Research article

Production and Utilization of Crop Residues in Cambodia: Rice Straw, Corn Stalk, and Cassava Stem

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Abstract Rice is the main staple crop, followed by cassava and corn in Cambodia. Annually, million tons of these crops are produced with the particularly need is its grain or root. After harvesting, these crop residues are usually collected for various purposes. Some of them are burned (the easiest option for farmers), which leads to loss nutrients and air and environmental pollution. However, it is limited report on these crop wastes production and utilization, and the crop residues management remain a challenge in Cambodia. Therefore, this study was conducted to assess to what extent that crop residues are available for further processing in Cambodia manufacture. Two hundred eighty eight key informers, were selected purposively to be interviewed through structure-questionnaire interview. The results showed that the crop residues were produced annually approximately 8.6, 0.9, and 2.9 million ton for rice, corn and cassava, respectively. The rice straw was collected for supplementary feed to cattle, vegetable mulch-based and mushroom production. The cassava stem was collected for next year planting and selling to other farmers. In term of quantity, the crop residues collection was just to meet the household's utilizations and the remaining are burned. For better crop waste management and practice, other alternative uses, for instance development

of packaging products, construction materials, paper and renewable energy such as biogas and bio-energy using these residues, will change the open-field option and add value chains to the farm owners and rural people.

Keywords: crop residues, rice paddy, corn stalk, animal feed, mushroom, packaging products

INTRODUCTION

Agriculture is one of the priorities economic activity in Cambodia, which contributed about 21% to GDP in 2019 with the contribution of crops, animal production, fisheries resources, and forestry resources were about 58%, 11%, 24%, and 7%, respectively. Rice is regarded as the main staple crop in Cambodia, approximately 3.328 million hectares planted with the average yield 3.338 ton per hectare (totally 10.885 million tons paddy rice produced in 2019) (MAFF, 2020). Rice straw is a residual by-product of rice at harvest. The total biomass of this residue depends on various factors including: varieties, soils, nutrient management and weather. The ratio of straw to paddy varies, ranging from 0.74 to 0.49 (Nguyen, et al., 2016, Nguyen, et al., 2020). At harvest, rice straw is piled or spread in the field depending on the harvesting methods, using human labor plus stationary threshers or self-propelled combined harvester. Rice straw that remains in the field after harvest can be collected, burned, or left to decompose (soil incorporation).

The intensification of rice production and rising labor costs have led to the spread of combine harvesters in Asian rice fields. Combine harvesters leave loose rice straw on the ground, making its collection and transportation difficult, laborious, and costly. Farmers choose the quick solution of burning rice straw to quickly remove the biomass and prepare the field for the next crop. In-field burning of rice straw contributes to greenhouse gas emission and poses health and environmental hazards (Tabil, 2011).

Unlike rice, corn and cassava are industrial crops, planted on approximately 200 thousand and 656 thousand hectares, respectively in Cambodia. There are two types of corn: white corn (mainly for human food) and yellow/red (mainly for animal feed) in term of grain (MAFF, 2020).

Annually, million tons of crops and its biomass are produced, but it is limited report about the residues. Even though, some amounts of the crop wastes are collected and used for various purposes and literatures showed that the agricultural waste has complex carbohydrate similar to those of wood sources, i.e, percentage of cellulose, hemicellulose and lignin (Theng, 2017), but field burning is still heard a quick solution for farmers to clear the land for next crop. Among several crops in Cambodia, rice straw, corn stalk and cassava stem are seasonal crop residues with widely available and fast growth, compared with wood sources.

OBJECTIVE

The study aimed to assess to what extent that crop residues are available for further processing in Cambodia manufacture.

METHODOLOGY

The results presented in this article are based on quantitative and qualitative methods of primary data collection. The total of 288 households are dealing with rice, corn and cassava production, utilization and supply of the crop residues were subjected for the interview. The study was conducted in six provinces including: Kampong Cham, Kampong Thom, Battambang, Kampong Chhnang, Kampong Speu, and Takeo (Fig. 1). The data collection instrument was a structure-questionnaire (Sa, 2011). The samples are purposively selected (Norng et al., 2011). The collected data was analyzed using SPSS computer software.

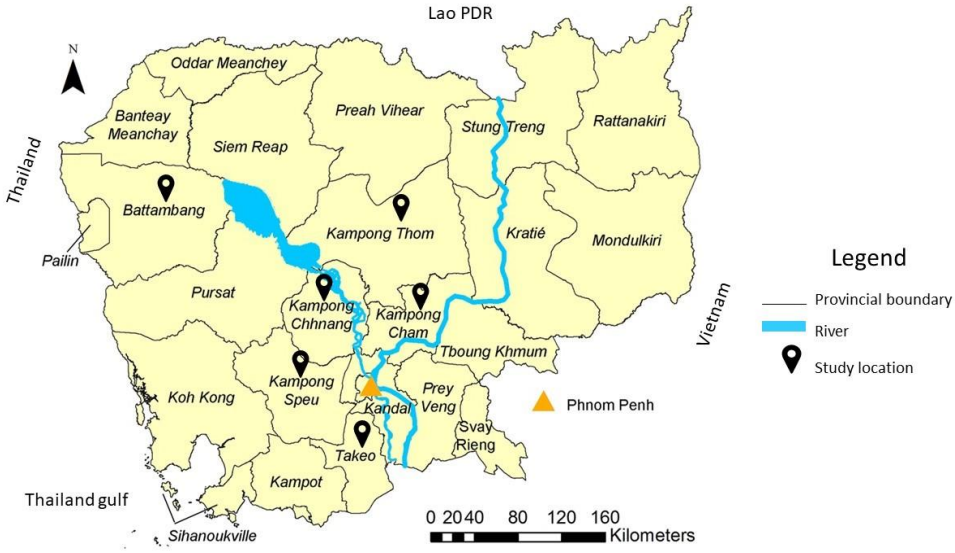

Fig. 1 Map of Cambodia and selected provinces for the data collection

RESULTS AND DISCUSSION

Household Demographic for Agricultural Categories

Table 1 shows the types of agriculture in the study sites. There were 232 (53.2%) rice producer, 36 corn, cassava, and other crops, 15 vegetable growers, 130 cattle producers with 9 cattle farms, and 23 mushroom producers. The household scale cattle are cows or water buffaloes raising at home with the number from 1-13 heads per household (4.22 heads in average) were observed, whereas the farm scale of cattle is raising in a large area of land with more number from 50 to 700 heads (137.77 heads in average) per farm were investigated.

Table 1 Types of agriculture in the studied areas

Agricultural categories	Frequency	Percentage
Rice	232	53.2
-Wet season rice	210	-
-Dry season rice	122	-
Plantation crops (corn, cassava, cashew, bean)	36	8.3
Vegetable	15	3.4
Cattle (farm scale)	130 (9)	29.8
Mushroom	23	5.3

Crops and Crop Residues Production

Rice, corn, and cassava is grown on 0.1 to 300 ha, 0.1 to 10 ha, and 0.5 to 100 ha per household, respectively (Fig. 2). The wet season rice was grown by 210 farmers on the land size range 0.1-50 ha and dry season rice was grown by 122 farmers on the land size from 0.1 to 300 ha. This study found that approximately 50% of the farmers grow 3 times a year for both seasonal rice. But, the majority a household owned between 1 and 2 ha and can grow rice only once a year with few can grow up to 3 times a year depending on irrigation availability and flooding condition. The average yield paddy was 3-6 ton per hectare of grain depend on variety, location, production time, input and water supply, and care. It was in range of the average yield 3.338 tons ha^{-1} (MAFF, 2020). However, there was no investigation and record about rice straw.

Corn and cassava are classified as upland crops, cultivated on smaller area and number of farmers, compared to rice. In this study, the yellow corn variety and cassava are found in Kampong

Cham, Kampong Thom and Battambang Provinces. The average yield of corn grain was 5-10 tons ha-, higher than the literatures (MAFF, 2020; PPDA, 2012; Net et al., 2013) i.e, about 4.5 tons ha^{-1}, but in the range compared to Belfield et al. (2013) and the average yield of cassava is 20-30 tons ha^{-1}. Corn and cassava can be grown two times per year or diversify together (Net et al., 2013). According to the key informers, the yield of cassava plant or stem was around 1500 bunch per hectare with around 3 kg a bunch.

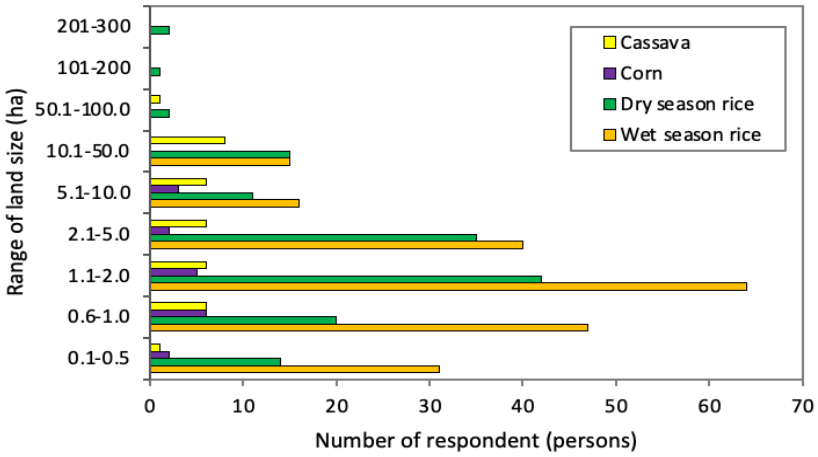

Fig. 2 Land size belong and/or rental by individual household for rice, corn, and cassava

Collection and Utilization of Crop Residues

Fig. 3 showed that about 55%, 0%, and 82% of the respondents collected rice straw, corn stalk, and cassava stem, respectively. The rice straw was collected in quantity ranging from less than 1 ton per year per household to more than 1000 tons and the cassava stem up to 3-5 tons (Fig. 4). Approximately 80%, 8%, and 12% of the collected rice straw was used for cattle feed, mulching and mushroom production, respectively (Fig. 5). The quantity of rice straw needed for household cattle was small, just below 10 tons per year depending on the number of cattle, the available time of household members to collect green grass, and the available free land for cattle feeding with natural green grass. Most of the cattle farm used planted grass or natural grass in orchard of coconut, longan, cashew, and other perennial crops. The more quantity of rice straw was used for mushroom production as the mushroom can be grown 10 to 13 cycles a year. The quantity from 100 to more than 1000 tons per year was collected by collectors or service providers using baler machine. The baler has high collection capacity, make easier to transport the baled rice straw from paddy to cattle farm, mushroom farm and vegetable garden, but the crop growing farmers experienced that the baled rice straw is difficult use, heavier and easier to damage when it is wet. The crop-based mulch using rice straw in vegetable production was commonly in Saang and Koh Thom Districts, bordering with Prey Kabas District of Takeo Province. Because more farmers live in Saang and Koh Thom selected vegetables growing than rice and other crops, they purchase more rice straw from other neighboring areas including Prey Kabas, Angkor Borey and Bati Districts for mulching and animal feed, whereas the other study sites collected and supplied locally. The 45% of respondents did not collect rice straw selected two means including: burning in the paddy field about 20% (IRRI (2019) reported around 3 million tons generated rice straw was burned) and other 25% was left degradation, those farmers or paddy allow once growing per year in rainy season. The cassava plant yield is approximately 10 times over the seedlings need, but generally Cambodian farmers reserved the stem at least double since sometimes experiences of damaged by drought or diseases and required the second planting. In addition, cassava plantation keeps increasing from year to year in Cambodia about 0.66% (MAFF, 2020). Therefore, the result from this study indicated that around 25% of the cassava stem was used for seedlings and the remaining was burned.

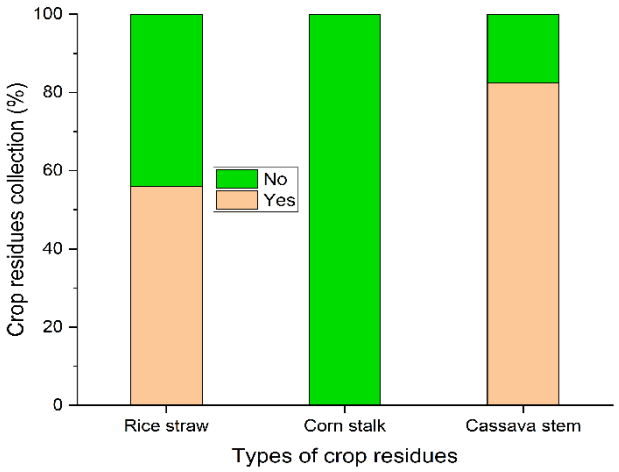

Fig. 3 Collection of crop residues by farmers

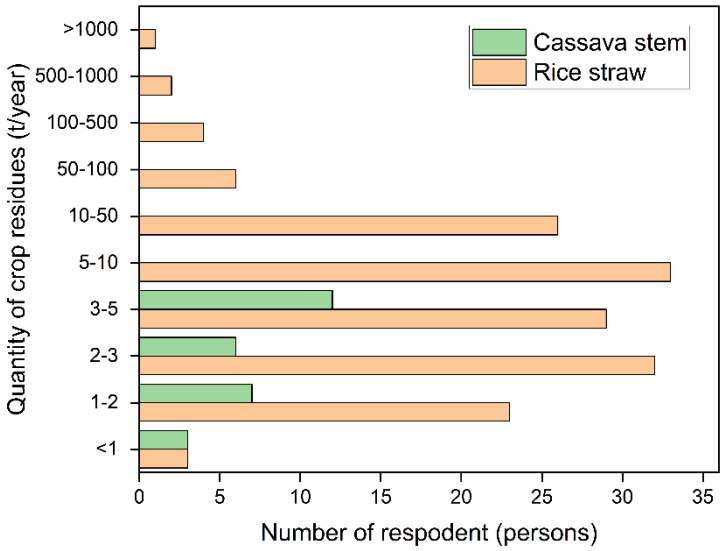

Fig. 4 Quantity of the collected crop residues

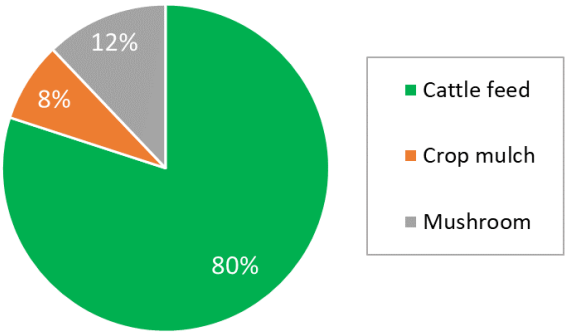

Fig. 5 Proportion of rice straw uses in Cambodia

Cost of Crop Residues

In this study, the rice straw is not value, except Battambang and Takeo Provinces, because the farmers do not care on selling the rice straw as it is widespread on the paddy with possible to collect either from their paddy or neighbors'. There is market in Battambang and Takeo provinces, although,

the farmer is paid at lower price around 17 USD per hectare when the collectors collected and sold between 20 and 50 USD per ton, depending on the location of transportation. The cassava stem costs around 1 USD/bunch of 3 kg, excluding transportation cost.

CONCLUSIONS

The by-product of rice, corn, and cassava are produced in lots of quantity with limited use seasonally and annually in Cambodia. The rice straw was used as household cattle feed, mushroom feedstock, and mulch-based vegetable production. Approximately 55% of the rice straw was collected and 45% was burned or left to natural degradation in the paddy field. In term of economic cost-effective, it is a huge loss of money when the biomass can be value added. Regarding, greenhouse gas emission through burning the rice straw, it is a high impact as million ton of rice straw is burned every year. It is similar to corn and cassava crop residues that plenty tons of biomass was produced annually and the matured corn stalk was only burn and cassava stem was only replanting. According to previous studies and literatures, the biomass has similar chemical and physical compositions compared to wood sources fiber, suitable uses for manufacturing various products such as biodegradable packaging materials, paper, construction materials, adding to the current uses for animal feed, mushroom and mulching.

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