of bio-organic fertilizer in agricultural production	01 - 5/2019	3 classes x 20 trainees/ class	Son La, Nam Dinh

4.5. Research output 5: Research on the technology for on-field rice straw decomposition and production of bio-organic fertilizers

Table 5: Implementation plan of Research output V

A. Plan to implement research on fast rice straw processing technology in the field

No	Work items	Time	Outputs	Location
1	Synthesize, analyze and evaluate documents outlined technologies of on-field rice straw decomposition in the world and in Vietnam	6/2018 - 7/2018	General report, analysis, evaluation	Ha Noi
2	Propose suitable technology for on-field rice straw fast decomposition in field in Vietnam.	6/2018 - 7/2018	Report proposing technology to fast decompose rice straw in rice field in Vietnam	Ha Noi
3	Research, propose and complete the technology to fast decompose rice straw on the field surface in Nam Dinh, Binh Dinh and Soc Trang provinces.	6/2018 - 12/2018	Process of on-field rice straw fast decomposition in Nam Dinh, Binh Dinh and Soc Trang provinces	Ha Noi
4	Formulating a model of on-field rice straw fast decomposition	01 - 5/2019	Scale: Farm household; Type: In the field Number of models: 12 sites (2 sites/crop x 2 sites for each province x 3 provinces); Quality criteria: Decomposition time <25 days, decomposition rate > 80%; Scale: 1 ha / model	Nam Dinh, Binh Dinh, Soc Trang;

B. Plan to implement research outputs of technology for on-field rice straw fast decomposition after concentrated collection by machines and production of bio-organic fertilizer

1	Synthesize, analyze and evaluate documents outlined technologies on rice straw concentrated collection for production of bio-organic fertilizers on different scales in the world and in Vietnam	6/2018 - 7/2018	General report, analysis, evaluation	Ha Noi
2	Propose suitable technology for rice straw concentrated collection for production of bio-organic fertilizers on different scales in the world and in Vietnam	6/2018 - 7/2018	Report proposing technology for concentrated collection of rice straw for production of bio-organic fertilizers on different scales in Vietnam	Ha Noi
3	Research, propose and complete technology for producing bio-organic fertilizer from rice straw	6/2018 - 12/2018	Technological process of producing bio-organic fertilizer from rice straw in Nam Dinh, Binh Dinh and Tien Giang provinces; capacity of 5 tons of raw materials/production batch	Ha Noi
4	Formulating models of producing bio-organic fertilizers from rice straw under concentrated collection conditions	01 - 5/2019	Scale: Farmer / farmer group / factory Number of models: 1 site/province x 2 provinces Quality criteria for bio-organic fertilizer: OM \geq 20%, humic / fulvic acid \geq 3,5%; Quality criteria for micro-organic fertilizer: OM \geq 15%, each useful microorganism reaches $\geq 10^6$ CFU / g; Scale: 15 tons of bio-organic fertilizer	Nam Dinh/ Binh Dinh, Soc Trang

4.6. Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologies that link advanced pellets /briquettes, activated coal, biochar production, on-field fast rice straw decomposition and production of bio-organic fertilizer from rice straw

Table 6: Implementation plan of Research output VI

No	Work items	Time	Outputs	Location
1	Determine the location of model demonstration	10/2018	- Select one province from each region to formulate the	5 provinces (Son La, Nam Dinh, Binh Dinh and

			model - Establishment of an executive board, a local steering committee, surveying and selecting locations, participating farmer households, signing contracts and building models.	Bac Giang and Soc Trang)
2	Research, design model	11/2018	- Forming detailed models for each location, types of crop, area, fertilizer use process, methods of assessing economic efficiency, seminars, visits, ...	5 provinces (Son La, Nam Dinh, Binh Dinh and Bac Giang and Soc Trang)
3	Model installation	12/2018 - 5/2019	Results of economic, social and environmental effects of the model along the value chain	5 provinces (Son La, Nam Dinh, Binh Dinh and Bac Giang and Soc Trang)

4.7. Research output 7: Policy recommendations for the uptake of crop residues (rice rice straw and corn stover) recycling

Table 7: Implementation plan of Research output 7

No	Work items	Time	Outputs	Location
1	Supplementing the regional construction according to the preferential level of investment	01/11-05/11/2018	- Special preferential investment areas. - Preferential Investment areas - Investment incentive areas - The rest areas	In each project province
2	Building value chains, identifying strengths, weaknesses, opportunities and challenges as a basis for policy formulation	6/11-06/12/2018	- General value chains and by each new technologies. - Strengths, weaknesses, opportunities and challenges with value chains of each new technology	In each project province
3	Develop policy indicators	06/11-06/12/2018	- Indicators of agricultural, forestry and fishery production value - Central budget allocation	In each project province

			indicators under the New Rural Program - Indicators on environment - General indicators of policies	
4	Building a policy framework	06/12-10/12/2018	Identify policy framework	In each project province
5	Develop policies for each technology and each product target of the technology	11/12/2018 - 11/03/2019	+ Policy for rice straw collection according to new technology is applied in Nam Dinh, Binh Dinh and Soc Trang + Policies for producing fuel pellets/briquettes from corn cob with new technology in Son La; from rice straw with new technology in Binh Dinh and Soc Trang. + Policy on producing animal feed from rice straw by new technology in Nam Dinh. + Policy of producing button mushroom and oyster mushroom from rice straw according to new technology in Nam Dinh + Policy of producing fertilizer from rice straw and spent substrate after mushroom production according to new technology in Nam Dinh and Binh Dinh.	In each project province
6	Conduct on-site consultation: - Obtaining critical comments for proposals on national and sectoral policies in support and development to improve the efficiency of using crop residues by	12-20/03/2019	- Critical comments on proposals on national and sectoral policies in support and development to improve the efficiency of using crop residues by value chains; - Identify participants in the policy consultation workshop: Farmers' households, local authorities, PPMUs and stakeholders - Planning and content of policy consultation	10 project provinces

	value chains; - Identify the subjects participating in the policy consultation: Farmers' households, local authorities, PPMUs and related parties; - Develop plans and content for policy consultation;		workshops;	
7	- 1st provincial policy consultation: Quantity: 3 meetings in 3 regions (North, Central and South); Participants: Farmers, local authorities, PPMUs and stakeholders. Number of attendees: 40 people. Number of days: 01 day/ event	21/03-21/04/2019	Consultation on the policy of using agricultural byproducts at the first level	Project provinces
8	- 2nd Regional Consultation Workshop/ National Policy: 3 events in 3 regions (North, Central and South). Participants: Farmer households, local authorities; PPMU and stakeholders. Number of attendees: 50 people. Number of days: 02 days / event	22/04-22/05/2019	Consultation on the policy of using agricultural byproducts at the first level	Nam Dinh, Binh Dinh and Soc Trang

9	<p>- Final consultation workshop: Quantity: 01 session. Participants: Farmers, local authorities, PPMUs and stakeholders. Number of attendees: 100 people. Number of days: 02 days / event</p>	23/05-30/05/2019	Consultation on the policy of using agricultural byproducts at the second level	Ha Noi
10	Revise, finalize and publish a draft of national and sectoral policies in support and development for effectively improving the value chain of crop residues by value chain and submit to state management agencies;	31/05-15/06/2019	Draft of national and sectoral policies in support and development of improving the effective value chain of crop residues by value chain	Ha Noi
11	- Propose draft national and sectoral policies to support and develop the effective improvement of using crop residues by value chains, and submit to state management agencies	16/06-30/06/2019	Final draft of national and sectoral policies in supporting and developing the efficiency of using crop residues by value chain	Ha Noi

PART V

PRODUCTS, TIME AND IMPLEMENTATION METHODOLOGIES

5.1. Product and delivery time

All research and reporting activities need to be carried out and completed from the date the contract comes into effect until May 30, 2019.

Reports and documents submitted for each topic are as follows:

No	Types of report	Quantity		Deadline
		Vietnamese	English	
1	Inception report and update of detailed implementation plan (Detailed research proposal)	5	5	Within 30 days after signing the contract
2	Technology review and identification reports being: (i) Methods and technology for collection and preliminary processing of crop residues (ii) Technologies of fuel pellets / briquettes, activated coal and biochar produced from rice straw (iii) Technology for animal feed production from crop residues (iv), Technology for producing edible and medicinal mushrooms from crop residues (v) On-field rice straw fast decomposition and production of bio-organic fertilizer from rice straw and mushroom substrate (vi) Project progress report	5 copies per each report	5 copies per each report	Within 3 months from the date of signing the contract
3	Updated and detailed pilot site management plan and supporting agreements - 1 per for proposed site (i) Technologies of fuel pellets / briquettes, activated coal and biochar produced from rice straw (ii) Technology animal feed production from crop residues (iii), Technology for producing edible and medicinal mushrooms from crop residues (iv) Technology for on-field rice straw fast decomposition and production of bio-organic fertilizer from rice straw and used mushroom substrate (v) Project progress report	5 copies per each report	5 copies per each report	Within 6 months from signing the contract

4	Technology design, production and evaluation reports based on test results at the workshop and field conditions (i) Technology for producing fuel pellets / briquettes, activated coal and biochar from rice straw (ii) Technology for producing animal feed from crop residues (iii), Technology of producing edible and medicinal mushrooms from crop residues (iv) On-field rice straw fast decomposition and producing bio-organic fertilizers from rice straw and from used mushroom substrate	5 copies per each report	5 copies per each report	Within 9 months from the date of signing the contract
5	Crop residues recycling technologies Policy Draft Report	5	5	Within 17 months from the signing of the contract
6	Research Completion Report	10	10	20 days before the end of the contract

Note: Each report must be prepared and submitted in 5 hard copies with the soft copy stored on USB in the usual text application. All data will be detained on the property of the LCASP / APMB Project CPMU

5.2. Implementation arrangement

Within 1 month, the consultant provided a detailed work plan, inception report that updates the methodology and technical standards proposed in the consultant's proposal document based on the final contract, initial consultation and assessment during the inception phase of the project.

Within 3 months of signing the contract, the consultant will conduct review of the technologies, propose recommendations on improved methods and identified reports: crop residues collection and preliminary processing methods; Technology for producing fuel pellets/briquettes from rice straw; Technology for producing animal feed from rice straw; Technology for producing edible and medicinal mushrooms from crop residues; Technology for fast decomposing rice straw in the field and producing bio-organic fertilizer from rice straw and used mushroom substrate; Project progress report.

Within 6 months after signing the contract, consultant will work out detail management plan of model site implementation as well as support agreements - one copy for each site: Technology for producing fuel pellets/briquettes from rice straw; Technology for producing animal feed from rice straw; Technology for producing edible and medicinal mushrooms from crop residues; Technology for fast decomposing rice straw in the field and producing bio-organic fertilizer from rice straw and used mushroom

substrate; Project progress report. CPMU will approve the plan on piloting the technologies within 30 working days.

After approval, the consultant will submit the final design of the technology, compilation of evaluation report based on test results at the workshop and field conditions: Technology of producing fuel pellets/briquettes from rice straw; Technology for producing animal feed from rice straw; Technology for producing edible and medicinal mushrooms from rice straw and corn cob; Technology of on-field rice straw fast decomposition and production of bio-organic fertilizer from rice straw and used mushroom substrate. All manufacturing work will be completed and ready for indoor and on field testing within 6 months of signing the contract.

The pilot program will be started after approval of the update plan and the technology selection plan will be approved by CPMU.

PART VI. DESCRIPTION OF ACTIVITIES AND METHOD OF IMPLEMENTATION

6.1. Description of activities

6.1.1. Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes

1. Activities to be implemented

Task 1: Investigate and evaluate current status of using crop residues by value chain in Vietnam (10 provinces implementing the project).

- Preparing survey form: 03 survey samples, each sample > 50 indicators.
- Investigate the current status of using crop residues by value chain in 10 project provinces: Including 980 questionnaire samples (880 survey samples for household, enterprises and traders; 100 management questionnaire samples).
- Survey data processing: Tables of surveyed data processing consists statistical indicators: Average value, range of variation, error, maximum value, minimum value.
- Survey report includes the following contents:
 - + Methods and technology of collecting and processing of crop residues for different uses;
 - + Technology for producing fuel pellets/briquettes, activated coal and biochar from rice straw with high thermal efficiency;
 - + Technology for producing animal feed from crop residues (rice straw and corn cob) and preservation;
 - + Technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling using substrates to produce bio-organic fertilizer;
 - + Technology for fast decomposing rice straw in fields, producing and using bio-organic/micro-organic fertilizers;
 - + Policy on crop residues recycling (rice straw and corn stover, corn cob).

Task 2: Summary, analysis, evaluation of documents outlined collection technology of crop residues in the world.

- Summarize, analyze and comparative evaluate the technologies of collecting crop residues in the world.

The information includes: (i) Collecting rice straw with a square baler; (ii) Collecting rice straw with a round baler; (iii) Collect corncocks for silage;

-Compile, analyze, evaluate and compare the technologies of collecting crop residues in Vietnam.

Task 3: Design and documentation of collection and preliminary processing methods, including designs and technical assistance

- Design evaluation includes production/modification of equipment to meet crop seasons, sizes and collection purposes in three selected provinces (Nam Dinh, Binh Dinh and Soc Trang). Each type proposed 02 technologies for testing suitable for each purpose such as composting, used mushroom substrate, animal feed and biochar.

- Estimating the cost to apply the collection and preliminary processing methods of rice straw, clearly analyzing the advantages and disadvantages of each collection method to make an appropriate selection for each locality.

- Prepare design and operating standards: main drive system, auxiliary drive system, powertrain system for mobile parts, rice straw pressing part, auto-strapping parts, drive systems, system of base frame, rice straw assembly part and rice straw conveyance into pressing box, pressing mold, cutting part, tightness adjustment part (this is an important part to adjust the rice straw bundle for other purposes); The overall operating procedure of the parts from which the overall design and operating standards are introduced. In addition, the expert team will combine with a number of combo devices to support some features suitable for each purpose of use: microbiological spray system, lime spray

Task 4: Develop a pilot model with priority technologies for each selected province

- Summary of test indicators including design, manufacture, use, operational and environmental standards.

- Testing and evaluating collection technology.

- Technology improvement (if necessary). Including: Technology improvement diagram; Detailed drawings of the system to be improved.

- Select the appropriate technology. Request 01 technology in each region to be applied.

Task 5: Prepare draft technology standards for each selected technology.

- Improved methods and technologies with 1 pilot site for each province

- Building technology development model in the locality with different scales (households, farms, companies): 1 site in each province, 3 sites/3 provinces (100 hectares of rice /site).

- Drafting technological processes for collecting comments from stakeholders.

2. Location for implementation: Nam Dinh, Binh Dinh and Soc Trang (100 ha of rice / site):

3. Scope of implementation: Improved technology for each province 01 pilot site

4. Composition and structure of the testing groups: 03 people, assigned according to the following table:

No	Group composition	Tasks are assigned in group
1.	Expert in charge	The team leader based in Hanoi is in charge of the following

No	Group composition	Tasks are assigned in group
	of developing rice straw collection technology in the field	<p>specific tasks:</p> <ul style="list-style-type: none"> - Improved design of a combined harvester system to collect rice straw from the field. - Improved design of rice straw cutting and burying in the field. - Designing and manufacturing parts of spraying microbiological probiotic for producing animal feed from fresh rice straw and rice straw processing on the field. - Develop a pilot model with priority technologies for each selected province. - Responsible to the Team leader for assigned tasks.
2.	Policy expert	<p>Coordinate with experts, perform the following tasks:</p> <ul style="list-style-type: none"> - Analyze and assess the economic efficiency of rice straw collection model in the field. - Proposing policies related to waste processing in the field, support policies to replicate the model; rice straw management policies to ensure not to pollute the environment, etc.,
4.	01 supporting expert (agriculture engineer)	Supporting key experts to record and directly monitor the operation of Research output 1.

5. Proposed products and requirements:

No	Products	Scientific requirements to be addressed
1	Review methods and technologies for collection and processing of crop residues and suitability for replication in Vietnam.	<ul style="list-style-type: none"> - Existing methods and technologies for collecting and processing of rice straw for different uses in Vietnam to understand the actual management and technical situation and related issues - including surveys end-users/farmers, business managers, local authorities in the agricultural sector. The survey will provide an insight at the following: (i) Methods of collection and processing of rice straw for different uses (animal feed, compost, bedding material, mushroom production, cooking fuel and others) in the project provinces; (ii) Quantity/proportion of rice straw collected; (iii) Preliminary processing methods applied; (iv) Costs/benefits of various methods of collection and preliminary processing including farmer's awareness; (v) Management issues; (vi) Existing policies and subsidies; - Overview of documents and important information on rice straw collection and disposal methods in the world, including desk research comparing the performance of different technologies.

		<ul style="list-style-type: none"> - Gather suggestions of methods and technologies for collecting and processing of residues, which can be integrated in the project provinces with appropriate costs.
2	Design documents, report materials on methods of collection and preliminary processing (including design drawings and technical support)	<ul style="list-style-type: none"> - Overview of collection and preliminary processing methods at different scales in the country and around the world - Evaluate designs, including production / modification of equipment to meet different rice production scale and harvest conditions of each region and locality in the project; - Overview of the method of rice straw collection and preliminary processing according to different conditions of the selected provinces - Estimating the cost of applying rice straw collection and processing methods - Develop designs and operation standards: The design of rice straw collection machine/tool specifies the technical specifications suitable to the cropping season, scale and purpose of use: <ul style="list-style-type: none"> + <i>Design document of LH collection machine, rice straw round baled in the field associated with tractors: Productivity: 55.7 bales / h; Tightness of the bale: 288 kg/m³; Bale size (DxL): 48 x 70 cm; Tractor capacity: 35 HP</i> + <i>Rice straw collection and square baling machine in the field in combination with tractor: Productivity: 90 bales/hour; Tightness of the bale: 314 kg/m³; Bale area: 32x42 cm; Bale length: 40-80 cm; Tractor power: 35 HP</i> + <i>Self-propelled round baling machine: Capacity: 51 bales/hour; Tightness of the bale: 190 kg / m³; Bale size (DxL): 45x50 cm;</i> + <i>Rice straw and stubble chopping machine in the field for green fertilizer: Quantity of rice straw after chopped with size <12 cm (for soil preparation): 81%; Working width: 1.2m; Productivity: 0.31 ha/h; Tractor: 35 HP; Ensuring agronomic requirements for tillage;</i>
3	Technology overview report	<ul style="list-style-type: none"> - Provide details of the pilot model of priority technologies for each of the 3 provinces selected for pilot implementation (representing 3 ecological regions); - Proposing the testing method and methodology approved by the Council of MARD; - Summary of test indicators including design, manufacture, use, operational and environmental standards; <p>For each approved technology, provide a certified test report;</p>

		- Principal proposals based on the results of the pilot model (i) further development of methods and technologies and (ii) technology transfer to PPMUs for demonstration purposes.
4	Draft technology standards provided to CPMU (for each pilot technology approved based on pilot results)	Technology standards show the following contents: - Form groups of rice farming households (households, farms, companies); - Follow-up the groups to develop a pilot model according to the agreed scale and structure for the proposed standards; - Draft process based on the results of consultation and feedback from stakeholders.

6.1.2. Research output 2: Research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice straw with high heating capacity

1. Works to be undertaken:

Task 1: Synthesis, analysis and evaluation of materials outlining technologies, materials for production of synthetic fuel pellets/briquettes, activated coal / biochar from rice straw in the world and Vietnam

- Collecting and analyzing the overview of technology and raw materials for production of synthetic fuel pellets / briquettes from rice straw in the world and in Vietnam

The information to be collected includes: (i) Type of commonly used input materials, (ii) Method of producing bio-fuel pellets/briquettes from rice straw using fuel compression type by mechanical piston; (iii) Method of producing bio-fuel pellets/briquettes from rice straw using fuel compression type by hydraulic piston; (iv) Method of producing biofuel pellets/ briquettes from rice straw using fuel compression type by the screw; (v) Method of producing biofuel pellets/briquettes from rice straw using fuel compression type by winder; (vi) Technology operation cost

- Collecting and analyzing the overview of technology and raw materials for production of activated coal / biochar from rice straw in the world and Vietnam

Information to be collected includes: (i) Method of burning rice straw; (ii) Improved method of burning rice straw; (iii) Method of burning rice straw in a closed compartment; (iv) Method of indirect rice straw burning (v) Technology operation cost.

Task 2: Orientation to identify technology for producing fuel pellets/briquettes and biochar from rice straw in Vietnam

- Identify suitable technologies with raw materials in Vietnam: Select 2-3 technologies in each region to evaluate.

- SWOT analysis to assess the type of oriented technology: SWOT analysis table shows the strengths, weaknesses, opportunities and challenges of each technology applied in the area.

- Proposing technology for priority application and trial evaluation: Each region proposes 01 suitable technology and 01 technology for the second choice

Task 3: Surveying and comparing each priority technology.

- Testing evaluation of some technologies for producing synthetic fuel pellets/briquettes from rice straw in Vietnam

Each region evaluates 02 technologies; Prototype production then evaluates the indicators including: Technology performance (production materials, technology),

production costs, people's awareness.

- Testing evaluation of some technologies for producing activated coal/biochar from rice straw in Viet Nam.

Each region evaluates 02 technologies; Sample production then evaluates the indicators including: Technology performance (total carbon (TC,%); total organic carbon (TOC,%); N (%); P₂O₅ (%); K₂O (%), production materials, technology, thermal energy), production costs, people's awareness .

- Making decisions to choose appropriate technology. Each region applies 1 type of technology.

- Improve technology (if necessary); Technology improvement diagram. Detailed drawings of the system to be improved

Task 4: Identify and develop technology for producing synthetic fuel pellets/briquettes and activated coal/biochar from rice straw in Vietnam

- Recommend applicable technology: 1 technology to be recommended. Technology to ensure a minimum capacity of 5 tons products/hour for synthetic fuel pellets/briquettes and 300 kg of products/hour for activate carbon/biochar.

- Develop technology in locality (building models). 10 models with a scale of 100 tons of biofuel pellets/ briquettes in each province; 10 models with a scale of 50 tons of biochar or / and activated coal in each province.

2. Implementation location: Nam Dinh, Binh Dinh and Soc Trang:

3. Scope of implementation: At 3 companies in selected provinces.

4. Composition and structure of the testing groups: 03 people, assigned according to the following table:

No	Group composition	Tasks are assigned in group
1.	Renewable energy expert, in charge of developing technology for producing energy pellets /briquettes; activated coal / biochar	Be the team leader, in charge of the following specific tasks: <ul style="list-style-type: none">- Synthesis, analysis and evaluation of materials outlined technologies, raw materials for production of synthetic fuel pellets / briquettes and activated coal / biochar from rice straw in the world and Vietnam.- Orientation to identify technology for producing bio-fuel pellets/ briquettes from rice straw in Vietnam.- Surveying and comparing each type of priority technology.- Identify and develop technology for production of synthetic fuel pellets / briquettes and activated coal / biochar from rice straw in Vietnam.- Responsible to the Team Leader for the assigned tasks.
2.	Policy expert	Coordinate with experts, perform the following tasks: <ul style="list-style-type: none">- Analyze and evaluate the economic efficiency of the production model of synthetic fuel pellets / briquettes and activated coal / biochar from rice straw.- Proposing policies related to the production of fuel pellets/briquettes and activated coal from rice straw to ensure no environmental pollution, etc.

No	Group composition	Tasks are assigned in group
3.	01 supporting expert (agricultural engineer)	Support key experts to record, directly monitor the operation of the Research output 2.

5. Expected products and requirements::

1	Overview, evaluation, proposal and technology development report on the production of fuel pellets / briquettes, activated coal and biochar from rice straw with high thermal efficiency	<ul style="list-style-type: none"> - Identify technology and overall evaluate technology solutions in the world and in Vietnam - Overview of technology, production materials, technology operation data, technology operating costs - Surveying the main technologies will be prioritized for detailed evaluation including production materials, technology, thermal energy and people's awareness. - Develop suitable technology to produce fuel pellets / briquettes, activated coal, biochar from rice straw and sawdust (for reference) - A proposed test form, test method including indicators
2	Inspection report at the research workshop on the production of fuel pellets / briquettes activated coal and biochar produced in Vietnam	<ul style="list-style-type: none"> - Results of inspection form and procedure in conditions at the research workshop and in the field - From user evaluation and monitoring support for at least 3 months of use of fuel pellets/briquettes, activated coal and biochar - Proposing recommendations on strengths and weaknesses of technologies including production technology, stability of raw materials, heat capacity, efficiency / cost and people's awareness.
3	Technological process for production of synthetic fuel pellets / briquettes from rice straw	Capacity of tons of products / hour; Calorific value is over 70% compared to fuel pellets from husks
4	Technological process of continuously producing activated coal / biochar from rice straw	Capacity of over 300 kg of activated coal/biochar / hour

6.1.3. Research output 3 - Research on technology for animal feed production from crop residues (rice straw and corn stover) and storage

1. Works to be undertaken:

Task 1: Analysis of nutritional content of rice straw and corn cob (N, P, K, protein,)

Task 2: Synthesis, analysis and evaluation of overview documents in the world and in Vietnam on the production technology of animal feed from rice straw, corn cob and storage.

- Collecting and analyzing an overview of the method of silage from raw rice straw in the world and in Vietnam.

Include the following information: (i) Method of processing materials before silage; (ii) Material silage technique; (iii) Method to assess the quality of raw materials after silage; (iv) Methods and techniques to ensure raw materials after silage (materials storage during winter and dry seasons).

- Collecting and analyzing an overview of the method of silage from corn cob material in the world and in Vietnam.

Include the following information: (i) Method of processing materials before silage; (ii) Material silage technique; (iii) Method to assess the quality of raw materials after silage; (iv) Methods and techniques to ensure raw materials after silage (materials storage during winter and dry season).

- Collecting and analyzing an overview of the method of drying and creating nutritious flour from corn cob in the world and in Vietnam.

Include the following information: (i) Minimum nutritional needs for ruminant cattle in winter and dry seasons; (ii) Methods and techniques of preliminary processing raw materials; (iii) Material processing methods and techniques; (iv) Methods and techniques for assessing the quality of raw materials after processing; (v) Methods and techniques to ensure raw materials after processing (nutritious powder).

- Collecting and analyzing an overview of the method of drying and creating nutritious cakes from rice straw and corn cob in the world and in Vietnam.

Includes the following information: (i) Methods and techniques for processing of raw materials; (ii) Methods and techniques of processing and supplementing additives; (iii) Methods and techniques for assessing the quality of raw materials after processing; (iv) Methods and techniques to ensure raw materials after processing (nutrition cake).

Task 3: Orientation, proposed priority technology in production of animal feed from rice straw, corn cob and storage ... which can be developed under different weather conditions.

- Identify suitable technologies for animal feed production from rice straw, corn cob and storage ... that can be developed under different weather conditions: Select 3 technologies in each region to evaluate.

- SWOT analysis to evaluate the technology in the production of animal feed from rice straw, corn cob and storage ... that can be developed under different weather conditions: The SWOT analysis table shows the strengths, weaknesses, opportunities and challenges of each technology when applied in the area.

- Proposed priority technology to be applied, trial evaluation: Each region proposes 01 suitable technology and 01 technology for the second choice.

- A detailed comparison evaluation with the recommended technology to be prioritized and test results in conditions of the research workshop and in the field.

- + Prepare a detailed assessment of advantages and disadvantages of the method and associated techniques including technical and economic indicators.

- + Surveying the actual situation of recommended technology at testing workshop. A detailed evaluation of the technology and advantages and disadvantages of the research facility conditions is worked out accordingly.

- + Surveying and checking the actual application of recommended technologies in the field, thereby giving preliminary results of the evaluation of advantages and disadvantages of the selected technology.

From the results of preliminary evaluation at the testing workshop and field practice will conclude technology costs in Vietnamese conditions.

Task 4: Detailed technical test report based on research workshop conditions for production of animal feed from rice straw, corn cob and storage.

- Survey the technology of producing animal feed from rice straw and corn cob to be selected at the research workshop at different scales with different amount of residues: Survey to find out suitable production scale for each farm; Survey to find out a formula of mixing food for each object of different residues; The survey give a mixed formula for each object of cattle. Preliminary assessment of nutritional value and economic efficiency of technology.

- Building a model of animal feed production from rice straw, corn stems and corn cob applying selected technologies under field conditions (winter and dry season): Assessing through sensory criteria, food consumption level, feed consumption efficiency, and growth rate.

- From the achieved results, recommendations on application of technology together with technical specifications and design instructions will be given.

Task 5: Formulating a model applying technology to produce animal feed from rice straw, corn stems and corn cobs in some project provinces.

- Building a pilot model of animal feed production from rice straw, corn stems and corn cobs with scale of 50 tons / model site, 02 sites/province, 04 sites for 02 provinces) and storage (duration of 3 months at the same location of feed production) during dry and winter seasons. Evaluate the nutritional value of feed; energy values of food; protein values of feed, production cost.

- Develop a model for application of feed produced from rice straw and corn cob in the local pilot model under practical conditions for assessment: Sensory evaluation of livestock, food consumption level, digestion of invivo feed in ruminant cattle, level of growth.

- Assess production costs, people's awareness ... about some technologies for producing feed for livestock from rice straw, corn cob and storage;

- User evaluation report and monitoring support within a cattle development cycle (12 months) for the applied technology (2 sites/province, total 4 sites in the target provinces).

- Decide to select an appropriate technology; each region will apply 01 technology.

- Technology improvement (if necessary). Technology improvement diagram; Detailed drawings of the system to be improved.

- Identify and develop the most suitable technology for producing animal feed from rice straw, corn cob and storage to be able to develop in different weather conditions in Vietnam: Including the selection and recommend technology, test with production and application of animal feed in field conditions (in the dry and winter seasons) and then develop a model.

Technology to ensure the quality of products produced after 6 months of dry and winter seasons;

Technology is easy to implement; Not much investment is required with the lowest maintenance costs.

2. Implementation scale and location

- Recommendation of technology for producing animal feed from rice straw and corncob and storage should be checked in Lao Cai and Son La provinces in the dry and winter seasons.

- Check the use of feed for livestock under workshop research and on field conditions at 10 households or/and 6 farms (5 households and/or 3 farms per province)

3. Implementation location: Nam Dinh, Binh Dinh and Tien Giang:

4. Scope of implementation: Workshop and field research conditions at 10 households or/and 6 farms (5 households and/or 3 farms per province).

5. Composition and structure of the testing group: 03 people are being assigned according to the following table:

No	Group composition	Tasks are assigned in group
1.	Expert in animal nutrition, responsible for the development of technology in production of nutritious flour/cake, silage from corn cob and rice straw	<ul style="list-style-type: none">- Analysis of the nutritional content of rice straw and corn cob (N, P, K, protein,)- Synthesize, analyze and evaluate general literature in the world and in Vietnam on the production technology of animal feed from rice straw, corn cob and storage.- Orienting and proposing priority technologies in the production of animal feed from rice straw, corn cobs and storage, etc., those are suitable for development in different weather conditions.- Detailed technological inspection report based on the conditions of the research workshop on the production of animal feed from rice straw, corn cob and storage.- Building a model for application of technologies to produce animal feed from rice straw, corn stems and corn cobs in some project provinces.- Responsible to the Team Leader for assigned tasks.
2.	Policy expert	<p>Coordinate with experts, perform the following tasks:</p> <ul style="list-style-type: none">- Analyze and evaluate the economic efficiency of the production model of animal feed from rice straw.- Proposing policies related to the production of animal feed from rice straw to ensure no environmental pollution, etc.
4.	01 supporting expert (agricultural engineer)	Support key experts to record, directly monitor the operation of the Research output 3

6. Expected products and requirements:

1	Overall report to evaluate, recommend and develop appropriate technology for the production of animal feed from crop residues	<ul style="list-style-type: none">- Overview of international literature, on the internet, to identify the technologies being applied- Proposing suitable technology that can develop in different weather conditions
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	(rice straw and corn cob) and storage.	<ul style="list-style-type: none"> - Detailed comparative evaluation with preferred technology recommendations and test results in conditions of research workshop and in the field - Technology cost in Vietnamese conditions
2	Technology test report based on research facility conditions for the production of animal feed from rice straw and corn cob and storage	<p>The report presents following contents:</p> <ul style="list-style-type: none"> - Application of feed production from rice straw and corncob and storage under factory conditions, use on different farm sizes and different quantity of residues - Application of animal feed to cattle under field conditions (during dry and winter seasons) - User evaluation and monitoring support within a cattle development cycle (12 months) for the applied technology (2 sites / province, total 4 sites in the target provinces) - Recommendation of technology application with technical specifications and design guidelines.
3	Technological process for processing of crop residues (rice straw, corn cob) for animal feed and storage	<ul style="list-style-type: none"> - The process is simple, easy to apply, using available local materials, suitable for model building in the Northern and Central mountainous provinces.
4	Report on a pilot model based on animal feed production technology from rice straw and corn cob and storage	<p>The report presents the following contents:</p> <ul style="list-style-type: none"> - Application of pilot models of feed production from rice straw and corn cob (50 tons / ha, 02 sites / province, total 04 sites for 2 provinces) and storage (3 months at same feed production location) in the dry and winter seasons. - Application of pilot models on using (for feeding animal) feed for animals from rice straw and corn cob in dry and winter seasons

6.1.4. Research output 4: Research on technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling of used substrate to produce bio-organic fertilizers

1. Works to be undertaken:

Task 1: Overall research on technologies of producing mushrooms from rice straw and corn cob in the world and in Vietnam

- Overview of technologies for producing mushrooms from rice straw and corn cob in the country.

- Overview of technologies of producing mushrooms from rice straw and corncobs in the world.

Task 2: Analyze current situation of market potential of mushroom production and consumption (size and types of products), production orientations and propose suitable technologies for different forms of mushroom cultivation.

- Surveying markets of mushroom production and consumption in Son La, Nam Dinh and Hanoi.

- Production orientations and recommend suitable technology for mushroom cultivation in Son La and Nam Dinh provinces.

Task 3: Complete the technological process for producing edible and medicinal mushrooms from rice straw and corn cob at household / farm scale.

- Complete technological process of Ganoderma cultivation;
- Complete technological process of oyster mushroom cultivation;
- Complete technological process of button mushrooms cultivation.

Task 4: Formulate a pilot model for producing Ganoderma, oyster mushrooms, button mushrooms from rice straw and corn cob on a household / farm scale in Son La, Nam Dinh.

- Investigate, survey and determine places to build models of mushroom production of all kinds suitable to required criteria of the project.

- Building a model of cultivating Ganoderma mushrooms on corn cob materials; oyster mushroom, button mushroom on rice straw in Son La, Nam Dinh.

Scale: 50 tons of substrate / site, 02 sites/province, total of 4 sites for the 2 provinces

Task 5: Conduct training courses for trainees in the area.

Guiding the theory and practice of technology of cultivating, preliminary processing and preserving Ganoderma, oyster mushroom, button mushrooms on rice straw and corn cob materials.

2. Location of implementation: Nam Dinh and Son La:

3. Scope of implementation: Conditions for research at the workshop and in field at 6 households and 2 farms per province.

4. Composition and structure of the testing group: 03 people are being assigned according to the following table:

No	Group composition	Tasks are assigned in group
1.	Expert in cultivating edible mushrooms, medicinal mushrooms, in charge of developing propagation technology, cultivating Ganoderma, oyster mushroom, button mushrooms from rice straw, corn cob	<ul style="list-style-type: none"> - Research overview of technology of producing mushrooms from rice straw and corn cob in the world and in Vietnam. - Analyze the current situation of market potential for mushroom production and consumption (size and type of products), production orientations and propose suitable technologies for different forms of mushroom cultivation. - Completing the technological process to produce edible and medicinal mushrooms from rice straw and corn cob at household / farm scale. - Develop pilot models of Ganoderma lucidum, oyster mushroom, button mushrooms production from rice straw and corn cobs according to household / farm scale in Son La, Nam Dinh. - Organize training courses for trainees in the area. - Responsible to the Team Leader for the assigned tasks.
2.	Policy expert	<p>Coordinate with experts, perform the following tasks:</p> <ul style="list-style-type: none"> - Analyze and evaluate the economic efficiency of the

No	Group composition	Tasks are assigned in group
		production model of edible mushrooms and medicinal mushroom from rice straw and corn cob. - Proposing policies related to the production of edible and medicinal mushrooms from rice straw, corn cob to ensure no environmental pollution, etc.
4.	01 supporting expert (agricultural engineer)	Support key experts to record, directly monitor the operation of the Research output 4

5. Expected products and requirements:

1	Overall report on evaluation, proposal and development of appropriate technologies for production of edible and medicinal mushrooms from crop residues (rice straw and corn cob); Recycling uses substrates to produce compost	<ul style="list-style-type: none"> - An overview of international literature, internet literature to identify the technologies used to process rice straw and corn cob for growing mushrooms; technology for producing compost from the substrate after growing mushrooms. - Proposing suitable technology that can be developed in different forms of mushroom cultivation. - Develop suitable technologies for growing mushrooms based on substrates from rice straw and corn cob for different types of mushrooms. - Develop technologies for producing bio-organic fertilizer from used mushroom substrate - Detailed comparative evaluation with technology recommendations tested in factory and field research conditions - Technology cost in Vietnamese conditions
2	Technology inspection report based on workshop research conditions for technologies of producing edible mushrooms, medicinal mushrooms from crop residues (rice straw and corn cob) and recycling substrates for production of bio-	<ul style="list-style-type: none"> - Application of various test forms in factory research conditions used at different substrate scales - Application of various test form in real conditions (in the field) with selected mushrooms (2 types of edible mushrooms, 01 type of medicinal mushroom) - User evaluation and monitoring support for a period of 6 months for technology of producing organic compost from used mushroom substrate (1 site for each province, a total of 2 sites) and 12 months for mushroom growing technology for each selected substrate (3 farms / province, total of 6 sites / 2 provinces) - Recommendation of technology application with technical specifications and design guidelines
3	- Ganoderma cultivation	- The process is simple, easy to apply, using available local materials, suitable for model development in Son La province.

	technological process - Oyster mushroom cultivation technological process	- Scale: 50 tons of substrate / model - Ganoderma yield reaches 25 - 32 kg of dried mushrooms / ton of dry raw material. - The oyster mushroom productivity reaches 600-700kg of fresh mushrooms / ton of dry materials
4	- Technological process of culturing oyster mushroom - Technology process of growing button mushroom	- Simple process, easy to apply, using available local materials, suitable for model development in Nam Dinh province - Scale: 50 tons of substrate / model - Yield of button mushrooms reaches 20-32% (200 - 320kg of mushrooms / ton of rice straw) - The oyster mushroom productivity reaches 600-700kg of fresh mushrooms / ton of dry material
5	Technological process of producing bio-organic compost from substrates after mushroom cultivation	The process is simple, easy to apply and use the material that is the substrate after growing mushrooms; Scale: 10 tons of organic material / production batch.
6	Report on the pilot model of producing edible mushrooms, medicinal mushrooms from rice straw, corn cob and storage; recycling substrates to produce bio-organic compost	- Application of pilot production models of edible and medicinal mushrooms from crop residues (rice straw and corn cob) (50 tons of substrate / site, 02 sites / province, total of 4 sites for 2 provinces). - Applying the pilot model of bio-organic fertilizer production from used mushroom substrate (10 tons of organic fertilizer / site, 2 sites for 02 provinces).

6.1.5. Research output 5: Research on the technology for on-field rice straw decomposition and production of bio-organic fertilizers

1. Works to be undertaken:

Task 1: Overview of technologies to quickly treat rice straw in the field and produce bio-organic fertilizer at different scales.

- Summarize, analyze and evaluate documents outlined fast rice straw processing technologies in the field and gathering for production of bio-organic fertilizer at different scales in the world;

- Summarize, analyze and evaluate documents outlined fast rice straw processing technologies in the field and gathering for production of bio-organic fertilizer at different scales in Vietnam;

- Propose appropriate technology for on-field rice straw fast decomposition and gathering for production of bio-organic fertilizer at different scales in Vietnam

Task 2: Research, propose and finalize the existing technological process to quickly decompose rice straw in the field, meeting production plan for the next crop.

Studying, proposing and completing technological process of on-site fast decomposition of rice straw into the pile form or directly on the surface of the field or on root lining type, using mineral nitrogen activators and micro-probiotics

Task 3: Researching and completing the technology of producing bio-organic fertilizer from rice straw.

- Concentrated processing conditions: Researching, proposing and completing the technological process of fast decomposition of rice straw after collecting by machine, using mineral nitrogen activators and probiotics.

- Researching, proposing and completing technology of producing bio-organic fertilizer from rice straw, with a capacity of 5 tons of raw materials/production batch .

- Assessing the quality of bio-organic fertilizer.

Task 4: Develop a fast decomposition model of rice straw in the field; model of producing bio-organic fertilizer from rice straw in Nam Dinh, Binh Dinh and Tien Giang provinces

- Develop a model for fast decomposing rice straw in the field.

Scale: Farmers; Number of models: 12 sites (2 sites/crop x 2 sites/province x 3 provinces); Quality criteria: Decomposition time is less than 25 days, the decomposition rate reaches over 80%; Scope of application: 1 ha/model/crop.

- Building a model of producing bio-organic fertilizer from rice straw in Son La and Bac Giang.

- Scale: Farmers - farmer group/factory; Type: Concentrated; Number of models: 2 sites (1 site/province x 2 provinces); Scale: 15 tons of organic fertilizer; Quality criteria: Organic content $\geq 20\%$, humic/fulvic acid $\geq 3.5\%$ (for organic fertilizer). organic content $\geq 15\%$. Calculate cost and economic efficiency when applying technology.

- Develop technological process for on-field rice straw fast decomposition and produce bio-organic fertilizer from rice straw.

Task 5: Training technology for on-field rice straw fast decomposition and production of bio-organic compost

Quantity: 03 classes (01 class/province), 20 trainees/class

2. Implementation location: Nam Dinh, Binh Dinh and **Tien Giang:**

3. Scope of implementation: Workshop and actual research conditions at 2 sites for the production of bio-organic fertilizer (one site for each province, in 2 provinces).

4. Composition and structure of the testing group: 03 people are being assigned according to the following table

No	Group composition	Tasks are assigned in group
1.	Expert in charge of processing bio-organic fertilizer from substrate after growing mushrooms, rice straw	<ul style="list-style-type: none"> - Overview of technology for fast processing rice straw in the field and production of bio-organic fertilizer at different scales. - Research, propose and complete the existing technological process to quickly decompose rice straw in the field, meeting the production plan for the next crop. - Research and complete technology for producing bio-organic fertilizer from rice straw. - Building a model for on-field rice straw fast decomposition; Model of producing organic fertilizer from rice straw in Nam Dinh, Binh Dinh and Tien Giang provinces.

No	Group composition	Tasks are assigned in group
	- Leading research on processing bio-organic fertilizer from agricultural residues in both scales (field and concentrated).	- Training on technologies for on-field rice straw fast decomposition and production of bio-organic fertilizer. - Responsible to the Team Leader for the assigned tasks.
2.	Policy expert	Coordinate with experts, perform the following tasks: - Analyze and evaluate the economic efficiency of the model of processing of rice straw and residue after growing mushrooms into bio-organic fertilizer. - Proposing policies related to processing of rice straw and residues after growing mushrooms into bio-organic fertilizer, ensuring no pollution to the environment, etc.
4.	01 supporting expert (agricultural engineer)	Support key experts to record, directly monitor the operation of the Research output 5

5. Expected products and requirements:

1	Review, evaluate, propose and develop appropriate technologies for on-field rice straw fast decomposition	- Ratify the overview of national and international literature and informational interview survey to identify the existing applied technologies to process rice straw in the field after harvesting. - Proposing suitable technology that can be developed to quickly decompose rice straw to meet production plan for the next crop. - Develop technology to fast decompose rice straw to suit the cropping seasons and needs of next crop - Detailed comparative evaluation with technology recommendations tested in factory and field research conditions - Technology cost in Vietnamese conditions
2	Review, evaluate, propose and develop appropriate technology for production of bio-organic fertilizer from rice straw	- Identify existing applied technologies for production of bio-organic fertilizer from rice straw through an overview of international and domestic literature and information interviews. - Proposing suitable technology that can be developed to produce bio-organic fertilizer from rice straw. - Developing technology of producing bio-organic fertilizer from rice straw.

		<ul style="list-style-type: none"> - Detailed comparative evaluation with technology recommendations tested in factory and field research conditions - Technology cost in Vietnamese conditions
3	Technology inspection report based on the testing results of on-field rice straw fast decomposition and production of bio-organic fertilizer	<ul style="list-style-type: none"> - Application of inspection methods in the workshop research conditions on the use of on-field rice straw fast decomposition and the production of bio-organic fertilizer; - Application of actual testing conditions for on-field rice straw fast decomposition (2 sites for the crop, 2 sites for each province, 12 sites for three provinces) and 2 sites for production of bio-organic fertilizer (one site for each province, in 2 provinces); - User evaluation and monitoring support for 6 months on the on-field rice straw fast decomposition and 12 months for the production of bio-organic fertilizer from rice straw. - Recommendation of technology application with technical specifications and design guidelines.
4	Technological process of producing bio-organic fertilizer from rice straw	<ul style="list-style-type: none"> - Simple process, easy to apply and use local materials. - Scale: 15 tons of raw materials / production batch.
5	Process of on-field rice straw fast decomposition	The process is simple, easy to apply, using local materials, suitable for local conditions.

6.1.6. Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologies that link advanced pellets /briquettes, activated coal, biochar production, on-field fast rice straw decomposition and production of bio-organic fertilizer from rice straw

1. Works to be undertaken:

Task 1: Plan a pilot model at each farm site - in the form of a management manual and a draft plan.

- Consult and determine the contents of the management manual and draft plan;
- Completing the compilation of notebook content.

Task 2: Identify geographical areas, target crops and coordinate with units / individuals with expertise and needs to build models of using organic fertilizer or biochar.

- Determination of geographical areas: Priority is given to key areas for rice or vegetable/subsidiary crops production;
- Determining types of crops used in the model: Priority should be given to the rice crops, then vegetables and subsidiary crops;
- Identify the implementation organization/model implementation coordination.

Task 3: Train farmers on quick handling of agricultural residues on-site and concentrate to produce organic compost; Use bio-organic fertilizer or biochar for the

selected crop.

- Quantity: 06 classes, 30 trainees/class.
- Identify the participants of the training.
- Develop a plan and content for the training.
- Identify training methods.
- Organization of evaluation and acceptance.

Task 4: Organization of model deployment

- Establishment of a local executive board and local steering committee;
- Contract signing, site survey, farmer households participating in the model;
- Select the location, farmer households and commitment to implementation;
- Model building: Deploying pilot model;

Scale: 2 ha/site, 1 site/province; Type of crop: Wet rice/ vegetable/ subsidiary crops).

Form of use: Using a mixture of biochar and bio-organic composting.

- Organizing the review, evaluation and pre-acceptance of activities in the demonstration model.

Task: Model visits/study tour

- On-site visits, seminars: 02 visits - seminars/ model site; An analysis of the awareness of potential users about the technology system based on self-assessment analysis of training/survey participants; An evaluation of technology replication demand. Quantity: 40 people / event.

- Propagating the results of model building: 02 articles to be broadcast on the radio - television system or published in local newspapers

2. Implementation location: Nam Dinh, Binh Dinh and Tien Giang:

3. Scope of implementation: Scale: 2ha/site/type of fertilizer;

- Target crops: Wet rice / vegetable /subsidiary crops).
 - Locations comply with research results of research outputs 2, 4, 6
- Specifically: Application model of bio-organic fertilizer.

+ Model of bio-organic fertilizer production of research output 5 in Son La and Nam Dinh provinces will use organic fertilizer to build a fertilizer application model for vegetables in the two above provinces.

+ Model of rice straw chopping and fast dissolving in the field into fertilizer applied to 3 regions (3 representative provinces). Tien Giang and Nam Dinh will apply to the rice model, in Binh Dinh will apply to the bitter melon model.

- Aggregate system is being tested and piloted at different farm / household scales.
- Awareness raising for stakeholders and at least 02 study tours at each pilot site.

4. Composition and structure of the testing group: 03 people are being assigned according to the following table

No	Group composition	Tasks are assigned in group
1	Experts develop model	Evaluate the efficiency of bio-organic fertilizer produced from spent substrate after mushroom production and rice straw on

No	Group composition	Tasks are assigned in group
	to evaluate the effectiveness of bio-organic fertilizer on rice and vegetables	rice and vegetables
2	Policy expert	Coordinate with experts, perform the following tasks: - Analyze and evaluate the economic efficiency of the model using bio-organic fertilizer on rice and vegetables. - Propose policies related to the use of bio-organic fertilizer in sustainable agricultural production
3	01 supporting expert (agricultural engineer)	Support key experts to record, directly monitor the operation of the Research output 6

5. Expected products and requirements:

1	Plan to build a pilot model at each farm site - in the form of a management manual and a draft plan	Identify: - Responsibilities of LCASP project, consultant and property owner and manager, - Ownership of equipment and maintenance of equipment; - Allocating costs; - Scale and scope of liability related to the pilot model;
2	Agreement on site for construction of pilot model signed by each province (3 ecological regions)	Confirm the detailed terms in the site management manual including location access, awareness raising, data monitoring
3	Detailed monitoring report	Identify: - Technology performance standards in the context of a farm system; - A financial evaluation of the overall adoption of the farm system including capital costs, operating costs and added benefits; - An assessment of environmental benefits including rice straw processing and in case of without technology;
4	Report analyzes the perceptions of potential users about the technology system.	- Self-assessment analysis of training/survey participants. - A need assessment of technology replication.
5	Trial models	10 models (10 provinces); 1 site / model / province; Scale: 02 ha/province piloting the use of organic

		<p>materials (compost and biochar) for soil carbon accumulation and as fertilizer for crops.</p> <p>Models that help restore fertilizer balance for crops by combining bio-organic / microbiological organic fertilizers from newly developed products.</p> <p>Models do not reduce soil quality (stabilizing soil organic matter).</p> <p>The models to be tested and accepted according to the signed agreement. Ensure a minimum productivity of 62 - 63 quintals / ha when applying a 15-20% reduction in the amount of NPK.</p> <p>There are monitoring reports on the model building process</p>
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6.1.7. Research output 7: Policy recommendations for the uptake of crop residues (rice straw and corn stover) recycling

1. Works to be undertaken:

Task 1: Develop an overview report on national target policies, sectoral level policies related to recycling of rice straw and corn cob.

Task 2: Research to identify goals and propose policies to achieve the goals of reusing rice straw and corn cob.

- Assess the current situation and existing use of crop residues in Vietnam and in the world;

- Legal basis and sanctions related to the existing policies of using crop residues;

- Identify favorable and difficult conditions in the implementation of existing policies on the use of crop residues.

- Proposing appropriate goals, policies and standards for recycling of rice straw and corn cob in Vietnam based on the trend of agricultural production, scientific and technological level in the world.

Task 3: Organize workshops:

- Obtaining critical comments for proposals on national and sectoral policies in support and development to improve the efficiency of using crop residues by value chains;

- Identify participants in the policy consultation workshop: Farmers' households, local authorities, PPMUs and stakeholders;

- Develop a plan and content of a policy consultation workshop;

- Provincial policy consultation workshop: Quantity: 10 events. Participants: Farmers, local authorities, PPMUs and stakeholders. Number of attendees: 40 people. Number of day: 01 day / event.

- Regional / national consultation workshop: Quantity: 03 events. Participants: Farmer households, local authorities; PPMU and stakeholders. Number of attendees: 50 people. Number of day: 02 days /event.

- Final consultation workshop: Quantity: 01 event. Participants: Farmers, local authorities, PPMUs and stakeholders. Number of attendees: 100 people. Number of day:

02 days / event.

Task 4: Revise, finalize and publish the draft policy to state management agencies.

- Revise, finalize and publish draft national and sectoral policies in support for development and improvement of the value chain of crop residues and submit to state management agencies;

- Proposing draft national and sectoral policies to support and develop the efficiency of using crop residues by value chains, and submit to the State management agencies.

2. Implementation location: Provinces involved in implementation of 6 above research outputs.

3. Scope of implementation: Policy studies at provincial level (typical) in selected provinces; National policies.

4. Composition and structure of the testing group: 03 people are being assigned according to the following table:

No	Group composition	Tasks are assigned in group
1	Expert on policy analysis (economics) on water environment. To be in charge of drafting national and sectoral policies in supporting and developing the improvement of the effective value chain of crop residues by value chain	Policy analysis on the crop residues recycling (rice straw, corn cob) in Vietnam and the world; Lessons learned and recommendations for Vietnam. Draft national and sectoral policies to support and develop the effective value chain of crop residues by value chain - Host workshops and write reports.
2	Policy expert	Coordinate with experts, perform the following tasks: - Analyzing policies on crop residues recycling. Propose policies related to the use of crop residues in sustainable agricultural production.
3	01 supporting expert (agricultural engineer)	Support key experts to record, directly monitor the operation of the Research output 7

5. Expected products and requirements:

1	Overview of national target policies and sector-level target policies related to recycle of rice straw and corn cob	<ul style="list-style-type: none">- Overview of available technologies on recycle of crop residues, including field treatment, fuel pellets /briquettes, activated coal, biochar, bio-compost, animal feed , and mushroom cultivation, the state of the industry in relation to targeted policies.- Assess future goals and the strategies that can be achieved.- Assess the relationship between environmental, energy, agriculture and rural development goals, including external impacts and constraints on the goal of reusing crop residues.
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2	Workshop on recycle of crop residues for related partners, including policy proposals to identify gaps and develop consensus policy goals for 2025-2030 period	Identify the actors involved in recycling crop residues to identify policy gaps and policy recommendations for period 2025 and 2030.
3	Policy options	<ul style="list-style-type: none"> - To sum up and propose policies and measures to encourage technology application, including: - Awareness raising; - Compliance regulations and strategies; - Market-based approach compared to the use of incentives and grants; - Sectoral financing options through credit lines, carbon-based financial support and green economy funds; - Sector management responsibilities from the State, provincial, private sector and National programs
4	A draft policy document in the field of crop residues recycling	Draft policy documents in the field of crop residues recycling and submit to MARD for approval.

6.2. Methods of implementation

6.2.1. Document research

This activity is basically carried out from the beginning and will be further studied in the implementation process. The implementation team collects documents and data related to the project research topic. Summarizing and updating research materials and data enableréarch team to find gaps, missing in previous studies that have not been solved or studies that have been successful but not yet applied or needed to be improved for effective application in practice. Based on the research results on the relevant issues of the project on effective utilization of rice straw by the value chain will help to better orient the contents and tasks to be performed.

Conducting analysis and re-processing datasets focusing on specific contents of the project, helping the implementation team inherit the existing research results to solve the project issues.

6.2.2. Other research methods

Combination of research methods to synchronously and logically perform the operations. Methods such as: Methods of economic statistics, historical methods, comparative and quantitative methods; method of policy analysis; SWOT analysis method (strengths - S, weaknesses - W, opportunities - O, challenges - T); Sociological, economical, environmental and organizational methods; method of desk study, special attention is given on:

- Methods of collecting and assessing information.
- Case study method.
- Expert methodology (Delphi) and analytical method.

- Methods of investigation and sociological interviews (questionnaires, in-depth interviews).
- Methods of field research.
- Methods of aggregating and processing data

6.2.3. Investigation/Survey

a) Field survey and assessment of technology of rice straw collection and processing, use of fuel pellets/briquettes, activated coal, biochar, bio-organic fertilizer, animal feed, mushroom growing at 10 provinces implemented LCASP's project to select 5 provinces to implement the research project:

i) Contents of investigation and survey:

Overview of rice straw / corn cob use.

- Situation of using rice straw, what is % of use? Economic efficiency?
- What is the situation of using corn cob, % of use? Economic efficiency?

Method of collecting rice straw / corn cob.

- Collect by machine: (Collection efficiency, how many %) what is used purpose?

Economic efficiency (how much VND / ha), environmental efficiency, etc.,

- Manual collection: (Collection efficiency, how many %), what is used purpose?

Economic efficiency (how much VND / ha), environmental efficiency, etc.,

- Field burning: Economic efficiency, environmental efficiency, etc.,
- Leaving in the field: Economic efficiency

Technology to process rice straws / corn cob as animal feed.

- Is rice straw used as animal feed? How to use? Economic efficiency,
- Is corn cob used as animal feed? How to use? Economic efficiency,
- If not? what is use purpose? Economic efficiency?

Technology for processing of rice straw / stubble/corn cob into biochar

- Is corn cob used for processing biochar? How to use? Economic efficiency,
- Is rice straw used for processing biochar? How to use? Economic efficiency,
- If not? what is use purpose? Economic efficiency?

Other rice straw / corn con processing technologies

- How many rice straw processing technologies, what is efficiency (%), what is the end product of the technology? What is used purpose? What is effective?

- How many corn cob processing technologies, what is efficiency (%), what is the end product of the technology? What is used purpose? What is effective?

Technology for growing mushrooms from rice straw / corn cob.

- Is rice straw used for mushroom cultivation? How many % ?, what type of mushroom to be grown? Economic efficiency?

- Is corn cob used for mushroom cultivation? How many % ?, what type of mushroom to be grown? Economic efficiency?

- If not? what is use purpose? Economic efficiency?

Technology for producing organic compost from used mushroom substrate.

- Is used mushroom substrate used to produce organic compost? How many % ?

Economic efficiency?

If not, why? what is use purpose? Economic efficiency?

Technology for producing organic compost from rice straw/corn cob.

- Is rice straw used to produce organic compost? How many %? Economic efficiency?

- Is corn cob used to produce organic compost? How many %? Economic efficiency?.

If not, why? what is use purpose? Economic efficiency?

ii) Conclusion:

- General assessment of the use of rice straw and corn cob in the surveyed province,

- Proposing solutions:

- + What technology is used? What are advantages?

- + Economic efficiency? Environmental efficiency? Social efficiency?

6.2.4. Proposal of technology to be implemented in the Package

- Proposed technologies suitable to the conditions of the project area or project province,

- Technology with economic, social and environmental efficiency.

PART VII

RESOURCES MOBILIZATION AND UPDATED WORK PLANNING

7.1. Resources mobilization

7.1.1. Consultancy unit implementing activities

a. Key consultancy unit:

The agency in charge of consulting is the Research Institute of Agriculture and Rural Planning, under the Vietnam Union of Science and Technology Associations, the Institute is located at 147 Nguyen An Ninh Street, Dong Tam Ward, Hai Ba Trung, Hanoi. Institute has much experience in organizing, implementing consultancy tasks, scientific and technological projects managed by MARD and non-governmental organizations. The Institute has facilities, staff and the ability to mobilize experts, scientists to participate in general consulting tasks and Package No. 28- Research on effective utilization of crop waste by value chain in particular. The Institute is responsible for leading and organizing the implementation of all project activities from the beginning to the end. The Director is responsible to the Laws of Vietnam and the Director of Low Carbon Agriculture Support Project - LCASP for the results of the work package.

b. Main coordinating units: Provincial Project Management Units of Low Carbon Agriculture Support Project in Ben Tre, Soc Trang, Tien Giang, Binh Dinh, Ha Tinh, Nam Dinh, Bac Giang, Phu Tho, Son La and Lao Cai.

7.1.2. Manpower involved in implementing the Package

The contractor mobilizes an expert teams includes 7 key experts who will work for 59 months, International consultants will work for 4.5 months and non-key specialists

work for 113 months during a period of 13 months. The team will work at the office of the Research Institute of Agriculture and Rural Planning in Hanoi.

Experienced professionals are contracted to the required positions. Experts are highly qualified in the sector, experienced in monitoring, evaluation and suitable for technical cooperation projects, meeting TOR standards signed in contract for major contents.

The composition of the expert team is determined and proposed as follows::

List of key experts

No	Name	Mission	Organization	Contact
1	Ass.Prof. Dr. Le Nhu Kieu,	Team Leader; leader of crop residues researching team	Research institute of Agriculture and Rural planning	Tel: 0903203767 Email: lenhukieusfri@gmail.com
2	Dr. Raj Kumar	Associate consultant, international consultant on assessment of organic recycling technology	Indian expert	Tel: +91 9956296804 Email: rajkumar76@gmail.com
3	Dr. Nguyen Duc Cuong	Key expert on renewable energy	Research institute of Agriculture and Rural planning	
4	MsC. Nguyen Viet Hai	Key expert on animal nutrition	Research institute of Agriculture and Rural planning	Tel: 0912.260.263 Email: hainv.khcn@mard.gov.vn ;
5	Dr. Nguyen Thi Bich Thuy	Key expert on edible and medicinal mushrooms cultivation	Research institute of Agriculture and Rural planning	Tel: 01679171187 Email: Thuy_chat@yahoo.com.vn
6	MsC. Nguyen Viet Hiep	Key expert on bio-organic fertilizer processing	Research institute of Agriculture and Rural planning	Tel: 0904676113 Email: nvhiepnisf@gmail.com
7	Dr. Nguyen Dnh Long	Expert on Policy Analysis (economics) on water environment	Research institute of Agriculture and Rural planning	Tel: 0903222629 Email: dinhlong1951@yahoo.com

Supporting specialists

No	Name	Position	Organization	Contact
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8	Dr. Dau The Nhu/ Engineer Ha Thu Thuy	Supporting specialist, in charge of developing rice straw collection technology in the field	Research institute of Agriculture and Rural planning	- Email: thuy286@gmail.co m /Tel: 01649779081 - Email: dauthenhu@yahoo. com Tel: 0912293006
9	Eng. Tran Thi Mong Kha	Supporting specialist on renewable energy	Research institute of Agriculture and Rural planning	No: 0125000222 Email: dotatthuy@gmail.c om
10	MsC. Nguyen Van Ga/ Eng. Nguyen Le Thuc Anh	Supporting specialist on animal nutrition	Research institute of Agriculture and Rural planning	- Tel: 0913382072 - Email: nvga73@gmail.co m /
11	Dr. Ngo Xuan Nghien / Engineer Vu Thanh Dong	Supporting specialist in edible and medicinal mushrooms cultivation	Research institute of Agriculture and Rural planning	Tel: 0912397476 Email:xuannghien2 006@yahoo.com
12	MsC Tran Thi Lua / Eng. Dang Thuong Thao	Supporting specialist on processing / assessing quality of bio-organic fertilizer	Research institute of Agriculture and Rural planning	Email: luanisf@yahoo.co m Tel: 01233036027
13	MsC. Dam The Chien/ Eng. Nguyen Thi Ngoc Thuy	Specialist in formulating / supervising models in Lao Cai / Phu Tho	Research institute of Agriculture and Rural planning	Email: dtchien78@yahoo. com.vn Tel: 0982237221
14	MsC. Truong Thi Duyen/ Eng. Ngo Thi Be	Specialist in formulating / supervising models in Son La	Research institute of Agriculture and Rural planning	Tel: 01678449969 Email: duyenprc@gmail.c om
15	MsC. Dinh Vo Sy/ Eng. Ngo Duy Tung	Specialist in formulating / supervising models in Nam Dinh/Bac Giang	Research institute of Agriculture and Rural planning	Tel: 0982712229 Email: dinhvosy@gmail.c om

16	MsC Lam Van Ha/Eng. Dam Thi Hai Yen	Specialist in formulating / supervising models in Soc Trang/Ben Tre	Research institute of Agriculture and Rural planning	Tel: 0943910278 Email: lamvanha77@yahoo.com.vn
17	MsC. Le Truong Binh/ Eng. Tran Dai Thang	Specialist in formulating / supervising models in Tien Giang/Binh Dinh	Research institute of Agriculture and Rural planning	Tel: 0983225265 Email: lbtcp@yahoo.com
18	Engineer Nguyen Thi Nhai	Supporting experts on model demonstration; In charge of models demonstration Son La, Lao Cai	Research institute of Agriculture and Rural planning	Tel: 0983567102 Email: son79solgen@yahoo.com.vn
19	Dr. Nguyen Vo Linh	Supporting expert on Policy analysis (economic) on water environment	Research institute of Agriculture and Rural planning	Email: volinh@gmail.com Tel: 0912082000

Main contact point for technical issues of this project is Assoc. Prof.Dr. Le Nhu Kieu, Team Leader. Main contact point for the contract between the contractor consortium and CPMU is Mr. Nguyen Van Toan, Director of the Research institute of Agriculture and Rural planning.

7.1.3. Facilities and supporting staff

In the framework of implementing Package 28, the Contractor prepares 01 office with size of 60 m² at headquarter of Institute, No. 147 Nguyen An Ninh street, Dong Tam ward, Hai Ba Trung, Hanoi and necessary equipment (computer, internet, ...) for professionals with the best working conditions for the assigned work.

The contractor also collaborates with research institutes such as Institute of Soil and Fertilizer, Institute of Animal Husbandry, Vietnam Academy of Agriculture, Institute of Agricultural Mechanics and Post-harvest Technology to implement the contents, the Institute has assigned supports staff as follows:

No	Name	Position	Organization	Contact
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1	Dr. Tran Thi Dinh	In charge of Administrative	Research institute of Agriculture and Rural planning	Tel: 0987496636 Email: tranthidinh5@gmail.com
2	MsC Le Thi Huong	Accountant	Research institute of Agriculture and Rural planning	Tel: 0945353946 Email:
3	Bachelor Nguyen Linh Phuong	Interpreter	Research institute of Agriculture and Rural planning	Tel: 0948380189; Email: linhphuongcva@gmail.com

7.2. Working regulations and management partners

After signing contracts with experts, the Institute has developed and issued working regulations for experts and assigned supporting staff, specifically as follows:

7.2.1. Working regulations

Details are in Annex 1), which specifies:

- Develop a monthly work plan (details in Appendix 2);
- Monthly work report (details in Appendix 3);
- Be responsible to the Director for the content of work and the working time recorded in the expert's timesheet (details in Appendix 4);

7.2.2. Updated implementation schedule

Position, missions and input of key experts

No	Name, nationality and year of birth	Expert input (manmonth) for each deliverable (listed in Tech 5)								Total time input (manmonth)		
		Position		D-1	D-2	D-3	D-4	D-5	D-6	Office	Field	Total
K1	Le Nhu Kieu	Team Leader; Crop residues processing	Office	0.4	1	0.5	1	0.5	0.5	3.9		13
			Field		2.3	1.5	2	1.5	1.8		9.1	
K2	Raj Kumar, India, 1976	Associate consultant, Assessment of organic recycling technology	Office	-	-	-	-	-	-	0		6
			Field		2	1	1.5	1	0.5		6	
	Nguyen Duc Cuong, Viet Nam, 1956	Key expert on renewable energy	Office	0.5	0.5	0.5	0.5	0.5	0.5	3		10
			Field	-	1	1	3	-	2		7	
K3	Nguyen Viet Hai, Viet Nam, 1953	Key expert on animal nutrition	Office	0.5	0.5	0.5	0.5	0.5	0.5	3		10
			Field	-	1	1	3	-	2		7	
K4	Nguyen Thi Bich Thuy Viet Nam 1972	Key expert in growing edible and medicinal mushrooms	Office	0.2	0.5	0.5	0.5	0.3	0.4	2.4		8
			Field	-	1	1	1	0.5	2.1		5.6	
K5	Nguyen Viet Hiep, Viet Nam, 1978	Key expert on processing organic fertilizer	Office	0.5	0.5	0.5	0.5	0.5	0.5	3		10
			Field	-	1	1	3	-	2		7	
K6	Nguyen Dinh Long, Viet Nam, 1951	Expert on Policy Analysis (economics) on water environment Chuyên gia về	Office	0.2	0.5	0.5		0.3	0.3	1.8		6
			Field	-	1			2.7	0.5		4.2	

N1	Dau The Nhu	Supporting specialist, in charge of developing rice straw collection technology in the field	Office	0.2	0.2	0.2	0.5	0.2	0.2	1.5		2
			Field	-	-	-	0.5	-	-		0.5	
N2	Ha Thu Thuy	Supporting specialist, in charge of developing rice straw collection technology in the field	Office	0.5	0.5	0.2	1	0.5	0.8	3.5		13
			Field	-	1.5	2	4.5	0.5	1		9.5	
N3	Do Tat Thuy	Supporting specialist on renewable energy	Office	0.5	0.5	0.5	0.5	0.5	0.5	3		10
			Field	-	1	1	3	-	2		7	
N4	Nguyen Van Ga	Supporting specialist on animal nutrition, project coordinator	Water	0.2	0.2	0.2	0.5	0.2	0.2	1.5		2
			Field	-	-	-	0.5	-	-		0.5	
N5	Nguyen Le Thuc Anh	Supporting specialist on animal nutrition	Water		0.2	0.2	1	0.2	0.4	2		8
			Field	-	0.5	1	2	0.5	2		6	
N6	Ngo Xuan Nghien	Supporting specialist in edible and medicinal mushrooms cultivation	Office	0.2	0.2	0.2	0.5	0.2	0.2	1.5		2
			Field	-	-	-	0.5	-	-		0.5	
N7	Vu Thanh Dong	Supporting specialist in edible and medicinal mushrooms cultivation	Office	0	0.2	0.2	-	-	0.2	0.6		6
			Field	-	0.4	1	2	-	2		5.4	
N8	Tran Thi Lua	Supporting specialist on processing / assessing quality of bio-organic fertilizer	Office	0.2	0.2	0.2	0.5	0.2	0.2	1.5		2
			Field	-	-	-	0.5	-	-		0.5	
N9	Dang Thuong Thao	Supporting specialist on processing / assessing quality of bio-organic fertilizer	Office		0.2	0.2	1	0.2	0.4	2		8
			Field	-	0.5	1	2	0.5	2		6	
N10			Office		0.2	0.2			0.4	0.8		6

	Nguyen Thi Ngoc Thuy	Specialist in formulating / supervising models in Lao Cai / Phu Tho	Field	-	0.2	1	2		2		5.2	
N11	Ngo Thi Be	Specialist in formulating / supervising models in Son La	Water		0.2	0.2			0.4	0.8		6
			Field	-	0.2	1	2		2		5.2	
N12	Ngo Duy Tung	Specialist in formulating / supervising models in Nam Dinh/Bac Giang	Office		0.2	0.2			0.4	0.8	0.8	6
			Field	-	0.2	1	2		2	5.2	5.2	
N13	Dam Thi Hai Yen	Specialist in formulating / supervising models in Soc Trang/Ben Tre	Office		0.2	0.2			0.4	0.8		6
			Field	-	0.2	1	2		2		5.2	
N14	Tran Dai Thang	Specialist in formulating / supervising models in Tien Giang/Binh Dinh	Office		0.2	0.2			0.4	0.8		6
			Field	-	0.2	1	2		2		5.2	
N15	Nguyen Thi Nhai	Supporting experts on model demonstration;	Office		0.2	0.2			0.4	0.8		6
			Field	-	0.2	1	2		2		5.2	
N16	Nguyen Vo Linh	Supporting expert on Policy analysis (economic) on water environment	Office		0.2	0.2			0.4	0.8		0.8
			Field									
N17	Tran Thi Dinh	In charge of Administrative	Office									
			Field									
N18	Nguyen Linh Phuong	Interpreter	Office									
			Field									

WORKING SCHEDULE AND PLANNING FOR DELIVERABLES

No	Activities	Months												
		2018							2019					
		1	2	3	4	5	6	7	8	9	10	11	12	13
D1	Inception report and updates of detailed implementation plan (Detailed research proposal)	1-30												
	Prepare documents and data	1-10												
	Prepare draft report	11-25												
	Edit the report	25-28												
	Delivery of report to the client	29-30												
	Approved by the client	30												
D2	Technology review and identification reports	1-30	1-30	1-30										
D2-1	Methods and technology for collection and preliminary processing of crop residues													
	Collecting and researching materials on collection and preliminary processing of crop residues for different uses in Vietnam and in the world.	1-20												
	Field survey of existing methods and technologies on rice straw collection and processing for different uses in Vietnam	21-30	1-10											
	Selecting suitable technology options and solutions suitable to Vietnamese conditions.		11-25											
	Formulating, proposing process, testing methods, monitoring and evaluation.		26-30	1-10										
	Delivery of report to the client			11-15										
	Approved by the client			16-30										
D2-2	Technologies of fuel pellets /briquettes, activated coal and biochar produced from rice straw													
	Collecting and researching materials on the technology of producing fuel pellets / briquettes, activated coal and biochar from rice straw in Vietnam and in the world.	1-20												

	Field surveys of key preferred technologies.	21-30	1-10											
	Select options and solutions for technology development to be suitable to Vietnamese conditions		11-25											
	Building, proposing process, testing methods, monitoring and evaluation.		26-30	1-10										
	Delivery of report to the client			11-15										
	Approved by the client			16-30										
D2-3	Technology for animal feed production from crop residues (rice straw and corn cob) and storage													
	Collecting and studying materials on technology for producing feed for livestock from crop residues (rice straw and corn cob) and storage in Vietnam in the world.	1-20												
	Investigate existing technologies on animal feed production from crop residues (rice straw and corn cob) and storage	21-30	1-10											
	Recommend appropriate technologies applicable for development in different weather conditions		11-25											
	Develop a report to evaluate and identify technology and economic efficiency in Vietnamese conditions		26-30	1-10										
	Delivery of report to the client			11-15										
	Approved by the client			16-30										
D2-4	Technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and reusing substrates to produce bio-organic fertilizer													
	Overview of international literature, internet literature to identify technologies used to process rice straw and corncobs for used mushroom substrate and technology for the production of organic compost from the substrate after growing mushrooms .	1-20												

	Investigate existing technologies for production of edible and medicinal mushrooms from crop residues (rice straw and corn cob) and use of substrates to produce bio-organic fertilizer	21-30	1-10											
	Recommend appropriate technology can be developed in different forms of mushroom cultivation and the technology of producing bio-organic fertilizer from used mushroom substrate		11-25											
	Develop a report to evaluate and identify technology and economic efficiency in Vietnamese conditions		26-30	1-10										
	Delivery of report to the client			11-15										
	Approved by the client			16-30										
D2-5	On-field rice straw fast decomposition and production of bio-organic fertilizer from rice straw and from used mushroom substrate													
	Literature review of technology to fast decompose rice straw in the field and produce bio-organic fertilizer	1-20												
	Investigate existing technologies on on-field rice straw fast decomposition and production of bio-organic fertilizer	21-30	1-10											
	Recommend appropriate technology applicable for development of rice straw fast decomposition to meet the production plan for the next crop		11-25											
	Develop a report to evaluate and identify technology and economic efficiency in Vietnamese conditions		26-30	1-10										
	Delivery of report to the client			11-15										
	Approved by the client			16-30										
D2-6	Project progress report													
	Prepare documents and data			1-10										
	Prepare draft report			11-20										

	Edit and complete the report			20-25										
	Delivery of report to the client			26-29										
	Approved by the client			30										
D3	Updated and detailed pilot site management plan and supporting arrangements - 1 per proposed site	1-30	1-30	1-30	1-30	1-30	1-30							
	Draft a plan to deploy testing models and supporting agreement.		1-30	1-30										
	Work with PPMU to select locations and technologies to implement the model				1-30									
	Develop a detailed and updated model management plan with support arrangements for the pilot sites					1-30								
	Provide draft implementation plan of testing models and supporting agreement minutes for client.						1-15							
	Approved by the client						16-30							
D4	Technology design, production and assessment report based on workshop and field testing	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30				
D2-1	Methods of collection and preliminary processing of crop residues													
	Test in the workshop		1-30	1-15										
	Test in the field			16-30	1-30	1-30								
	Evaluate product quality, economic efficiency, social, and environmental effects of the proposed technology						1-30							
	Develop technology report							1-30						
	Deliver technology assessment report to client								1-30					
	Approved by the client									1-30				
D4-2	Technology of fuel pellets/briquettes, activated coal and biochar produced from rice straw													
	Test in the workshop		1-30	1-30										
	Test in the field			16-30	1-30	1-30								
	Evaluate product quality, economic efficiency, social, and environmental effects of the proposed technology						1-30							

	Develop technology report							1-30						
	Deliver technology assessment report to client								1-30					
	Approved by the client									1-30				
D4-3	Technology for animal feed production from crop residues (rice straw and corn cob) and storage													
	Test in the workshop		1-30	1-30										
	Test in the field			16-30	1-30	1-30								
	Evaluate product quality, economic efficiency, social, and environmental effects of the proposed technology						1-30							
	Develop technology report							1-30						
	Deliver technology assessment report to client								1-30					
	Approved by the client									1-30				
D4-4	Technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and reusing substrates to produce bio-organic fertilizer													
	Test in the workshop		1-30	1-30										
	Test in the field			16-30	1-30	1-30								
	Evaluate product quality, economic efficiency, social, and environmental effects of the proposed technology						1-30							
	Develop technology report							1-30						
	Deliver technology assessment report to client								1-30					
	Approved by the client									1-30				
D5-5	On-field rice straw fast decomposition and producing bio-organic fertilizer from rice straw and from used mushroom substrate													
	Test in the workshop		1-30	1-30										
	Test in the field			16-30	1-30	1-30								
	Evaluate product quality, economic efficiency, social, and environmental effects of the proposed technology						1-30							
	Develop technology report							1-30						

	Deliver technology assessment report to client								1-30					
	Approved by the client									1-30				
D4-6	Project progress report													
	Prepare documents and data									1-10				
	Prepare draft report									11-20				
	Edit and complete the report									20-25				
	Delivery of report to the client									26-29				
	Approved by the client									30				
D5	Formulate testing models			1-30	1-30	1-30	1-30	1-30	1-30	1-30	15-30	15-30	15-30	1-30
	Develop training materials, technical instructions, monitoring and evaluation of indicators at the model.			1-30										
	Training for farmers				1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30
	Deploy the models				1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30
	Model monitoring and evaluation				1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30
	Field survey, technology assessment				1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30
	Model summary report													30
D6	Crop residues recycling technologies Policy Draft Repor(rice straw and corn stover, corn cobs)	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30	1-30
	Collecting policy documents related to the future crop residues recycling (rice straw and corn stovers, corn cob) in Vietnam and in the world.	1-30	1-30											
	Survey and evaluate the current policies related to the crop residues recycling in the future (rice straw and corn stovers, corn cobs)	1-30	1-30											
	Propose new policy to promote future crop residues recycling (rice straw and corn stovers, corn cobs)			1-30	1-30	1-30								
	Workshops/seminars						1-30	1-30	1-30	1-30				
	Develop policy report										1-30	1-20		
	Delivery of report to the client											21-30		
	Approved by the client												1-30	

D7	Research completion report													
	Prepare documents and data													1-10
	Prepare draft report													11-20
	Edit and complete the report													20-25
	Delivery of report to the client													26-29
	Approved by the client													30

PART VIII

PROPOSAL

8.1. Support from LCASP Central Project Management Unit

We perceive that LCASP is a large and long-term project, requiring effective coordination between stakeholders to ensure the achievement of goals. Therefore, we suggest that there should be regular technical meetings and updates between the Consultant, CPMU and other stakeholders (PPMU, other consultants) to discuss difficulties and issues and propose solutions to ensure smooth research implementation.

We also expect the CPMU to facilitate a coordination mechanism between the consultant and stakeholders. This mechanism should be discussed and agreed upon by all parties during the start-up of consultancy service. We understand that timely communication and information sharing through the Team Leader and Deputy Team Leader are important factors for the success of the consulting service.

8.2. Support from PPMU and local authorities, local people

In case additional data from other sources is required, we expect that CPMU and PPMU will send letters and request forms to provide necessary data information. We also need the support of PPMU in the survey activities, selecting the applicable model.

APPENDIX 1. WORKING PRINCIPLES FOR SPECIALISTS AND ASSIGNMENT OF SUPPORTING STAFF

**VIETNAM UNION OF SCIENCE AND
TECHNOLOGY ASSOCIATIONS**
Research Institute of Agriculture and Rural
Planning

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

Ha Noi, date, 2018

RULES ON WORKING OF EXPERTS AND ASSIGNMENT OF SUPPORTING STAFF

Package 28: Research on effective utilization of crop waste by value chain

To effectively implement the project management work, experts and support staff (attached appendix) are required to implement the expert management method as follows:

1. Experts and supporting staff must work and closely coordinate with each other.
2. Monthly, there should be a brief report to the Director on the content of the consultant's work for that month and coordinate with the Team Leader to develop the proposed agenda and work plan for the following month.
3. To be responsible to the Director for the work content and working time recorded in the expert's timesheet.
4. All arising issues should be reported to the director immediately for timely handling.

TEAM LEADER

DIRECTOR

Le Nhu Kieu

Nguyen Van Toan

APPENDIX 2. MONTHLY PLAN

DỰ ÁN HỖ TRỢ NÔNG NGHIỆP CÁC BÓN THẤP/ LOW CARBON AGRICULTURAL SUPPORT PROJECT

Gói 28: Nghiên cứu sử dụng hiệu quả phế phụ phẩm trồng trọt theo chuỗi giá trị

Package 28: *Research on effective utilization of crop waste by value chain*

Tên chuyên gia/ Expert's Name	Vị trí/Position	Ngày/date

KẾ HOẠCH CHUYÊN GIA THÁNG ... NĂM 201... (Expert Plan of.....)

TT (No.)	Mô tả hoạt động/Activities	Thời gian dự kiến/ Estimated time	Địa điểm/ Location	Kết quả mong đợi/ Expected results

Người lập/ Prepared by
(Chuyên gia/Expert)

Phê duyệt/Approved by
(*Tư vấn trưởng/Team Leader*)

Phê duyệt/ Approved by
(*Giám đốc công ty/Company
director*)

APPENDIX 3. MONTHLY REPORT

DỰ ÁN HỖ TRỢ NÔNG NGHIỆP CÁC BÓN THẤP/ LOW CARBON AGRICULTURAL SUPPORT PROJECT

Gói 28: Nghiên cứu sử dụng hiệu quả phế phụ phẩm trồng trọt theo chuỗi giá trị

Package 28: Research on effective utilization of crop waste by value chain

Báo cáo số/Report number	Tháng/Month	Năm/Year

Tên chuyên gia/Expert's name	Vị trí/Position	Ngày/date

BÁO CÁO THÁNG ... NĂM 201.../REPORT.....

TT	Mô tả hoạt động theo TOR/ Description of activity according to TOR	Kết quả mong đợi/ Expected results	Kết quả đạt được/ Achievement

Signature of the expert

Signature of Team Leader

APPENDIX 4. TIMESHEET

<div>DỰ ÁN HỖ TRỢ NÔNG NGHIỆP CÁC BON THẤP/ LOW CARBON AGRICULTURAL SUPPORT PROJECT</div> <div>Gói 28: Nghiên cứu sử dụng hiệu quả phế phụ phẩm trồng trọt theo chuỗi giá trị</div> <div>Package 28: <i>Research on effective utilization of crop waste by value chain</i></div>			
Tên chuyên gia/Expert's Name		Vị trí/Position	Ngày/date
BẢNG CHẤM CÔNG THÁNG ... NĂM 201.../TIMESHEET			
Ngày/ Date	Địa điểm làm việc/Location	Ngày công/Workday	Công việc/Activities
1			
2			
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30			
31			
Tổng/Total			
<p><i>Tổng số ngày làm việc của chuyên gia/Summary of Consultant's Inputs as per contract</i></p> <p>Tổng số ngày công/Total inputs as per contract: ngày/days</p> <p>Số ngày công tháng trước/Previous inputs billed: ngày/days</p> <p>Số ngày công tháng này/Inputs billed this month: ngày/days</p> <p>Tổng số ngày công đến nay/Inputs to date: ngày/days</p> <p><i>Còn lại/Balance:</i> ngày/days</p>			

Người lập/ Prepared by

Phê duyệt/Approved by

(Chuyên gia/Expert)

(Tư vấn trưởng/Team Leader)

Ngày/Date:

Ngày/Date:

Phê duyệt/ Approved by

(Giám đốc công ty/Company director)

Ngày/Date:

APPENDIX 5. EXPECTED SCIENCE AND TECHNOLOGY PRODUCTS OF THE PACKAGE

Main S&T products of the Package and quality requirements						
Type I:						
No	Specific product name and major quality criteria of the product	Measur ement unit	Quality level			Expected quantity / scale of products generated
			Required achievem ent	Similar samples (according to the latest standards)		
				National	Interna tional	
1	Biochar used as fertilizer: - Total carbon (IBI world standard)	%	30 - 60	Unavailable standards	30 - 60	50
2	Fuel pelleting pellets / briquettes suitable for local use conditions for cooking, heating or boiler burnt: - Dry total calorific value(Q_{gr}^k), not lower - Humidity - Ashy content	Cal/g % %	> 3.500 <10 <15	Unavailable standards	> 3.500 <10 <15	50
3	Silage is suitable for the needs of direct feeding livestock, meets the technical nutrition requirements for small, medium and large TMR mixers: - Dry matter - Protein content - Total minerals - NDF - ADF - ADL - pH (According to the results of the research project: Handling and preserving fresh rice straw as feed for cattle by Nguyen Xuan Trach et al., published in Animal husbandry Magazine No. 9/2006, page 2732	Ton % % % % % %	 ≥ 28 $\geq 7,9$ ≥ 18 ≥ 67 ≥ 35 ≥ 4 4-5	Unavailable standards		50

4	Substrate for growing mushrooms from rice straw and corn cobs (50 tons / site, 02 sites/province, total of 4 sites for 2 provinces) (quality criteria are expected to be achieved according to the process of each product) - pH - Humidity - C/N ratio - Sterility	ton/site % %	50 7 68 - 72 30 - 50 Pasteurized with saturated steam at 100°C	Not available commercial products		200
5	Ganoderma growing substrate from corn cobs (5 tons / site, 02 sites / province, total of 4 sites for 2 provinces) (quality criteria expected to follow process) - pH - Humidity - C/N ratio - Sterility	ton/site %	5 7 60 - 62 20 - 30 Pasteurized with saturated steam at 100°C	Not available commercial products		20
6	Bio-organic compost made from rice straw (Quality criteria meeting the provisions of the Government's Decree No. 108/2017/ND-CP of September 20, 2017)	ton				45
	- Organic content	%	≥20	≥20		
	- Humic / fulvic acid content (for bio-organic fertilizer)	%	≥3,5	≥ 3,5		
	Humidity	%	≤30	≤30		

7	Microorganism probiotic for on-field rice straw fast decomposition and production of bio-organic fertilizer	kg				100
	- Useful microorganism density per each type	CFU/g	$\geq 1,0 \times 10^8$	$1,0 \times 10^8$		
	- Decomposition time - Achieved decomposition rate	Day %	25 > 80	25 > 80		
8	Model of rice straw collection and processing technology Successfully applied in 3 testing provinces; 1 site / province	ha/province	100			300
9	Fuel rod /briquettes and biochar / activated coal production model	Ton	100			100
	- Fuel pellets/briquettes		50			50
	- Biochar		50			50
10	Model of production and processing of agricultural residues as cattle feed 2 sites / province, 2 provinces Storage for 3 months	Ton/site	50			200
11	Model of evaluating the efficiency of using agricultural byproducts as feed for cattle	Household	5			10
12	Models of producing Ganoderma, Rice straw mushrooms, Button mushrooms - Location: Son La and Nam Dinh provinces - Quantity: 3 farms / province x 2 provinces Ganoderma yield reaches 25 - 32 kg of dried mushrooms / ton of dry raw material; rice straw mushrooms reach 100 - 120 kg of fresh mushrooms / ton of dry raw material; Button	Farm/ province	3			6

	mushrooms reach 200-300 kg of fresh mushrooms / ton of rice straw.					
13	<p>Model of on-field rice straw fast decomposition</p> <ul style="list-style-type: none"> - Location: Nam Dinh, Binh Dinh and Soc Trang Provinces - Quantity: 12 sites (2 sites/crop x 2 sites/province x 3 provinces). - Decomposition time <25 days, the rate of decomposition > 80%. 	ha	1			12
14	<p>Model of producing bio-organic fertilizer from rice straw</p> <ul style="list-style-type: none"> - Location: Nam Dinh, Binh Dinh / Soc Trang Provinces - Quantity: 2 sites (1 site / province x 2 provinces). - Scale: 15 tons / production batch - Quality meets the standards specified in Decree No. 108/2017 / ND-CP. 	Ton	15			30
15	<p>Crop models using bio-organic fertilizer / biochar</p> <ul style="list-style-type: none"> - Location: 5 project provinces - Quantity: 5 models (1 site/model / province) - Scale: 02 ha / province - Efficiency: Increase the efficiency of using mineral fertilizers (equivalent to a reduction of 15-20% of mineral fertilizers without impact on productivity) or increase economic efficiency by 15%; The soil fertility index (organic matter in 	Ha	2			20

	the soil) is maintained stably. The models to be accepted in accordance with the signed agreement. There is a monitoring report on the model formulation process.					
Type II:						
No	Products	Scientific requirements				Remarks
I	Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes					
1	A report presenting the findings of the review of alternative method and technology of collection and processing of crop residues and their suitability for promotion in Vietnam	The report shows the following contents: - A survey of existing methods and technology of collection and preliminary processing of rice straw for different purposes in Vietnam to understand the technical and management status and issues/problems - including a surveys of end-users / farmers, company managers, and local authorities in the agricultural sector. The survey will seek to provide insight into the following issues: (i) Methods for collecting and preliminary processing rice straw for different purposes (animal feed, composting, bedding material, mushroom production, cooking fuel and others) in the project provinces, (ii) Quantity/ percentage of rice straw to be collected, (iii) Methods of preliminary processing applied, (iv) Costs / benefits of different methods of collecting and preliminary processing including farmers perception, (v) Management issues, (vi) Existing related policies and subsidies - Literature review and key informant survey of international methods of rice straw collecting and preliminary processing technology and costs, including a desk study of the comparative performance of different technologies. - A set of recommendations on new methods of collecting and preliminary processing technologies, that could be incorporated in the project provinces along with cost estimates.				
2	Design and documentation report on methods of collecting and pre-processing including	This report includes: - Review of methods of collecting and pre-processing of various scales both nationally and internationally				

	design drawings and supporting specifications.	<ul style="list-style-type: none"> - Assessment of alternative design including manufacturing / modification equipment that meet the different rice production scale and harvesting season's conditions; - Review of methods of rice straw collecting and pre-processing needs under the range of conditions in the selected provinces - Cost estimates for application of methods of rice straw collecting and pre-processing - Development of design and performance standards: The design of the rice straw collection machine / tool is expected to provide technical specifications suitable to the cropping seasons, size and purpose of use: <ul style="list-style-type: none"> + <i>Design of combined rice straw collection and round rice straw baling machine in the field associated with tractor: Productivity: 55.7 bales/hour; Tightness of the bale: 288 kg/m³; Bale size (DxL): 48 x 70 cm; Tractor capacity: 35 HP</i> + <i>Rice straw collection and square baling machine in the field in combination with tractor: Productivity: 90 bales/hour; Tightness of the bale: 314 kg / m³; Bale area: 32x42 cm; Bale length: 40-80 cm; Tractor power: 35 HP</i> + <i>Self-propelled round baling machine: Capacity: 51 bales/hour; Tightness of the bale: 190 kg / m³; Bale size (DxL): 45x50 cm</i> + <i>Rice straw and stubble chopping machine in the field for fertilizer: Quantity of rice straw after chopped with size <12 cm (for soil preparation): 81%; Working width: 1.2-1.4 m; Productivity: 0.31 ha/h; Tractor: 35 HP; Ensuring agronomic requirements for tillage;</i> 	
3	A technology performance review	<p>The report includes the following contents:</p> <ul style="list-style-type: none"> - Provides the details of pilot testing of the preferred (and accessible) technology within each of the 3 provinces (representing 3 agro-ecological zones) with no more 1 site per province. - Proposed testing protocol and methodology that is approved by the MARD's science committee 	

		<ul style="list-style-type: none"> - A set of agreed testing parameters that include; design and manufacturing/fabrication equipment standards, operational standards, performance standards and environmental standards. <p>For each approved technology, provide a certified test report</p> <ul style="list-style-type: none"> - A formal recommendation based on the pilot testing for (i) further methods and technologies development and or (ii) passing the technology option to PPMUs for the purpose of demonstration to the wider sector. 	
4	Draft technology standards provided to CPMU for each of the pilot technologies approved based on the pilot results	<p>Technology standards show the following contents:</p> <ul style="list-style-type: none"> - Forming a working groups from rice farming stakeholders (households, farms, companies); - Using the working group for developing an agreed scope and structure for the proposed standards; - A consultative draft process that builds on consultants findings and the feedback from wider stakeholders consulted. 	
II	Research output 2: Research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice straw with high heating capacity		
1	Review, assessment, proposal and technology development report on the production of fuel pellets / briquettes, activated coal and biochar from rice straw with high heating capacity	<p>The report includes following contents:</p> <ul style="list-style-type: none"> - Technology identification and assessment frameworks that includes both Vietnam and internationally source technology solutions - A literature review of technologies, production materials, technology performance data, technology and operating costs - Survey of key technologies to be high priority for detailed assessment including production materials, technologies, heating capacity, and perceptions of farmers. - Development of appropriate technologies for fuel pellets / briquettes, activated coal, biochar production from rice straw and rice husk (for reference) 	

		- A proposed testing protocol, testing methodology including the range of parameters to be tested	
2	Workshop testing report for fuel pellets /briquettes, activated coal and biochar produced in Vietnam	<p>The report includes following contents:</p> <ul style="list-style-type: none"> - Present the findings of the testing protocols and procedure in both workshop and field conditions - From user evaluation and assisted monitoring by the consultant conducted over a period of at least 3 months for using fuel pellets/briquettes, activated coal and biochar. - Provide clear recommendations on the strengths and weaknesses of the technology including production technologies, raw material stability, heating capacity, cost/benefit and farmer perception 	
3	Technological process for production of synthetic fuel pellets / briquettes from rice straw	Capacity of tons of products / hour; Calorific value is over 70% compared to fuel pellets from husks	
4	Technological process of continuously producing activated coal / biochar from rice straw	Capacity of over 300 kg of activated coal/biochar / hour	
III	Research output 3 - Research on technology for animal feed production from crop residues (rice straw and corn stover) and storage		
1	A report the present the identification of appropriate technology for animal feed production from rice straw and corn stover and storage.	<p>The report presents following contents:</p> <ul style="list-style-type: none"> - International literature, internet and literature research to identify technology being currently being used - Propose an appropriate technology that could be developed for different climatic conditions - A detailed comparative assessment with recommendations for preferred technology for workshop and field testing - The cost of technologies in Viet Nam conditions 	
2	A technology testing report based on workshop testing of animal feed production from rice straw and corn stover and storage performance	<p>The report presents following contents:</p> <ul style="list-style-type: none"> - Application of animal feed production from rice straw and corn stover and storage under workshop conditions using a range of farm sizes and residue quantities. 	

		<ul style="list-style-type: none"> - Application of feed for cattle under two field conditions (dry and winter seasons) - User evaluations and assisted monitoring by the consultant conducted over a period of 1 cattle live cycle cycle (12 months) for technology application (2 sites / province, total 4 sites in target provinces) - A technology applicability recommendation along with technical specifications and design guidelines 	
3	Piloting report based on animal feed production from rice straw and corn stover and storage performance	<ul style="list-style-type: none"> - The process is simple, easy to apply, using available local materials, suitable for model building in the Northern and Central mountainous provinces. 	
4	Application of the piloting protocols of animal feed production from rice straw and corn stover and storage	<p>The report presents the following contents:</p> <ul style="list-style-type: none"> - Application of pilot models of feed production from rice straw and corn stover (50 tons / ha, 02 sites / province, total 04 sites for 2 provinces) and storage (3 months at same feed production location) in the dry and winter seasons. - Application of the piloting protocol of feeding cattle with animal feed produced from rice straw and corn stover and stored during dry and winter seasons 	
IV	Research output 4: Research on technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling of used substrate to produce bio-organic fertilizers		
1	A report the present the identification of appropriate technology of edible and medicinal mushrooms production from crop residues (rice straw and corn cob) and recycling of used substrates to produce bio-organic fertilizers	<p>The report presents the following contents</p> <ul style="list-style-type: none"> - International literature, internet and literature search to identify technology currently being used to processing rice straw and corn cob for mushroom substrate production and technologies for production of bio-organic fertilizer from spent substrate. - Propose an appropriate technology that could be developed for different types of mushrooms - Develop technologies for mushroom substrate production from rice straw and corn cob for different type of mushrooms - Develop technologies for bio-organic fertilizer production from used substrate 	

		<ul style="list-style-type: none"> - A detailed comparative assessment with recommendations for preferred technology for workshop and field testing. - The cost of technologies in Viet Nam conditions 	
2	A technology testing report based on workshop testing of edible and medicinal mushrooms production technologies from crop residues (rice straw and corn cob) and recycling of spent of substrates to produce bio-organic fertilizers	<p>The report presents the following contents</p> <ul style="list-style-type: none"> - Application of the testing protocols under workshop conditions using a range of substrate production scale. - The application of the testing protocols under up to two field conditions with selected mushroom types (2 types of edible mushrooms, 01 for medicinal mushroom) - From user evaluations and assisted monitoring by the consultant conducted over a period of 6-months for substrate technology production (1 site per province, total 2 sites) and 12 months for mushroom production using selected substrates (3 farms / province, total of 6 sites in 2 provinces) - A technology applicability recommendations along with technical specifications and design guidelines 	
3	- Ganoderma cultivation technological process	<ul style="list-style-type: none"> - The process is simple, easy to apply, using available local materials, suitable for model development in Son La province. - Scale: 50 tons of substrate / model - Ganoderma yield reaches 25 - 32 kg of dried mushrooms / ton of dry raw material. 	
4	Oyster mushroom cultivation technological process	<ul style="list-style-type: none"> - The process is simple, easy to apply, using available local materials, suitable for model development in Nam Dinh, Son La provinces. - Scale: 50 tons of substrate; - The oyster mushroom productivity reaches 600-700kg of fresh mushrooms / ton of dry materials. 	
5	- Technology process of growing button mushroom	<ul style="list-style-type: none"> - Simple process, easy to apply, using available local materials, suitable for model development in Nam Dinh province - Scale: 50 tons of substrate / model - Yield of button mushrooms reaches 20-32% (200 - 320kg of mushrooms / ton of rice straw) 	

6	Technological process of producing bio-organic compost from substrates after mushroom cultivation	The process is simple, easy to apply and use the material that is the substrate after growing mushrooms; Scale: 10 tons of organic material / production batch.	
7	Piloting report on edible and medicinal mushrooms production from rice straw and corn cob and storage; recycling substrates to produce bio-organic compost	The report presents the following contents - Application of the piloting protocols of edible and medicinal mushrooms production technologies from crop residues (rice straw and corn cob) (50 tons of substrate/site, 02 sites/province, total of 4 sites for 2 provinces). - Application of piloting protocols for producing bio-organic fertilizers from spent substrates (10 tons of organic fertilizers / site, 2 sites in 02 provinces).	
V	Research output 5: Research on the technology for on-field rice straw decomposition and production of bio-organic fertilizers		
1	Review report presents identification of appropriate technology for rice straw fast decomposition	The report presents the following contents Through international and national literature and key informants survey, conduct a literature search to identify technology currently being used for processing of rice straw on the paddy field after harvesting. - Propose an appropriate technology that could be developed for fast decomposition meeting the next crop planting requirement. - Develop technologies for fast rice straw decomposition suitable the cropping seasons next crop demand - A detailed comparative assessment with recommendations for preferred technology for workshop and field testing - The costs of technologies in Viet Nam conditions	
2	Review, assesse, propose and develop appropriate technology for production of bio-organic fertilizer from rice straw	The report presents the following contents - Identify existing applied technologies for production of bio-organic fertilizer from rice straw through an overview of international and domestic literature and information interviews. - Proposing suitable technology that can be developed to produce bio-organic fertilizer from rice straw.	

		<ul style="list-style-type: none"> - Developing technology of producing bio-organic fertilizer from rice straw. - A detailed comparative assessment with recommendations for preferred technology for workshop and field testing - The costs of technologies in Viet Nam conditions 	
3	A technology testing report based on workshop testing of on-field rice straw fast decomposition and production of bio-organic fertilizers	<p>The report presents the following contents</p> <ul style="list-style-type: none"> - Application of the testing protocols under workshop conditions using on-field rice straw fast decomposition and producing bio-organic fertilizers technologies; - Application of testing protocols under field conditions for on-field rice straw fast decomposition (2 sites per season, 2 sites per province, total 12 sites per 3 provinces) and 2 sites for producing bio-organic fertilizers (1site for per province, in 2 provinces); - For user evaluations and assisted monitoring by consultant conducted over a period of 6 months for on-field rice straw fast decomposition technology and 12 months for bio-organic fertilizer production technologies using rice straw. - A technology applicability recommendations along with technical specifications and design guidelines. 	
4	Technological process of producing bio-organic fertilizer from rice straw	<ul style="list-style-type: none"> - Simple process, easy to apply and use local materials. - Scale: 15 tons of raw materials / production batch. 	
5	Process of on-field rice straw fast decomposition	The process is simple, easy to apply, using local materials, suitable for local conditions.	
VI	Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologies that link advanced pellets /briquettes, activated coal, biochar production, on-field fast rice straw decomposition and production of bio-organic fertilizer from rice straw		
1	Pilot plan for each farming site - in the form of a management manual and plan outlining	<p>Identify:</p> <ul style="list-style-type: none"> - Responsibilities of the LCASP, consultant and property owner and manager, - ownership of equipment and its maintenance; - The distribution of and; 	

		- scale and scope of liabilities associated with the pilot;	
2	A signed pilot site arrangement for 1 site in each province (3 agro-zones)	Confirming the provisions detailed in the site management manual including access to site, awareness visit, data monitoring	
3	Detailed monitoring report	<ul style="list-style-type: none"> - The performance standards of the technology within a farming systems context; - A financial assessment of the adoption of a farming systems perspective including capital costs, operating costs and additional benefits; - An assessment of environmental benefits including rice straw processing with and without the technology; 	
4	An analysis of potential user perception of the technology system.	<ul style="list-style-type: none"> - Self-evaluation analysis of people visiting sites. - A demand assessment for wider uptake of the technology. 	
5	Trial models	<p>5 models (5 provinces); Scale: 02 ha/province piloting the use of organic materials (compost and biochar) for soil carbon accumulation and as fertilizer for crops. Model of vegetables in Son La, Bac Giang; rice model in Nam Dinh; Binh Dinh and Soc Trang.</p> <p>Models that help restore fertilizer balance for crops by combining bio-organic / microbiological organic fertilizers from newly developed products.</p> <p>Models do not reduce soil quality (stabilizing soil organic matter).</p> <p>The models to be tested and accepted according to the signed agreement. Ensure a minimum productivity of 62 - 63 quintals / ha when applying a 15-20% reduction in the amount of NPK.</p> <p>There are monitoring reports on the model building process</p>	
VI I	Research output 7: Policy recommendations for the uptake of crop residues (rice straw and corn stover) recycling		
	Overview of national target policies and sector-level target policies related to rice straw and corn cob recycling	- A review of the current crops residues recycling technologies, including on-field processing, fuel pellets /briquettes, activated coal, biochar, bio-fertilizers, animal feed and mushroom substrate	

		<p>production policy objectives and the status of the sector in relation to the policy target.</p> <ul style="list-style-type: none"> - An assessment of future targets and strategies to achieve these targets. - An assessment of the linkages between environment, energy, agriculture and rural development goals, including externality effects and constraints of crop residues recycling goals. 	
	Workshop for crop residues recycling stakeholders covering the proposed policy issues to identify gaps and to develop agreed policy targets for 2025 and 2030	Identify the actors involved in recycling crop residues to identify policy gaps and policy recommendations for period 2025 and 2030.	
	Policy options	<ul style="list-style-type: none"> - The range of policy options to stimulate the adoption of technologies including: - Awareness raising, - Regulations and compliance strategies, - Market-based approach versus the use of incentives and subsidies - Sector financing options linked to credit, carbon-based financing and green economy funding - Sector management responsibilities including State, Provincial, Private Sector and National Programs 	
	A draft policy document on crop residues recycling	A draft crop residues recycling policy documents to review and approve by the sector and MARD.	

ANNEX. SUMMARY OF DRAFT REPORT ON EFFICIENCY OF PACKAGE AND REPLICATION PROGRESS

It is estimated that the country's rice area is 3 million hectares by 2020 and 2.5 million hectares by 2025. Each hectare produce 5 tons of rice straw

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
1	Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes	Eliminating rice straw burning in the field will prevent from soil exhausted, destroying beneficial microorganisms and polluting the environment due to dust and smoke, returning a part of biomass will improve the	Create more jobs for farmers, release from hard labor	i) Profits for rice producers. ii) Economic efficiency for farmers. iii) be proactive in sourcing mushrooms and fodder for feed during the food scarcity) Creating more commodity products for	Rice straw roll: 3.0	180	900	540	3 mill.	15 mill,	9,000,000	2,5 million	12,5 mill.	7,500,000
					Pressed into briquettes: 5.0				3,0 mill. ha	15 mill.	15,000,000	2,5 mill.	12,5 mill	12,500,000

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
		soil (improving loose soil, returning nutrients to the soil) as a factor of sustainable agricultural production		domestic manufactu ring facilities.										
2	Research output 2: Research on cost efficient technologi es for fuel pellets / briquettes, activated coal and biochar produced from rice straw with high	Reduce rice straw burning in the field, reducing environmen tal pollution.	Create jobs for farmers, increase income for workers, create products that partly meet society's needs.	1. Economic efficiency for biochar production	1,250	10	50	12,500	3 mill.	15 mill.	3,750,000	2.5	12,5 mill.	3,125,00 0
				2. Fuel briquette production efficiency	0,750	10	50	7,500	3 mill	15 mill.	2,250,000	2.5	12.5 mill.	1,875,00 0

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
	heating capacity													
3	Research output 3 - Research on technology for animal feed production from crop residues (rice straw and corn stover) and storage	Limiting the burning of rice straw in the field causes environment al pollution due to greenhouse gas emissions and dust, reducing soil hardness, protecting soil beneficial microorganis ms	Create jobs. Release of hard labor. It does not take time and effort to dry the rice straw during the busy crop season. Provide a stable and quality source of roughag e for cattle during	Increasing about 1.1 to 1.2 million VND (more than 47%) per hectare of field compared to convention al dry rice straw collection method	2,31	8,3	50	29,2	3 mill.	15 mill.	6,930,000	2,5 mill.	12,5 mill.	5,775,00 0

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
			the scarcity of feed..											
	Part A: Research output 4: Research on technology for producing edible and medicinal mushroom s from crop residues (rice straw and corn cob) and recycling of used substrate to produce	Processing of rice straws, corn cob to grow mushrooms to limit the rice straw discarding or burning causing environment al pollution	Create more jobs, increase income for labors who grow mushroo ms	Improve the efficiency in the value chain of using residues such as rice straw, corn cob to grow edible mushroom medicinal mushroom and then produce bio- organic fertilizer.	2.5 to 4.8 / ton of rice straw or corn cob material	11 ha rice or 12 ha corn,	Equivale nt to 50 tons of rice straw or 50 tons of corn cob	125 to 240	3 mill. ha rice	15 mill.	37,500,000 to 72,000,000	2,5 mill.	12,5 mill.	31,250,0 00 to 60,000,0 00
									0.5 mill. ha corn	2 mill.	5,000,000 to 9,600,000	0,35	1.4 mill.	3,500,00 0 to 6,720,00 0

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
	bio-organic fertilizers													
4	Part B: Recycle mushroom substrate for production of organic fertilizer	Solid waste processing is the substrate after growing mushrooms which is currently being discarded or burned causing environmen tal pollution	Creating more jobs for workers and farmers at mushroo m growing establish ments	Improving the efficiency in the value chain of using waste residues as rice straw after used to grow edible and medicinal mushroom s	2.1	13.5 ha rice, equal to 59.5 tons of rice straw	20 tons of bio- organic fertilizer	27.73	3 millio n	15 million	6,300,000	2,5 million	12,5 million	5,250,00 0
5	Research output 5: Research on the technology for on-field rice straw decomposi	Reducing methane and H ₂ S emissions due to anaerobic decompositi on of rice straw; reduce	Create rice products that are cultivate d in an organic and safe way for	Reduce the cost of buying and fertilizing organic fertilizers, mineral fertilizers, and	Quick handling in the field: 2.0 Handling centraliz ed collectio	12 ha rice		24.0	3 mill.	15 mill.	6,000,000	2.5 mill	12.5 mill.	5,000,00 0
						9 ha rice	30 tons	30.2	3 mill.	15 mill.	10,080,000	2.5 mill.	12.5 mill	8,400,00 0

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
	tion and production of bio- organic fertilizers	the amount of mineral fertilizers and chemical pesticides.	humans and the environ ment	pesticides, increasing income for farmers	n rice straw and producin g bio- organic fertilizer products: 3.36									
6	Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologi es that link advanced pellets /briquettes, activated coal, biochar	Limiting the burning of rice straw in the field, preventing soil hardiness, destroying beneficial microorganis ms and polluting the environment due to dust and smoke ...	Creating more jobs for farmers, creating a habit of using rice straw as fertilizer , not burning rice straw in the field, ...	<i>Annually with 45 million tons of rice straw of the whole country to be treated will produced about 20 million tons of organic fertilizer, which generate</i>	<i>For rice model: 1 ha with 5 tons of rice straw to be treated in field will reduce 20% of mineral fertilizer and increase 15% of rice producti vity,</i>	9 ha rice	45	47.7	3 millio n	15 million	15,900,000	2.5 mill.	12.5 mill.	13,250,0 00

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
	production, on-field fast rice straw decomposi tion and production of bio- organic fertilizer from rice straw			<i>about VND 11,000 billion of profit.</i>	<i>accordin g to calculati ons, it is possible to gain about 5.3 million / ha. Speci fically: 1. Saving 20% of mineral fertilizer s: 20% of VND 4,000,00 0 (inorgani c fertilizer price / ha of rice, VND 400kg x10,000)</i>									

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
					is VND 800,000. 2. The rice yield will increase by 15% from 6,500 kg / ha with 975 kg / ha, with the selling price of VND 5,500 / kg, the profit will be around VND 5,362,50 0. Add 1 and 2: 800,000 VND + 5,362,50									

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
					0 VND = 5,363,30 0 VND / ha									
6				Annually with 45 million tons of rice straw from the whole country to be treated will be about 20 million tons of organic fertilizer, which bring about VND 11,000 billion of profit.	For the vegetabl e model: Inorgani c fertilizer: about 6,500,00 0 VND / crop. If a 20% reduction of inorganic fertilizer s, then the cost of this input is only VND 5,200,00 0; animal manure and compost are equivale nt. The	2 ha	130 tons	9.4	100,00 0	6,500	9.40	150,000	9,750	1,410

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
					<p>output is about 65 tons / ha, the selling price is 4,000 VND / kg, the total revenue is 260,000,000 VND / ha.</p> <p>Thus, if calculated:</p> <p>1. Reduction of 20% inorganic fertilizers will induce a profit of 800,000 VND;</p>									

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
					2. Increasing productivity by 15% will be 975kg, profit is 4,000 VND x 975 kg = 3,900,000 VND Adding 1 and 2 would be: VND 3,900,000 + VND 800,000 = VND 4,700,000 / ha.									
7	Research output 7: Policy recommendations for the uptake													

N N	Research outputs	Environmen tal efficiency	Social efficienc y	Economic efficiency	Profit: VND Mill./ ha	Application progress								
						2018 (model)			2020 (whole country)			2025 (whole country)		
						Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill. VND)	Area (ha)	Output (ton)	Profit (mill.V ND)
	of crop residues (rice straw and corn stover) recycling													

APPENDIX 7. EXPECTED ECONOMIC AND ENVIRONMENT EFFICIENCY IN CASE THE RESULT OF PACKAGE IS DISSEMINATED AND REPLICATED

It is estimated that annually volume of rice straw is 45 million tons

1. Research output 1: Research on development of methods and technology of collection and preliminary processing of crop residues for different application purposes

i) Phase 1 (2018): The existing rice straw price is 700 - 800 VND / kg. If winded into rolls, the price is 1,800-2,000 VND/kg, the price of pressed into briquettes is 2,500 VND. The rice straw winding will bring a profit of about 1,000 VND/kg, pressed into briquettes will profit about 1,700 VND/kg. Subtracting costs and depreciation of machinery, each kilogram of rice straw when winded will yield profit about 600 VND / kg, equivalent to 600,000 VND / ton and 3,000,000 VND / ha; When pressed into briquettes, interest is about 1,000 VND / kg, equivalent to 1,000,000 VND / ton and 5,000,000 VND/ha. In 2018, the testing was conducted on 180 hectares (Soc Trang, Binh Dinh and Nam Dinh), the profit was of about VND 540,000,000 when the rice straw was winded. And the profit was 900,000,000 VND when the rice straw was pressed into a fuel pellets.

ii) Phase 2 (2020):

+ If only 5% of rice straw is used for winding (equivalent to 2,250,000 tons of rice straw x 600,000 VND = 1,350,000,000,000 VND (One thousand three hundred and fifty billion Vietnamese Dong).

+ If only 5% of rice straw is used to press it into a fuel pellets (equivalent to 2,250,000 tons of rice straw x 1,000,000 VND = 2,250,000,000,000 VND (Two thousand two hundred and fifty billion VND).

iii) Phase 3 (2025):

+ If only 10% of rice straw is used for winding (equivalent to 4,500,000 tons of rice straw x 600,000 VND = 2,700,000,000,000 VND (Two thousand seven hundred billion Vietnamese Dong).

+ If only 10% of rice straw is used to press it into a fuel pellets (equivalent to 4,500,000 tons of rice straw x 1,000,000 VND = 4,500,000,000,000 VND (Four thousand five hundred billion VND).

2. Research output 2: Research on cost efficient technologies for fuel pellets / briquettes, activated coal and biochar produced from rice straw with high heating capacity

After the work package is being accepted by the Ministry of Agriculture and Rural Development, the results of the testing model may be replicated for:

For biochar production:

i) Phase 1 (2018): Testing on 10 hectares with net profit of VND 12,500,000, equivalent to VND 250,000 / ton of rice straw.

ii) Phase 2 (2020): If only 5% of the rice area is used, equivalent to 2,250,000 tons of rice straw x 250,000 VND = 562,500,000,000 VND (Five hundred and sixty two billion five hundred million VND).

iii) Phase 3 (2025): If only 10% of the rice area is used, equivalent to 4,500,000 tons of rice straw x 250,000 VND = 1,125,000,000,000 VND (One thousand one hundred twenty five billion VND).

For fuel pellets/briquettes production:

i) Phase 1 (2018): Testing on 10 hectares with net profit of VND 7,500,000, equivalent to VND 150,000 / ton of rice straw.

ii) Phase 2 (2020): If only 5% of the rice area is used, equivalent to 2,250,000 tons of rice straw x 150,000 VND = 337,500,000,000 VND (Three hundred thirty seven billion five hundred million VND).

iii) Phase 3 (2025): If only 10% of the rice area is used, equivalent to 4,500,000 tons of rice straw x 150,000 VND = 675,000,000,000 VND (Six hundred and seventy five billion VND).

3. Research output 3 - Research on technology for animal feed production from crop residues (rice straw and corn stover) and storage

After the work package is being accepted by the Ministry of Agriculture and Rural Development, the results of the testing model may be replicated for:

i) Phase 1 (2018):

- Soc Trang province implements a model to treat 50 tons of rice straw. To collect 50 tons of fresh rice straw into animal feed, collectors have to spend a large amount of money (VND 34.33 - 40.33 million). The money is used to rent a spraying-winding machine, buy fresh rice straw, compost bags and composting ingredients (urea or ammonia or inoculant, molasses and salt). However, the money collected from the sale of 50 tons of composted rice straw is also very large VND 55 - 60 million. Therefore, the profit gained from VND 18.92 - 20.67 million. This interest rate is 5.1 - 6.8 million higher than collecting dry rice straw on the same area. Equivalent to 1 ton of fresh rice straw processed into animal feed will profit about VND 100,000 / ton compared to collection and sale of dried rice straw.

- Binh Dinh and Nam Dinh provinces follow the same model and the profit will be similar to that in Soc Trang province.

ii) Phase 2 (2020):

If only 5% of fresh rice straw is used for producing animal feed, the profit will be: 2,250,000 tons of rice straw x 100,000 VND = 225,000,000,000 VND (Two hundred and twenty five billion VND).

iii) Phase 3 (2025): If only 20% of fresh rice straw is used for producing animal feed, the profit will be: 9,000,000 tons of rice straw x VND 100,000 = VND 900,000,000,000 (Nine hundred billion VND).

4. Research output 4: Research on technology for producing edible and medicinal mushrooms from crop residues (rice straw and corn cob) and recycling of used substrate to produce bio-organic fertilizers

After the work package is being accepted by the Ministry of Agriculture and Rural Development, the results of the testing model may be replicated for:

i) Phase 1 (2018):

- Nam Dinh province has implemented 2 models of processing 50 tons of rice straw / model = 100 tons: In the stage of testing model, the inputs included purchasing raw materials, supplies, mushroom varieties, labor, etc.: VND 8,600,000 / tons of raw materials; Turnover of 13,200,000 VND / ton of raw materials; **Profit:** 4,600,000 VND / ton or 230,000,000 VND / model of 50 tons of raw materials; Produces about 10 tons of compost from mushroom residue.

- Son La province has implemented 2 models of processing 50 tons of corn cob / model = 100 tons: In the stage of testing model, the inputs included purchasing raw materials, supplies, mushroom varieties, labor, etc.: VND 8,500,000 / ton of raw materials; Revenue of 11,000,000 VND / ton of raw materials; **Profit:** 2,500,000 VND / ton or 125,000,000 VND / model of 50 tons of raw materials; Produces about 15 tons of compost from mushroom residue.

ii) Phase 2 (2020):

The corn cob and rice straw are collected and sold to raw material-processing establishments to increase income for corn and rice farmers at an average purchase price of (600 - 1200) VND / kg of corn; (800 - 1500) VND / kg dry rice straw.

Each ton of raw material put into mushroom cultivation will attract about 20 labors with a labor value of 150,000 - 250,000 VND and give an average yield of 120 to 700kg of fresh mushrooms depending on each type of mushroom and about 200kg of organic fertilizer from spent substrate after mushroom production. So with 10% of waste (rice straw, corn stover/cob) / year equivalent to 4 million tons will produce about 1 million tons of mushrooms with a turnover of about 2 billion USD; attracting about 80 million working days and nearly 1 million tons of organic fertilizer to help improve the fields, protect the environment ...

iii) **Phase 3 (2025):** If only 15% of the rice straw and corn cob is used to grow mushrooms equivalent to about 5.5 million tons will produce about 1.5 million tons of mushrooms with a turnover of about 3 billion USD; about 1.2 million tons of organic fertilizer help improve the field, grow organic vegetables, protect the environment, improve community health ...

Processing of mushroom residues into bio-compost:

i) **Phase 1 (2018):** Profit / 1 ha is VND 2.1 million, testing on 13.5 ha, profit is VND 27.73 million. Equivalent to 420,000 VND / ton of rice straw.

ii) **Phase 2 (2020):** If only 5% of the rice area is used, equivalent to 2,250,000 tons of rice straw x 420,000 VND = 945,000,000,000 VND (Nine hundred and forty five billion VND).

iii) **Phase 3 (2025):** If only 10% of the rice area is used, equivalent to 4,500,000 tons of rice straw x VND 420,000 = VND 1,890,000,000,000 (One thousand eight hundred and ninety billion VND).

5. Research output 5: Research on the technology for on-field rice straw decomposition and production of bio-organic fertilizers

After the work package is being accepted by the Ministry of Agriculture and Rural Development, the results of the testing model may be replicated for:

On-field rice straw fast processing

i) Phase 1 (2018): Profit / 1 ha is VND 2.0 million, testing on 12 hectares, profit is VND 24 million. Equivalent to 400,000 VND / ton of rice straw.

ii) Phase 2 (2020): If only 5% of the rice area is used, equivalent to 2,250,000 tons of rice straw x VND 400,000 = VND 900,000,000,000 (Nine hundred billion VND).

iii) Phase 3 (2025): If only 10% of the rice area is used, equivalent to 4,500,000 tons of rice straw x VND 400,000 = VND 1,800,000,000,000 (One thousand eight hundred billion VND).

Processing of concentrated rice straw collection

i) Phase 1 (2018): Profit / 1 ha is VND 3.36 million, testing on 9 hectares, profit is VND 30.2 million. Equivalent to 672,000 VND / ton of rice straw.

ii) Phase 2 (2020): If only 5% of the rice area is used, equivalent to 2,250,000 tons of rice straw x VND 672,000 = VND 1,512,000,000,000 (One thousand five hundred and twelve billion VND).

iii) Phase 3 (2025): If only 10% of the rice area is used, equivalent to 4,500,000 tons of rice straw x VND 672,000 = VND 3,024,000,000,000 (Three thousand and twenty four billion VND).

6. Research output 6: Using the outputs from (ii) (iv) and (v) above to establish pilots of integrated technologies that link advanced pellets /briquettes, activated coal, biochar production, on-field fast rice straw decomposition and production of bio-organic fertilizer from rice straw

For rice cultivation:

i) Phase 1 (2018): Profit / 1 ha is VND 5.3 million, testing on 9 hectares, the profit was VND 47.7 million.

ii) Phase 2 (2020): If only 5% of the rice area is used (3 million ha), equivalent to 150,000 ha x VND 5,300,000 VND = VND 795,000,000,000 (Seven hundred and ninety five billion VND).

iii) Phase 3 (2025): If only 10% of the rice area is used, equivalent to 300,000 ha x 5,300,000 VND = 1,590,000,000,000 VND (One thousand five hundred and ninety billion VND).

For cultivation of green mustards:

i) Phase 1 (2018): Profit / 1 ha is VND 9.4 million, testing on 2 ha, profit of VND 18.8 million.

ii) Phase 2 (2020): If using 100,000 ha, equivalent to 100,000 ha x 9,400,000 VND = 940,000,000,000 VND (Nine hundred and forty billion VND).

iii) Phase 3 (2025): If using 150,000 ha, equivalent to 150,000 ha x 9,400,000 VND = 1,410,000,000,000 VND (One thousand four hundred and ten billion VND).

7. Research output 7: Policy recommendations for the uptake of crop residues (rice straw and corn stover) recycling

The final draft of national and sectoral policies on crop residues recycling in support and development of improving the efficiency of using crop residues by value chains will be considered and approved for implementation in the shortest time. It is the basis for making policy on the use of crop residues in the future.

Ha Noi, date 2018

Team leader

Le Nhu Kieu