



*Rice science for a better world*  
*irri.org*

## **Technical Report**

# **Market study on rice straw-based compost and biodegradable products in Vietnam's Mekong River Delta**

International Rice Research Institute, Philippines  
International Rice Research Institute, Vietnam  
Tiền Giang University, Vietnam  
Nong Lam University, Vietnam

October 2023

# TABLE OF CONTENTS

1. Introduction
  - 1.1. Background
  - 1.2. Methods
    - 1.2.1. Farmers' survey
    - 1.2.2. Exploratory interviews
    - 1.2.3. Multistakeholders Workshop
  - 1.3. Geographic coverage of the market study
  - 1.4. Research Instruments
2. Farmers' profile and farming practices
3. Rice straw-based value chain
  - 3.1. The value chain actors and supporters
    - 3.1.1. Rice farmers
    - 3.1.2. Rice straw traders
    - 3.1.3. Processors
    - 3.1.4. Wholesalers
    - 3.1.5. Retailers
  - 3.2. Supporting market
  - 3.3. Value chain map:
    - 3.3.1. Linkages between the circular economy of rice straw-based value chain
    - 3.3.2. The flow of rice straw in the RS-based value chain
4. Trends, opportunities, and constraints in rice straw-based value chain development
  - 4.1. The opportunities in the RS-based compost value chain
  - 4.2. Challenges faced by farmers and other value chain actors
  - 4.3. Future Prospects
5. References
6. Annex
  - Respondent Criteria for Key Informant Interviews and Multistakeholders Workshop
  - Questionnaire for Farmers' survey
  - KII questionnaire for VC actors
  - Manual for Rice Straw-based Product Farmers Survey In Vietnam
  - Manual for Rice Straw-based Product Key Informant Interview to Value Chain Actors In Vietnam
  - Results from the Farmers' survey
  - SWOT Analysis from the Multistakeholders Workshop

## **LIST OF TABLES**

- Table 1. Distribution of value chain actors interviewed for each RS-based product  
Table 2. Distribution of Value Chain Actors in the Multistakeholders' Workshop  
Table 3. Geographic coverage of the market study in Vietnam  
Table 4. Summary of the rice area grown and the yield across seasons from 2021–2022  
Table 5. The farming practices for growing rice

## **LIST OF FIGURES**

- Fig 1. Map of Southern Vietnam  
Fig 2. Farmers' annual gross household income and membership in an agricultural organization  
Fig 3. Rice varieties grown from May 2021 to April 2022  
Fig 4. The distribution of farmers who experiences flooding of rice field before sowing across the season  
Fig 5. Fertilizer application and the type of organic material in the fertilizer  
Fig 6. Farming practices in disposing of rice straw  
Fig 7. Purpose of farmers in collecting rice straw  
Fig 8. Farmers' agreement with buyers when selling rice straw  
Fig 9. Farmers' source of rice straw market information  
Fig 10. The value chain map of RS-based products in the MRD, Vietnam

## EXECUTIVE SUMMARY

Rice straw burning has been a significant contributor to global warming due to greenhouse gas (GHG) emissions. It leads to nutrient loss in rice straw and high air pollution in regions like Vietnam, where in-field burning is prevalent. This practice accounts for over 50% of Vietnam's national greenhouse gas emissions. Sustainable alternatives for rice straw management have been proposed, but challenges hinder their adoption, including economic viability, farmer perception, technology gaps, and a lack of successful business models. To upgrade the rice straw value chain, it is essential to identify new market opportunities for rice straw products, ensuring that upgrading strategies align with demand and encourage a shift from one use (e.g., incorporation of rice straw in the field) to more sustainable options (e.g., composting, biodegradable products). The Market Study employed a two-pronged approach: (1) Farmers' Survey and Exploratory Interviews, and (2) Multistakeholders' Workshop. The study was conducted in the southern part of Vietnam, including Can Tho, Tra Vinh, Dong Thap, and Tien Giang provinces, where there is high demand for compost and organic substrate for various crops and flower production.

The rice straw value chain in the Mekong Delta is divided into three segments with following value chain actors: (1) upstream (i.e., rice farmers, rice straw traders, input supplier), (2) midstream (i.e., mushroom and compost processors, and wholesalers, and (3) downstream segments (i.e., retailers), with activities ranging from straw collection and processing to distribution and utilization in various applications, such as mushroom cultivation and compost production. Circular economy practices, including recycling used rice straw, were identified within the midstream segment and the use of rice straw-based compost as input to farming and gardening.

Opportunities in the rice straw-based compost value chain include supportive government policies, growing market interest in organic products, and an increasing demand for rice straw collection services. Farmers are recognizing the benefits of using rice straw-based compost for organic farming, leading to higher profits and reduced greenhouse gas emissions. Challenges include a shortage of local labor, limited large-scale collection services, technological limitations in wet rice straw collection, and variability in rice straw prices. Negotiations with suppliers and fluctuations in prices pose challenges for retailers. Steady growth in demand for RS-based compost is anticipated, with potential expansion beyond rice farming to other crops. Wholesalers expect to remain competitive, while midstream actors look forward to technological improvements in compost formats and quality.

In summary, the recycling of rice straw within the rice straw-based compost value chain exemplifies a circular economy, adding an additional layer of value to rice straw and offering economically feasible solutions for its management. The findings from this research hold the potential to inform the development of strategies aimed at enhancing the rice straw-based value chain, ultimately contributing to the reduction of carbon emissions associated with rice production.

## 1. Introduction

### 1.1. Background

Rice straw burning has highly contributed to global warming through greenhouse gas (GHG) emissions. Burning rice straw causes loss of all nitrogen, 25% of phosphorus, and 20% of potassium contained in rice straw (Dobermann and Fairhurst, 2002). In addition, in-field burning causes high air pollution due to black carbon and particulate matter emitted during in-field burning (Nguyen et al., 2019). In Vietnam, where in-field rice straw burning prevails. Rice cultivation causes more than 50% of Vietnam's national GHG emissions, mainly from in-field burning of straw, anaerobic decomposition of straw in flooded fields, and nitrogen fertilizer. Sustainable options for rice straw management were relentlessly promoted to reduce carbon footprint. Alternative options for rice straw management have been developed and reported. For example, the BMZ-funded IRRI rice straw management project (IRRI, 2019) introduced scalable options for rice straw management such as mechanized collection, mechanized composting, mushroom and fodder production, and biodegradable product development. However, rice straw burning continues to persist due to limited economically viable alternatives, gaps in farmers' perception; technology gaps; and a lack of successful business models for demonstrations that would encourage adoption and reduce in-field burning. Understanding the flow of rice straw and developing rice straw-based products, such as compost, provide opportunities for value chain upgrading to incentivize the adoption of sustainable agricultural practices. This, in turn, contributes to the reduction of GHG emissions.

The project aims to develop innovations in the rice straw value chain and hasten the adoption of sustainable management practices to avoid rice straw in-field burning in Vietnam and contribute to sustainable rural development in line with GIZ objectives. One of the project's specific objectives is to improve the markets and value chain of rice straw in Vietnam based on research technologies.

The value chain of rice straw can be upgraded if new market opportunities for rice straw can be identified:

1. To ensure that upgrading strategies are demand-driven
2. Demand for rice straw-based products in diverse markets will not trigger the production of rice straw but will encourage the diversion of straw utilization from one use (e.g. incorporation) to another (e.g., composting, biodegradable products)

Thus, the goal of the study is to explore the rice straw circular economy in the Mekong Delta (MKD), Vietnam. The first objective of this study is to map the flow of the rice straw value chain for RS-based compost by (1) identifying key segments of the rice straw value chain for RS-based and the main actors within each segment, (2) determining the product usage, purpose, and features of RS-based compost that the value chain actors/stakeholders. Secondly, the study aims to explore opportunities and constraints for value chain upgrading based on multistakeholder discussion.

## 1.2. Methods

The study applied a two-pronged approach to investigating the flow of rice straw in rice straw compost's value chain in the MKD: (1) farmers' survey and exploratory interviews with value chain actors to elicit information about farming practices and map the flow of rice straw, and (2) multistakeholder workshop to explore opportunities and constraints for value chain upgrading.

### 1.2.1. Farmers' survey

A quantitative survey was conducted in Can Tho last July 2022 province which includes the towns of Co Do, Thot Not, and Vin Thanh. A face-to-face survey using a self-administered structured questionnaire was conducted to collect data on farmers' characteristics, the rice varieties grown, farming practices on rice disposal and fertilizer application, the purpose of rice straw collection, buyer relations, and information and financing. The survey collected responses from 74 farmers who have grown rice for at least 1 season per year in the past 3 years or more and sold rice straw.

### 1.2.2. Exploratory interviews

Explorative key informant interviews (KII) were conducted in the provinces of Can Tho, Tra Vinh, Tieng Giang, and Dong Thap in May 2023 to identify key segments of the rice straw value chain for RS-based compost and the main actors within each segment of the RS-based value chain and map the flow of rice straw value chain for RS-based compost and biodegradable products. The study implemented purposive sampling in selecting respondents for the interview based on the study's respondent criteria (see ANNEX 1.1: Respondent Criteria for Key Informant Interviews and Multistakeholders' Workshop). Prior to conducting the interviews, the IRRI Vietnam Office sought assistance from the Department of Agriculture and Rural Development (DARD) for setting appointments with some value chain actors in Tien Giang and Can Tho. The research team had set up an appointment with IRRI partners (i.e., New Green Farm Cooperative) for an interview. One challenge that the team faced was the refusal of prospective respondents. To compensate for the challenge, the team would look for potential respondents (i.e., retailers) through shop visits. The table below shows the number of value chain actors interviewed:

Rice straw	Rice straw-based/organic compost
Rice farmer (2)	Mushroom farmer (3)
Rice straw trader(1)	Cow farmer (2)
	Processor (1)
	Trader/wholesaler (4)
	Wholesaler/Retailer (1)
	Retailer (2)
Total: 3	Total: 13

### 1.2.3. Multistakeholders' Workshop

A Multistakeholders' Workshop was conducted to explore opportunities and constraints for value chain upgrading. Key stakeholders in the Vietnam rice straw value chain who are involved in buying and selling RS-based compost OR organic fertilizer/compost or plant pots were invited. The findings from the farmers' survey and KII conducted in the MKD in July 2022 and May 2023, respectively, were presented to the stakeholders and their feedback was elicited. Moreover, the SWOT methodology was utilized. The SWOT methodology involves analyzing the internal strengths and weaknesses of an organization (SWOT) and identifying the opportunities and threats (see SWOT Analysis from the Multistakeholder Workshop). The table below shows the number of stakeholders who participated in the workshop:

Table 2. Distribution of Value Chain Actors in the Multistakeholder Workshop

Value chain Segment	No. of stakeholders
Upstream	Rice farmers (8) Dairy farmers (2)
Midstream	Rice straw traders(2) Processors of RS-based compost (4) Trader/wholesaler of organic fertilizer (2)
Downstream	Retailers of organic fertilizer (2)*
End-users	Vegetable farmers (4)
Local Government	Government official (6)
Total	28

\*Note: Retailers are also involved in trading/wholesaling of organic fertilizer

### 1.3. Geographic coverage of the market study

The study sites for the market study were pre-selected. The market study was conducted in the southern part of Vietnam, specifically in the provinces of Can Tho, Trà Vinh, Đồng Tháp, and Tien Giang. The pre-selected areas have a high demand for compost and organic substrate for fruit crops such as banana, dragon fruit, pomelo, etc., in the MRD). Also, flower producers in Sa Dec City in Đồng Tháp need about 6-7 million flower vases each year (see Fig 1).

Table 3. Geographic coverage of the market study in Vietnam

Provinces	Key cities/districts	Rationale
1) Trà Vinh	Tra Vinh City	The province has a high demand for compost and organic substrate for fruit crops such as banana, dragon fruit, pomelo, etc., in MKD.
2) Đồng Tháp	Sa Dec Town	Flower producers in Sa Dec City in Đồng Tháp need about 6-7 million flower vases each year.
3) Tien Giang	Chau Thanh Cai Lay Tan Phuoc	The province has a high demand for compost and organic substrate for fruit crops such as banana, dragon fruit, pomelo, etc., in MKD.
4) Can Tho	Vinh Thanh Thot Not Co Do	Can Tho Province is selected to be focused on interviewing rice farmers to verify the rice straw uses after harvesting.



Fig 1. Map of Southern Vietnam

#### 1.4. Research Instruments

The researchers developed a pen-and-paper survey questionnaire for rice farmers and a discussion guide for each segment of the value chain to identify their practices and understand the potential opportunities and constraints in the value chain. The survey questionnaire was translated into the local language. An online data-entry program was developed using TablePlus for database management, Mysql for database, and PHP language. Hands-on training on data entry and use of the data-entry program was provided to encoders to ensure the quality of the encoded data.

On the other hand, the discussion guide was written in the English language since it served as a guide for the interviewer and was not shown to the respondents. The researchers conducted the KII sessions in a conversational manner. As an exploratory approach, probing and follow-up questions were asked based on the respondent's responses and the flow of discussion during each session. The team also conducted an interview briefing prior to the interviews for familiarity with the guide questions. The team used a note-taking document highlighting crucial information to be collected. The interviews were summarized and used to develop a schematic diagram of the value chain map of RS-based compost depicting the activities of the value chain actors and the flow of rice straw to the value chain of RS-based compost fertilizer in MKD.

## 2. Farmers' Profile and Farming Practices

The study found that the majority of the respondents were male farmers (81%). Approximately half of these farmers derived their income from agriculture, with a significant portion earning over 60,000,000 VND, while a quarter of them had alternative sources of income exceeding 60,000,000 VND. Moreover, more than half of the farmers (53%) were members of agricultural organizations (Fig 2).

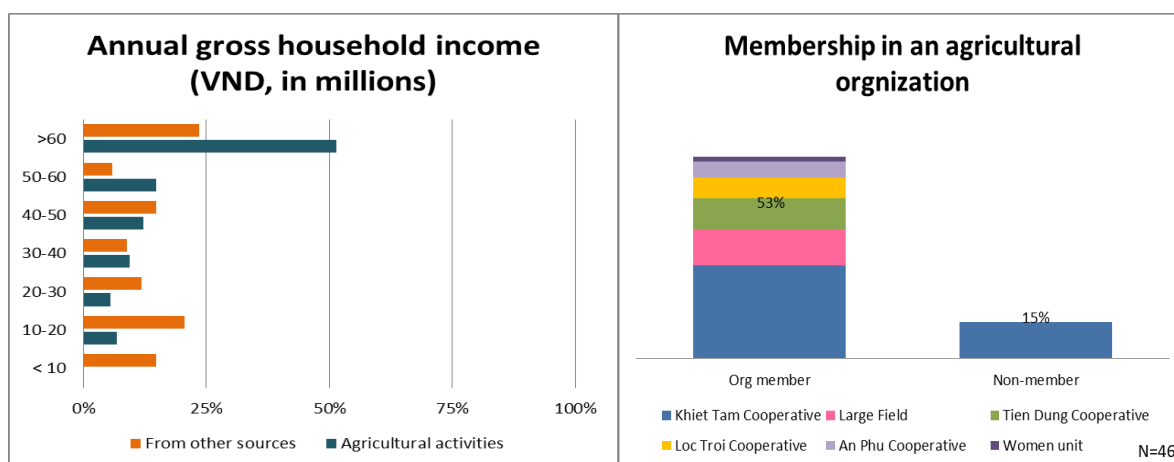


Fig 2. Farmers' annual gross household income and membership in an agricultural organization

Table 4 below shows the information about the rice area and yield from growing rice from May 2021 to April 2022. It was found that the area used in growing rice consistently ranged from 0.26 ha to 6.00 ha with an average of 2.24 ha across the season. The highest amount of seed per ha used recorded was 283 kg/ha during the winter-spring season while across seasons, the minimum amount of seed per ha is 90 kg/ha. The average amount of seed used per ha across season ranges is 168 kg/ha. During the winter-spring season, most of the farmers grew Dai Thom 8 (76%), while farmers grew OM5451 during the autumn-winter season (85%) and summer-winter season (80%).

Table 4. Summary of the rice area grown and the yield across seasons from 2021–2022

Rice area and yield	Winter-spring: Nov 2021–April 2022 (Current season) (n=74)		Autumn-Winter: Jul 2021–Oct 2021 (Previous season) (n=73)		Summer-Autumn: May 2021–Jul 2021 (Previous 2 seasons) (n=74)	
	mean	range	mean	range	mean	range
Area (in ha)	2.24	0.26–6	2.26	0.26–6	2.24	0.26–6
Amount of seed used (in kg)	373.26	45–1000	384.89	45–1000	381.85	45–1000
Amount of seed per ha (kg/ha)	166.67	90–283	168.39	90–250	168.52	90–250

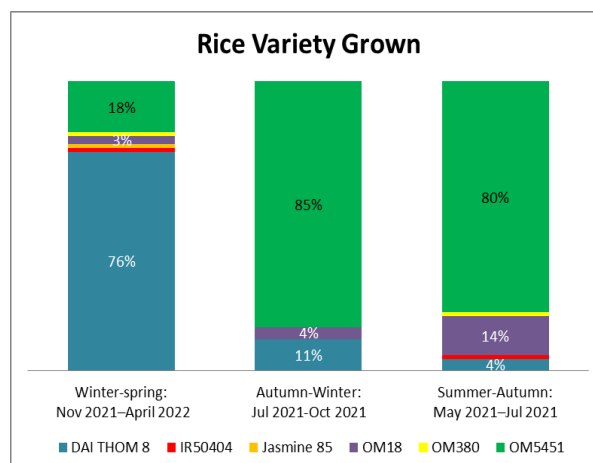


Fig 3. Rice varieties grown from May 2021 to April 2022

The survey revealed that planting rice was the longest during the winter season with an average of 100 days. Before sowing, farmers experience flooding in the field. During the winter-spring season, the field is flooded for 30 days, on average, before sowing (Table 5). The majority of the farmers experienced flooding before sowing (96%) during this season while the prevalence of farmers who experienced flooding of rice areas decreased for the rest of the planting year (Fig 4). Farmers dried the field four (4) times per season, on average. However, there were farmers who did not dry the field during the cropping season.

Table 5. The farming practices in growing rice

Farming practices	Winter-spring: Nov 2021–April 2022 (Current season)			Autumn-Winter: Jul 2021–Oct 2021 (Previous season)			Summer-Autumn: May 2021–Jul 2021 (Previous 2 seasons)		
	n	mean	Range	n	mean	Range	n	mean	Range
Length of rice planting (in days)	74	100	90–115	74	96	87–115	74	96	90–115
No. of days field is flooded before sowing	71	30	2–60	65	9	2–30	63	8	2–30
No. of times of field drying during cropping season	72	4	0–8	71	4	0–8	70	4	0–8

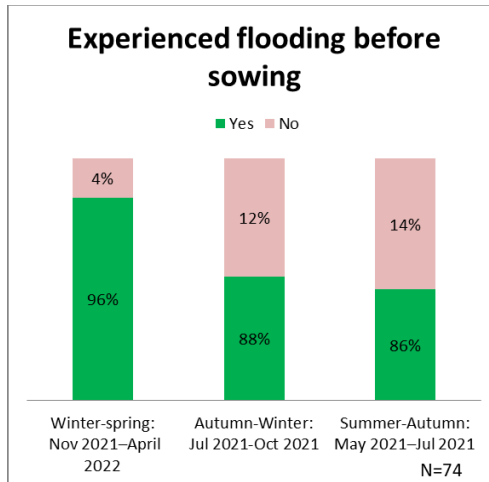


Fig 4. The distribution of farmers who experiences flooding of rice field before sowing across season

Out of 58 farmers who responded, only 28% of farmers employed other types of organic fertilizers. Among those who utilized organic fertilizers, the majority preferred humic substances (63%), followed by compost (19%) (Fig 5). It is worth noting that out of 24 farmers who responded, around 83% of the farms procured their organic fertilizers from traders.

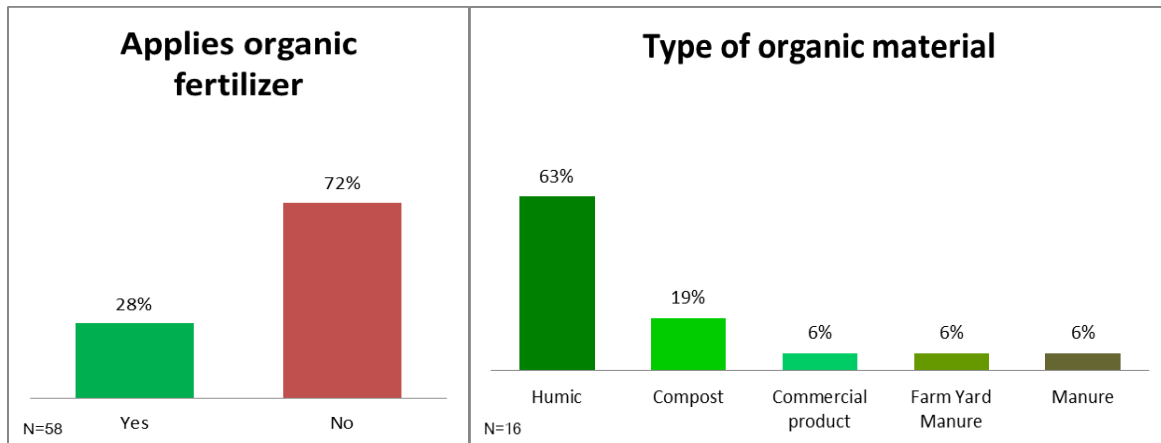


Fig 5. Fertilizer application and the type of organic material in the fertilizer

### 3. Rice straw-based value chain

A value chain, in the context of agriculture, is a set of actors and activities that are involved in bringing an agricultural product from production to final consumption, with value addition at each stage (FAO, 2018). A rice straw value chain is the full range of farms and firms and their successive coordinated value-adding activities to transform a particular intermediate rice straw product into a particular end-product which is sold to final consumers in an end-market (FAO, 2014, Demont, et al., 2019). Value chains are demand-driven. In contrast, rice straw supply chains are primarily driven by the availability of supply since rice straw is a by-product. Technically, the rice straw value chain does not satisfy the traditional definition of a value chain.

Nevertheless, the concept of a value chain can be utilized to ensure that strategies for improvement are aligned with the demands of the market.

### 3.1. The value chain actors and supporters

Following the Sustainable Food Value Chain (SFVCD) Framework, the core rice straw-based value chain comprises the input supplier (i.e., rice farmers) who grows rice, produces rice straw after harvest, and sells rice straw to end-users (i.e., farmers and gardeners), processors (i.e., mushroom and compost) who procure rice straw as a raw material for producing their RS-based products, wholesalers who aggregate RS-based compost and sell, and retailers who sell RS-based compost to end-users as an input to the next value chain or as feed for consumption. These actors use their own capital in purchasing rice straws and thereby share risks such as price, quality losses, physical losses, or damage. The “service providers”, such as rice farmers who trade rice straw from other rice fields, liaise the collection and transportation of rice straw from the field to the processors. The use and reuse of rice straw in mushroom and RS-based compost production illustrates a circular economy of rice straw translating to lowering of GHG emissions.

#### 3.1.1. Rice Farmers

The farmers are the main value actor who supplies rice straw to the RS-based value chain. Results from the survey showed that a significant portion of farmers (86%) removed rice straw directly from the field and utilized baler machines for collecting rice straw. During the Winter-Spring season, nearly a quarter of the farmers (23%) resorted to burning rice straw after harvest. Additionally, 26% of farmers incorporated rice straw into their fields before sowing, with a maximum duration of 30 days, primarily during the winter-spring season (Fig 6).

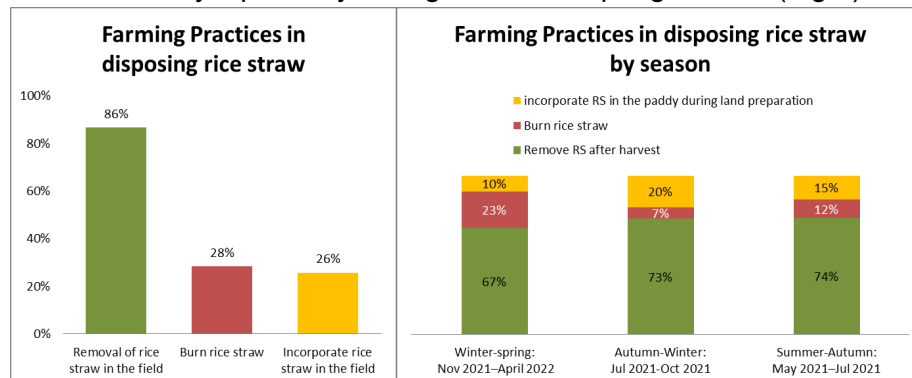


Fig 6. Farming practices in disposing of rice straw

Most of the farmers collected rice straw with the intention of selling (81%). However, a few farmers repurposed rice straw for various other uses, including farming, mushroom cultivation, composting, mulching, and livestock feed (Fig 7).

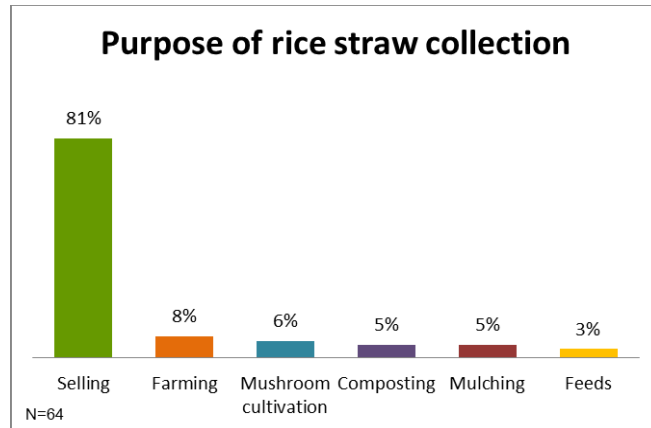


Fig 7. Purpose of farmers in collecting rice straw

In selling rice straw, a substantial portion of buyers imposed specific quality standards. Only a minority of buyers (24%) entered into written agreements with the farmers, primarily concerning price (92%) (Fig 8). Additionally, roughly one-third of farmers possessed knowledge about the end market for rice straw, with this information typically originating from their initial buyers or traders (85%). Moreover, nearly half of the farmers also gleaned market insights from their neighbors or fellow farmers (48%) (Fig 9).

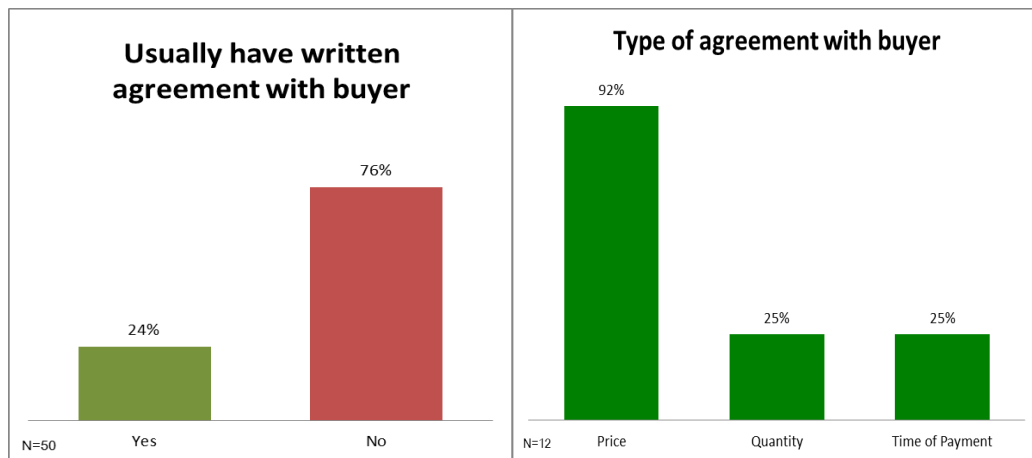


Fig 8. Farmers' agreement with buyers when selling rice straw

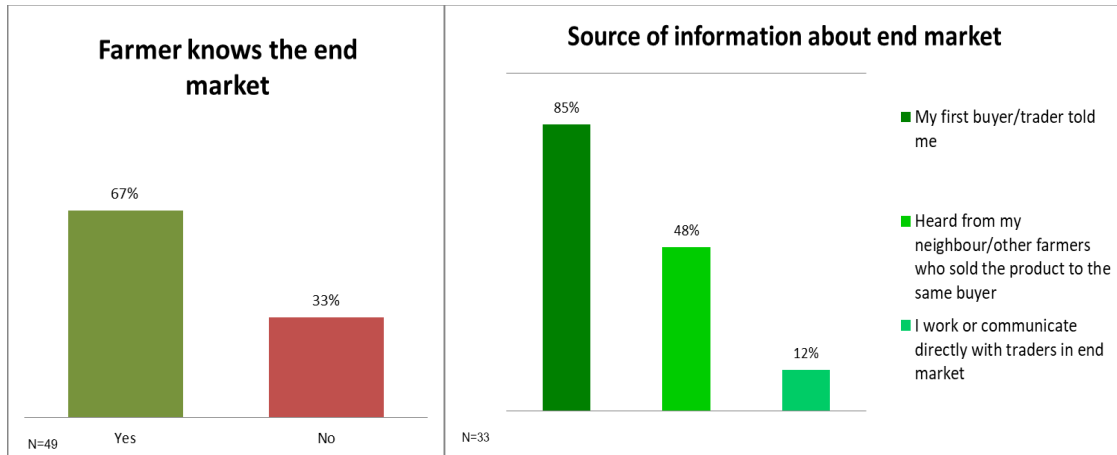


Fig 9. Farmers' source of rice straw's market information

### 3.1.2. Rice straw traders

A rice straw trader, often a rice farmer, operates by procuring rice straw from local rice farmers in Can Tho, Vietnam. Typically, within three days of the rice harvest, the local farmers must clear their fields to make way for new crops. In this process, they utilize a baler machine to efficiently bundle the rice straw, which the rice straw trader contracts. These baler machines are owned by larger companies. Each bale of rice straw weighs approximately 18-25 kg, making it a manageable unit for transportation. These bales are temporarily stored in outdoor locations for about three months, protected from the elements by covering them with canvas and plastic.

Traders constituted the primary source of market information for selling rice straws. The primary market for the rice straw includes garden owners who use it for mulching and mushroom growers who utilize it as a substrate for mushroom cultivation. The peak demand for rice straw occurs during the transition from winter to summer, with February being a particularly high-demand period. Conversely, the lean period falls between June and July. They liaise the selling of rice straw from farmers' fields and the need for processors of rice straw as their raw material in their product. They rent baler machines for the collection and transportation of rice straw, at the expense of their customers. On some occasions, raw rice straw is sold to compost processors.

### 3.1.3. Processors

Processors of RS-based products includes the use of raw rice straw as a substrate in growing mushroom and used rice straw in producing a compost fertilizer. The section below describes the processing of RS-based mushroom and compost fertilizer.

### *RS-based Mushroom*

Mushroom growers source their rice straw through rice straw traders. They maintain a continuous growth cycle, planting mushrooms approximately 20 to 24 times each year. To support their mushroom cultivation, they rely on a substantial quantity of rice straw, typically ranging from 700 to 1,000 bales. The cost of these bales varies from 20,000 VND to 25,000 VND per bale, inclusive of transportation expenses. Consequently, mushroom production can incur expenses of up to 55,000 VND, accounting for labor, raw materials, and transportation costs. Furthermore, the selling price of mushrooms exhibits a seasonal pattern, reflecting the changing dynamics of the market throughout the year. During the dry season, spanning from December to February, mushrooms typically command higher prices due to reduced supply. In contrast, the rainy season from February to June ushers in more moderate prices. From June to October, the market often experiences a downturn, resulting in lower prices for mushrooms. These seasonal fluctuations underscore the importance of timing in mushroom cultivation and sales strategies.

The rice straw required for mushroom cultivation is primarily sourced from various locations in MKD, including Trà Vinh, Vĩnh Long, Kiên Giang, Sóc Trăng, Cà Mau, and Cần Thơ. Once the mushrooms are harvested, they are typically sold at prices ranging from 40,000 VND to 80,000 VND per kilogram. Mushroom traders handle the transportation costs when purchasing the grown mushrooms from the farmers.

Following the mushroom harvest, the used rice straw is sold to rice straw traders, fetching prices of approximately 2,500 VND to 3,000 VND per bale. Some of the used rice straw materials are sold to composting processes, contributing to the growth of ornamental plants and fruits in regions such as Kiên Giang, Đồng Tháp, Cần Thơ, and An Giang.

### *Rice straw-based compost*

The manufacturing and processing operations involved in the production of RS-based compost follow a meticulous sequence of steps. Initially, the process entails stacking windrows with alternating layers of rice straw and cow manure. Subsequently, the first turning of the windrow is carried out, accompanied by the incorporation of a solution comprising inoculant, molasses, and water. To maintain optimal conditions, the windrows are covered with canvas, and crucial parameters such as temperature, moisture, and pH levels are monitored. As the process progresses, the second turning of the windrow is performed after a span of 7 to 10 days. At this stage, coconut coir and rice husk ash are introduced into the mix during the third turning. To ensure the quality of the compost, canvas coverings remain, and continued assessments of ventilation, temperature, moisture, and pH levels are conducted. This composting process ultimately culminates in a period ranging from 45 to 60 days.

Used rice straw, which is lower in price compared to raw rice straw, is obtained from either mushroom farmers or rice straw traders, while cow manure, coconut coir, and rice husk ash are procured from local traders. These raw materials originate from diverse regions within the

Mekong River Delta, with rice straw and rice husk ash hailing from Can Tho Province, cow manure from Tra Vinh Province, and coconut coir from Ben Tre Province. The acquisition of these raw materials is facilitated through a combination of ordering via mobile phone and transportation by the processor. The form in which these materials are acquired varies, with cow manure, coconut coir, and rice husk ash typically packaged in bags, while rice straw is sourced directly from the field.

The machinery utilized in the processing operations includes tractors and turning machines, vital for the composting process, as well as machines used for packaging the final product. A compost turner is crucial for mixing the raw materials, although a rented tractor is required to operate this turner. On certain occasions, there were delays in initiating the composting process due to the unavailability of the tractor, consequently impeding the timely production of compost.

Following production, the processor engages in packaging the compost in both small and large sizes. These materials are typically packed in 2.5 kg and 25 kg bags, with nylon bags being a common packaging choice. The smaller packs are utilized for demonstration purposes, while the larger packs are intended for sale. The finished product is stored in a warehouse for 3 to 6 months, ensuring its readiness for distribution. The raw materials themselves are not stored in a warehouse, as they are acquired on an as-needed basis. The selling price of RS-based compost exhibits a fluctuating range, varying between 2,500 VND and 4,000 VND.

#### 3.1.4. Wholesalers

The wholesalers of organic composts are value chain actors who procure the following products: 1) organic fertilizer, 2) RS-based compost, and 3) inorganic fertilizer and then sold the product in bulk. The products are mainly sourced from Lai Vung district, Đồng Tháp provinces. The RS-based compost is typically purchased from processors and mushroom growers while organic fertilizers are bought from fertilizer companies. There are occasions when the products they sell are also sourced from other wholesalers of organic composts. The wholesalers subsequently sold their products to farmers, garden owners, retailers of organic composts, and to some extent, other wholesalers in baskets or using plastic bags weighing 2.5 kg for small packages and 25 kg for larger purchases.

Wholesalers whose RS-based compost is their most traded product used the processors' company branding in the packaging. The RS-based products are stored in a warehouse only for a short period of time. For other wholesalers, the RS-based compost is collected using boats and temporarily stored in baskets for 3-15 days, while some are collected by trucks where the source will transport the product to the wholesaler.

In terms of their relationship with buyers, the wholesaler in Can Tho City has been conducting business with customers for more than a decade, establishing long-term relationships built on trust. They operate without formal contracts, with payment being made in cash and pricing decisions left to the wholesaler.

### 3.1.5. Retailers

The retailers in this context are primarily store owners who have been engaged in selling agricultural products. The range of products they offer includes rice straw compost, coconut coir, rice husk ash, and organic fertilizer. These products are sourced from specific regions, such as Lai Vung district in Đồng Tháp province, Phong Hòa hamlet in Lai Vung commune, Cần Thơ, while the RS-based compost from the New Green Farm Cooperative.

In terms of their customer base, retailers primarily cater to farmers, gardeners, and rice farming cooperatives. They operate within specific regions serving Đồng Tháp province and Cần Thơ City. From the KII, retailers sales methods vary, with the first retailer transporting products directly to farmers and gardeners within their province, the second welcoming customers to their store, and the third primarily relying on farmers visiting and purchasing products themselves. The products are typically sold in bagged form, with different weight options such as 2.5 kg and 25 kg.

Regarding the sales patterns, the first retailer experiences their highest sales volumes during the months of August to October, typically attributed to preparations for the Tet holiday. In contrast, their lowest sales months align with the remaining months of the year. The second retailer witnessed peak sales from May to June, while maintaining relatively consistent sales throughout the year. The third retailer's sales peak during the winter-spring season, spanning from October to March of the following year, and experiences relatively steady sales during the other months. These variations in sales are influenced by factors such as seasonal demand and agricultural practices.

### 3.2. Supporting market

The rice straw trader has sustained trading for the past 4-5 years without any external financial support, relying solely on field prices and engaging in additional side jobs to support their operations. Notably, trading faces no competition and continues to thrive due to the increasing demand from local farmers. One noteworthy aspect is that buyers of rice straw have established long-term relationships with the trader. The rice straw trader places trust in the information provided by their customers. There are no written contracts involved in these business transactions. Typically, buyers engage in price negotiations, but the final price is determined by the rice straw trader. Payments are made in full, using cash.

The processors and wholesalers operate with their own capital and do not seek financial assistance. The wholesaler's relationship with buyers is based on long-term connections, including farmers, gardeners, and retailers. They do business without formal contracts, with payments made in cash, and pricing is decided by the wholesaler. Buyers occasionally provide information regarding market trends.

### 3.3. Value chain map: The circular economy of rice straw-based value chain

#### 3.3.1. Linkages between rice straw-based value chain

Linkages in the rice value chain in the MKD involve the upstream, midstream, and downstream segments. The upstream segment includes the input supply for mushroom and compost production. The midstream level includes the rice straw collection, transportation, and processing, and distribution of RS-based products (i.e., raw and used rice straw, mushroom, and compost). The retailer, a value chain actor in the downstream segment, sells to local users of RS-based product used as an input to the next value chain or feed for ruminants. This created a circular economy by completing the cycle of rice straw, starting from its collection in rice fields, through its use in mushroom cultivation, and ultimately its recycling as an input material (i.e., fodder, fertilizer for rice, fruits, and flower).

Fig. 10 depicts the value chain map of RS-based products in the MKD. This schematic diagram is based on FGDs with farmers and KII with VC actors. The left panel shows the activities in the value chain while the rest of the figure depicts the flow of rice straw to mushroom production and the recycling of used rice straw to produce RS-based compost. The **rice straw** flows are depicted through green solid arrows while **used rice straw** flows are depicted by green solid double arrows. The flow of RS-based products is outlined with dotted lines of colors brown for mushrooms, and blue for compost. Service providers are depicted by boxes in broken lines while input material with heavy solid lines.

The structure of the RS-based compost value chain is found to be “geographically and intermedationally short”, wherein rice straw and RS-based compost are mainly traded within MKD, featuring rice straw traders liaising rice straw from the rice field to mushroom growers. After mushroom production, the used rice straw was aggregated by processors for compost production. Processors, also a wholesaler) then sell the compost in bulk to other wholesalers and retailers. The midstream segment (i.e., processing of RS-based products) presents a vertical integration and dis-intermediation. A cooperative in Can Tho City aggregates rice straws for their mushroom production. They then reuse the rice straw after harvesting mushrooms to process RS-based compost and sell them in bulk to other wholesalers. On some occasions, they directly purchase used rice straw from other mushroom growers revealing that this occurrence of “dis-intermediation” or cutting middleman. The dis-intermediation in the RS-based value chain tends to reduce transaction costs and increase profit for the cooperative.

#### 3.3.2. Flow of rice straw in RS-based value chain

We try to map the flow of rice straw to the value chain of RS-based products, focused on the compost fertilizer in MKD. Fig 10 presents the schematic diagram of the value chain map of RS-based products in the MKD.

### *Upstream segment*

From the survey results, most rice farmers practice removing the rice straw directly from the field and utilize baler machines for collecting rice straw. Moreover, most of the farmers remove the rice straw for selling. Used rice straw also served as an input supply as raw material for compost production. This segment also includes the sourcing of other raw materials that served as input supply for producing RS-based mushrooms (i.e., mushroom spawn), and compost (i.e., bio-products, cow manure, coconut coir, and rice husk ash). are traded and supplied to processors of biodegradable products.

### *Midstream segment*

The midstream segment starts with the trading of rice straw from farmers to processors. Rice straws are sourced in two ways: (1) raw rice straw from the field, and (2) used rice straw after mushroom production. Rice straw traders who have information about the markets inform rice farmers about potential buyers and then facilitate the collection and transportation of dried rice straw with baler machines to its customers including mushroom growers, compost processors, ruminant raisers, garden owners, and other local users (e.g., small-scale farmers and gardener). The rice straw is then utilized as an input supply for mushroom production, composting, feed for ruminants, and for mulching.

The next stage in the midstream segment is processing. Raw rice straws, along with mushroom spawn, are utilized to produce RS-based mushrooms. Following the harvest of mushrooms, the used rice straws are sold to processors of RS-based compost. A mushroom processor in Can Tho City, who also processor compost fertilizer, reuses its used rice straw for processing compost. In the event that they have a limited supply of used rice straw, they then source raw rice straw through rice straw traders, which is found to be more expensive than used rice straw.

The last stage in the midstream segment is the distribution of RS-based products. After the mushroom production, mushroom growers sold RS-based mushrooms to mushroom traders which they distributed to wholesalers. On the other hand, the distribution of RS-based compost of one cooperative in Can Tho City flows in several ways: 1) wholesaler only selling RS-based compost, 2) wholesaler of organic fertilizer, and 3) retailer selling RS-based compost and organic fertilizer, and 4) directly to local users as an input to the next value chain.

### *Downstream segment*

The retailers mainly sold organic fertilizers to the end-market and added the RS-based compost as an additional product in their product catalog. The buyers of RS-based products are local farmers who visit the retailers' stores.

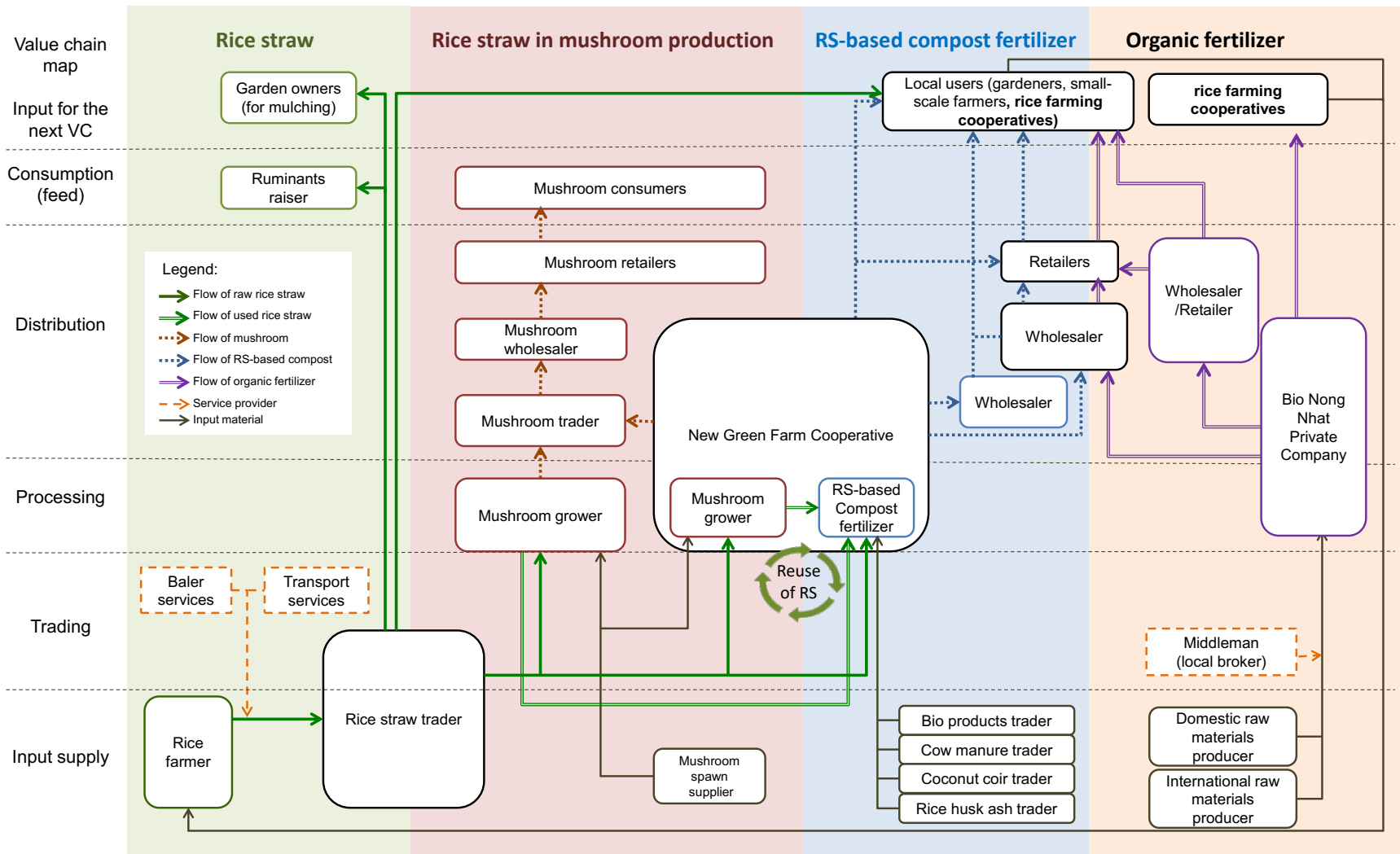


Fig 10. The value chain map of RS-based products in the MRD, Vietnam

### Box 1: A special case of horizontal and vertical integration (midstream to downstream)

New Green Farm Cooperative is a cooperative in Can Tho City, Vietnam which engages in horizontal and vertical integration from production which is characterized as same organization dealing with different processes in the value chain (FAO and UNDP, 2020). The cooperative actively promotes the RS-based compost through field demonstrations, often in collaboration with the International Rice Research Institute (IRRI), and offers samples of the RS-based compost for trials. Their primary customer base comprises other wholesalers and retailers, with a focus on distributing biodegradable compost products (i.e., RS-based mushroom and compost, and organic fertilizer). The New Green Cooperative uses rice straws to produce mushrooms. After harvesting the mushroom, the used rice straw from mushroom production is utilized to produce rice-straw-based compost. The used rice straw is mixed with other raw materials in making biodegradable compost such as humic etc. The cooperative owns a turner that is used for mixing the raw material; however, they would need to rent a tractor for the turner. There were times when cooperatives had to wait for the tractor to be available before they could start processing the compost, hence, delaying the production of the compost. It takes several days/months to produce rice straw-based compost.



Fig 9. RS-based compost processing and packaging

After the production, the cooperative also packs the compost in small (i.e., 2.5 kg) and large (i.e., 25 kg) sizes. The smaller pack is given as a tail pack or for demonstration while the larger pack is for selling. The cooperative promotes the RS-based compost through field demonstration, with the help of IRRI, and provides a sample of the RS-based compost for trial. Mainly sells biodegradable compost to other wholesalers and retailers. They have a salesman who goes to different provinces to promote their product. If some farmers would like to buy compost from the cooperative, they refer them to a retailer of biodegradable compost. The retailer mainly sells compost to farmers (i.e., rice, fruits, and vegetables).

## 4. Trends, opportunities, and constraints in rice straw-based compost value chain development

### 4.1. The opportunities in the RS-based compost value chain

During the Multistakeholder Workshop, opportunities that were raised included the state policies aimed at promoting the production of organic vegetables and substrate, alongside ambitious local programs like the cultivation of one million hectares of high-quality, low-emission rice. These measures align with the surging market interest in organic vegetables and substrate, as consumers increasingly prioritize healthier and more sustainable choices. Additionally, a growing number of farmers are keen to remove rice straw from their fields, leading to a rising demand for rice straw collection services. This shift is not just about field cleanliness; it's also driven by the recognition of the benefits of using rice straw-based compost for organic produce. This eco-friendly practice not only promises higher profits but also contributes to environmental friendliness by reducing greenhouse gas emissions.

### 4.2. Challenges faced in the RS-based compost value chain

The challenges faced in the RS-based compost value chain include the shortage of local labor and a lack of large-scale collection services equipped with baler machines, which results in price instability for rice straws. Technological limitations persist, particularly in the collection of wet rice straw and the production of rice straw-based compost in various forms (i.e., pellet form, powder form). These constraints contribute to the low adoption and application of rice straw technology. Additionally, there is a limited availability of used rice straw from mushroom cultivation for compost production. Rice straw from the field is found to be more expensive than used rice straw. One of the challenges retailers face during transactions is price fluctuations based on seasons. Challenges also include negotiations based on the current price when dealing with garden owners as suppliers and the introduction of products to new customers.

### 4.3. Future Prospects

Looking ahead, the rice straw trader anticipates a steady increase in demand over the next five years, driven by consistent market requirements and a lack of competition in their segment. The demand for RS-based compost is already rising among rice farmers, and there's potential for increased demand in the coming years from gardeners growing fruits and vegetables. Looking ahead, wholesalers expect to remain competitive and do not anticipate significant changes in their operations or clientele. On the technological side, the midstream actors are anticipating enhancements in compost format, such as pellets, across different crops, along with improvements in its overall quality.

## 5. References

Dobermann A. & Fairhurst T.H., 2002. Rice Straw Management. Better Crops International Vol. 16, Special Supplement.

[http://www.ipni.net/publication/bci.nsf/0/163087B956D0EFF485257BBA006531E8/\\$FILE/Better%20Crops%20International%202002-3%20p07.pdf](http://www.ipni.net/publication/bci.nsf/0/163087B956D0EFF485257BBA006531E8/$FILE/Better%20Crops%20International%202002-3%20p07.pdf) (2002).

**FAO.** 2018. *Developing gender-sensitive value chains: Guidelines for practitioners*. Rome. (also available at <http://www.fao.org/3/a-i6462e.pdf>).

FAO and UNDP. 2020. *Toolkit for value chain analysis and market development integrating climate resilience and gender responsiveness - Integrating agriculture in National Adaptation Plans (NAP-Ag) Programme*. Bangkok. <https://doi.org/10.4060/cb0699en>

IRRI (International Rice Research Institute), 2019. Final report of the BMZ-funded IRRI sustainable rice straw management project (unpubl.).

Nguyen V.H., Sander B.O., Quilty J., Balingbing C., Castalone A.G., Romasanta R., Alberto M.C., Sandro J.M., Jamieson C., Gummert M., 2019. An assessment of irrigated rice production energy efficiency and environmental footprint with in-field and off-field rice straw management practices. *Scientific Reports* (2019) 9:16887. <https://doi.org/10.1038/s41598-019-53072-x>.

# ANNEX