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POTENTIAL USE OF BY-PRODUCTS FOR ANIMAL FEED FROM CASSAVA IN VIET NAM

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ABSTRACT

Cassava plays an important role in food security in Viet Nam since it is among the four most important crops including rice, maize and sweet potato. Main products from cassava are starch and cassava chips. However, a large volume of by-products and wastes from different cassava processors can be further exploited for animal feed. In the framework of GRATITUDE project, the way to gain from post-harvest losses of tubers, potential uses of cassava by-product and wastes for animal feed was identified. A Value Chain Analysis was carried out in order to get an insight of cassava production, processing and consumption in Viet Nam. Total volume of a wide range of by-products and wastes along the cassava value chain was estimated, many of which can be used for animal feed such as: leaves, pulp, and black starches generated from different cassava processing. Market research was then performed to analyze the potential use of these wastes in animal feed sectors and potential solutions for cassava wastes in Viet Nam were further discussed.

Keywords: Animal feed, by-products, cassava, Viet Nam.

Tiềm năng sử dụng phụ phẩm của ngành sắn trong sản xuất thức ăn chăn nuôi

TÓM TẮT

Cây sắn đóng vai trò quan trọng đối với an ninh lương thực của nước ta. Các sản phẩm chính được chế biến từ sắn bao gồm tinh bột và sắn lát. Trong chuỗi canh tác và chế biến sắn, còn tồn tại rất nhiều phụ phẩm có tiềm năng lớn chưa được đầu tư nghiên cứu và ứng dụng nhằm gia tăng giá trị cho cây sắn. Trong khuôn khổ dự án GRATITUDE, với mục tiêu giảm tổn thất sau thu hoạch trong canh tác các loại củ, nghiên cứu này tập trung tìm hiểu khả năng sử dụng các phụ phẩm của ngành sắn trong chế biến thức ăn chăn nuôi. Nghiên cứu đã sử dụng kỹ thuật phân tích chuỗi giá trị áp dụng cho ngành sắn từ khâu canh tác, thu hoạch, chế biến tới tiêu thụ. Khối lượng các phụ phẩm trong chuỗi đã được đánh giá và tính toán. Trong số đó, có nhiều loại có khả năng ứng dụng để sản xuất thức ăn chăn nuôi như lá cây sắn, bã sắn từ quá trình sản xuất tinh bột khô và bã đen từ quá trình sản xuất tinh bột ướt. Bên cạnh đó, nghiên cứu thị trường được thực hiện cho phép phân tích được tiềm năng của việc sử dụng các phụ phẩm này trong sản xuất thức ăn chăn nuôi.

Từ khoá: Phụ phẩm, sắn, thức ăn chăn nuôi, Việt Nam.

1. INTRODUCTION

Cassava is among the four most important food crops in Viet Nam. It has always been considered a secondary crop even though it has played an important role in national food security. According to the report on the Viet Nam's cassava situation in 2012, total cassava production of Viet Nam was 9.87 million tons, grown on 559,800 ha (MARD - Report on Cassava Sector, 2012). In Viet Nam, cassava is mostly used as fresh, chips and starch in which cassava starch and cassava chips are the main products for the export market.

A main constraint in cassava productio is the amount of post-harvest losses (PHL) (Booth and Coursey, 1974). PHL in cassava are serious concern because of its high perishability and rapid post-harvest deterioration. These losses have negative impacts such as loss of income for the stakeholders and loss of food intake and nutrition, affecting food security. The reduction of PHL and the transformation of roots into various forms for food, feed, and industrial raw material have the potential to help improve food security, create additional value in rural settings, generate income and employment and develop a more favorable balance of trade.

To reduce PHL losses and foster development along the cassava value chain, it is necessary to understand the wastes and losses created during difference stages of cassava chain, i.e. from farm to fork or from root production to final consumption. In doing so, value chain analysis (VCA), which analyses the full range of activities required to bring a product through different stages of production, processing, and marketing until it reaches the end-user has to be evaluated (Kaplinsky and Morris, 2001). Value chain analysis therefore is an efficient tool to assess the wastes and losses generated along the cassava value chain.

Post-harvest by-products (PHbP) in cassava (e.g. stems and leaves, peels, pulp, and waste water) represent an important volume and can have substantial environmental impact particularly in terms of water availability and agricultural sustainability. Efficient reuse of PHbP could add value to them and enhance the role that cassava plays in food and income security.

This paper has two-fold objective. First objective was to identify PHL and PHbP in cassava production and processing in Viet Nam as well as to assess their volume and value. Second objective was to analyse potential use of cassava PHbP in different sectors, especially in animal feed production where more than 70% of raw materials are imported.

2. METHODOLOGY

2.1. Definition of PHL in this study

PHL include 2 types of losses:

Physical losses are losses which do not have any alternative uses or residual value. They have been categorised according to the stage of the value chain where they occur: (i) on-farm; (ii) during trading, transport and handling; (iii) at the processing sites; and (iv) at distribution, retail and consumption level.

Economic losses are losses which have alternative uses. They refer to (a) spoiled or damaged product whose market price is discounted and (b) spoiled or damaged product that cannot be used for what it was initially meant. Since major issue is the deterioration of fresh cassava roots (FCR), we assumed that only FCR incur economic losses.

2.2. Time and area of survey

The survey was conducted between August and September of 2012.

Three provinces with concentarated cassava production or processing were chosen: Yen Bai province (North East region), Ha Tay province (peri-urban Hanoi in the Red River region), and Tay Ninh province (South East region).

2.3. Value chain analysis

A tool to map out the full range of actors, activities and services was required to bring a product from production to final consumption/use. The VCA has been designed in a semi-structured questionnaire to gather specific information (including by in-depth literature review) on how much, where and when PHL and PHbP occur and what are the main causes and remedies adopted by the actors involved in the different stages of the cassava value chains.

2.4. SWOT analysis

During the VCA survey, the relevant actors in the cassava value chain were identified. Critical stages along the value chain where wastes are generated were then identified. At these stages, interviews with key informants were conducted on the question of what do they do to these generated wastes. Literature review as well as industry players and expert interviews on the various sectors under consideration for potential use of a range of generated wastes were conducted. Key areas covered included description of the various sectors, description of the market segments, and SWOT analysis for the potential of cassava wastes for the various sector components. Each SWOT analysis was conducted by a group of two researchers.

3. RESULTS AND DISCUSSIONS

3.1. Overall cassava value chain in Viet Nam

The cassava in Viet Nam is mostly used as fresh, chips and starch (including wet and dry starch). Among these products, cassava starch and cassava chip are main processed products from cassava and mainly for the export market. Figure 1 represents the share of FCR for different uses.

The value chain for cassava in Viet Nam differs from region to region in terms of characteristics of the actors and interactions among them. The regions differ in terms of climatic and socio-economic conditions, cultivation practice and organization, level of specialization, scale of the processing, etc. Figure 2 represents the principal actors and their roles in the cassava value chain in Viet Nam. Key actors in the value chains include farmers, processors, labour (for specific activities such as harvesting and peeling) and traders (including agents, wholesalers and retailers). Others are catering and institutions as well as household consumers.

The cassava value chain can be divided into three sub-value chains namely (1) cassava dry starch sub-value chain, (2) cassava wet starch sub-value chain and (3) cassava chip sub-value chain.

In *dry starch sub-value chain*, farmer produces FCR and often sells it to second actor, trader or collector. Processors buy FCR from trader or directly from farmers who can bring cassava root to them. Some processors process fresh cassava roots into dry starch, especially industrial level, processors only produce dry starch. The other processors, most of whom are craft villagers, focus on their production of dry starch from wet starch. The dried starch is then sold to another middleman or directly to starch-based industries, such as modified-starch processor, noodle, confectionery, MSG manufacturing, cardboard and plywood, pharmaceutical industries. Large part of the processed dry starch (70%) is sold to exporter or directly to importer from importing countries.

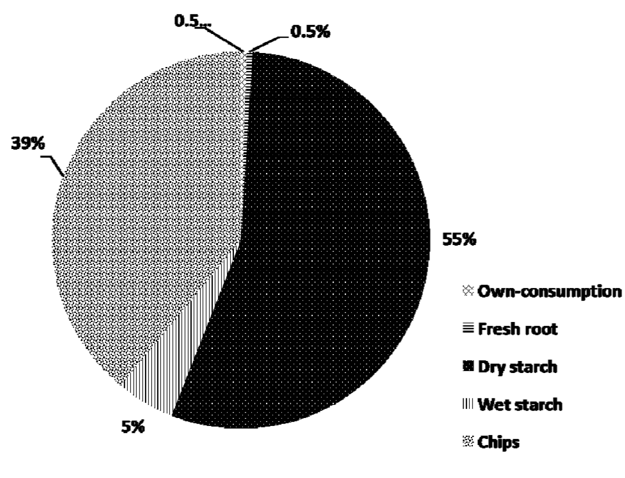

Figure 1. Share of FCR for different uses

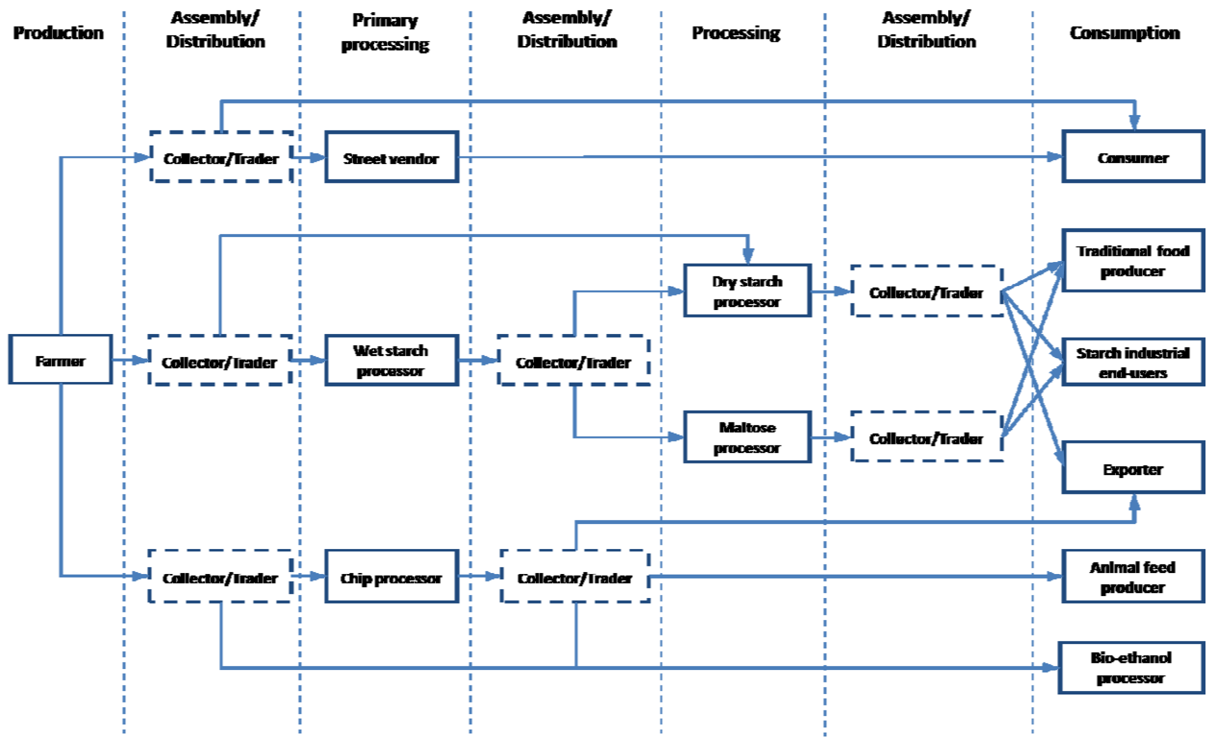

Figure 2. The overall cassava value chain in Viet Nam

The production of the *cassava wet starch* occurs mainly at craft village level in the North of Viet Nam. This sub-value chain is characterised by micro/household and small processors. Wet starch processor is the primary processor of the chain. Wet starch can be stored in anaerobic condition for quite long time or sold to other secondary processors such as dry starch processor (60%), maltose, dextrin, glucose producer or noddle and confectionary processor.

In the *cassava chip value chain*, farmer sells FCR directly to cassava chip processor or through trader. Chip processor cuts the cassava roots into slices manually or by slicing machine. After chipping, fresh cassava chip is dried using natural solar radiation or in coal kiln. The cassava chips are sold directly to end-user such as animal feed producer, bio-ethanol processor, and exporter or through trader. Large quantity of cassava chip is exported mainly to China market.

3.2. Estimation of volume and value of physical and economic losses in three sub-value chains

3.2.1. Volume of physical losses

The estimated volume of physical losses by stage of the sub-value chains is presented in Figure 3. As far as the extent of physical losses at different stages of the sub-value chains is concerned, these can be estimated as follows:

On-farm physical losses: in the dry starch sub-chain, cassava is usually purchased by the trader before the harvest. Some losses occur in the wet starch and chip value-chains because often there is an intermediary that purchases the roots harvested by the individual farmer at the farm gate and transport them to the processing site. As such some physical losses may occur in the field in case of delays. These can be estimated at 0.5% of fresh root for both sub-chains.

Losses during trading, transport and handling: during these phases some delays may occur and some roots can completely spoil and have to be thrown away. In the wet starch value chain, cassava has to be transported over considerable longer distances than the roots to be processed into dry starch and chips whose processing site are usually located nearby the cassava plantation area. Moreover, in the wet starch chain, it might take several hours to sell all the roots, which usually are delivered the day after the harvest. As such the physical losses were estimated at 2% for the wet starch chain and 0.5% for the dry starch and chip chains.

Losses during processing: good coordination of the actors exists in the dry starch chain. Some delays may occur and hence physical losses are estimated at 0.5%. In the wet starch and chip value chains in the North the considerably weaker coordination, the lower processing capacities and the higher humidity result in higher losses than in the South. These have been estimated at 1% and 5%, respectively.

Losses during distribution, retail and consumption: losses of dry starch and chips may exceptionally occur but these were negligible. Conversely some physical losses occur for wet starch when the block is exposed to aerobic conditions. In this case the outer part of the block has to be removed and thrown away and the inner part has to be immediately processed. These losses were estimated at up to 5% with 1% on average.

The chip value chain is responsible for about 75% of overall physical losses. In this value chain around 6% of roots intended to be processed into chips are lost along the chain. The great majority of losses (75%) occur at the processing sites.

The dry starch sub-value chain incurs minimal losses in relative terms (1% of roots are lost) but, in absolute terms, they represent 18% of total physical losses. Conversely, the wet starch sub-value chain incurs significant losses in relative terms (6%) but, overall, they are just 7% of total losses in the country due to the low volume of roots processed in wet starch.

3.2.2. Volume of economic losses

The price of roots is determined by their quality. As rule of thumb, the "point system" mechanism reduces the price of roots by about 10% and 20% in the first and second day after harvest, respectively. In the dry starch and chip value chain it can be roughly estimated that 75% of roots are processed the day of harvest, 20% the day after and 5% two days after. In the wet starch value chain, due to the long distances and frequent delays previously described, it is estimated that only 10% of roots are processed the same day of the harvest. Around 80% are sold the following day and the remaining 10% the day after (Figure 4).

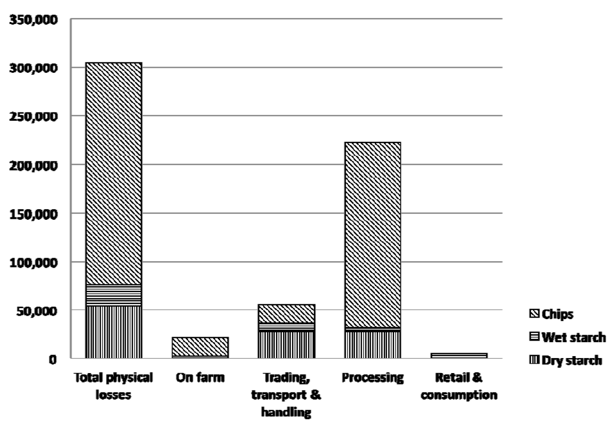

Figure 3. Estimated volume of physical losses by stage of the sub-value chains *(tonnes)*

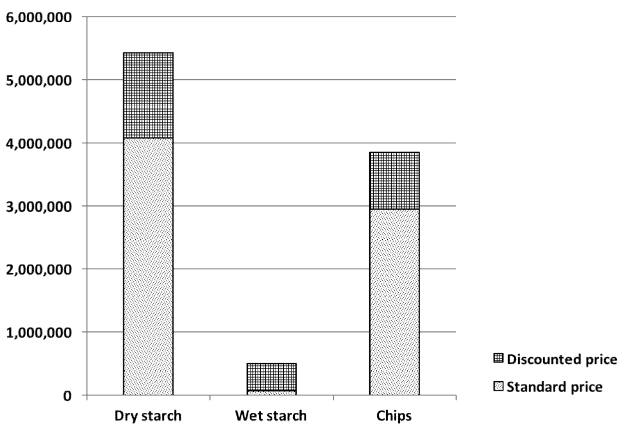

Figure 4. Estimated volume of roots affected by economic losses by sub-value chain (tonnes)

3.2.3. Value of physical and economic losses

In Viet Nam, almost 3 million tons of cassava incur some loss, either physical or economic. These losses worth over US$ 36 million per year, representing around 4% of the current retail value (Figure 5). The chip chain is the only one where the value of physical losses outweigh economic losses (by 3 to 1).

3.2.4. Identification of PHbP in the overall value chain

Table 1 shows the estimated amount and location of by-products along the cassava value chain. In the selected sub-value chains the following by-products were found:

Stems: these are found on farm. Part of them is used as planting material for the next season.

Small volumes are used for the preparation of substrates for growing mushrooms. The rest is either left in the field as organic fertilizer or burnt.

Leaves: these are found on farm and either left in the field as organic fertilizer or burnt.

Dry peels: this is a by-product of the dry starch factories. They represent around 3% of root's weight and are usually given free of charge to farmers and used as fertilizer. Only negligible amount of chips is from peeled roots.

Wet peels: this is a by-product of the dry starch factories and wet starch processors; they represent 2% and 3% of root's weight, respectively. They are also given to farmers to increase the organic matter content in the soil.

Wet pulp: it represents between 25% and 28% of root weight in the dry and wet starch sub-chains. At industrial level production of dry starch, the wet pulp is usually dried by sun or tunnel using fuel, biogas or biomass. In wet starch processing the wet pulp is usually sold to pulp collectors that sundry it and sell the dry pulp to animal feed processors, usually through specialized intermediaries.

Black starch: this is a by-product of the processing of roots into wet starch processing only. Some black starch is also produced by the reprocessing of wet starch into dry starch at small scale level but this was not taken into account in the calculations. Currently this by-product is given free of charge or sold for animal feed (mainly pigs) at household level in the area nearby the craft villages.

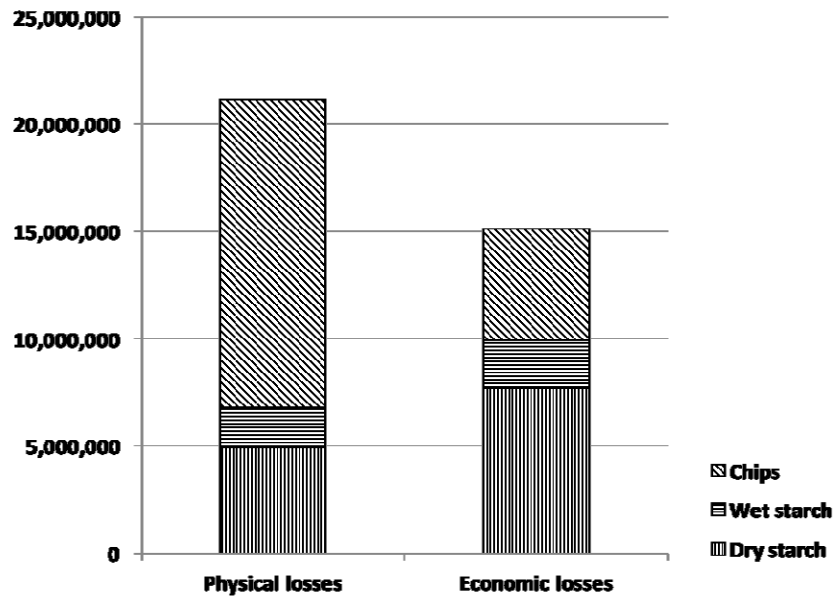

Figure 5. Estimated total value of physical and economic losses by sub-value chain (USD)

Table 1. Estimated amount and location of PHbP in the overall value chain

	Parameters	On farm (t)	Dry starch processor (t)	Wet starch processor (t)	Total (t)
Stems (t)	10 t/Ha	5,542,160			5,542,160
Leaves (t)	9 t/Ha	4,987,944			4,987,944
Dry peels (t)	3% of FCR weight (dry starch)		161,299		161,299
Wet peels (t)	2% of FCR weight (dry starch) 3% of FCR weight (wet starch)		107,533	14,221	121,753
Wet pulp	25%-28% of FCR weight		1,505,461	118,504	1,623,966
Black starch	4.5% of FCR weight (wet starch)			21,331	21,331
Waste water (m^3)	6.3 m^3/t FCR processed (dry starch) 3.5 m^3/t FCR processed (wet starch)		33,872,876	1,659,062	35,531,938

Waste water: it was estimated that around 6.3 m^3 and 3.5 m^3 of waste water are produced for each tons of fresh root processed into dry starch and wet starch, respectively. All industrial processors of dry starch produce biogas by treating the waste water while wet starch processors discharge this by-product in the surrounding area.

3.3. Potential use of PHbP in the animal feed sector

Among identified PHbP, black starch is served for animal feeding at the household level whereas dried wet pulp is one of the raw materials for animal feed production. However, the cost of drying is one the main limit for the use of dried wet pulp. The substitution of cassava leaf in animal feed for pig, poultry or aquaculture production can reduce the feed production cost thank to the availability of the leaf in large quantity. The leaf is a rich source of protein and fibre for pig production and an important source of pigment for poultry raising industry. The substitution of dried cassava powder up to 6% in chicken feed has been studied and proved that it assure the quality and growing rate of chicken (Tran Thi Hoan, 2012). However, it is necessary to estimate the production cost of the leaves into digestible form for the feeds.

The SWOT analysis of cassava leaves as a substitution in animal feed revealed that the main strength of cassava leaves is a rich source of protein, fibre and pigments for animal feed. With the availability with large quantity thanks to large cassava production, the cassava leaves would be an important source of nutrients for animal feeds. However, the toxic compounds contained in the leaves are the limiting factors for usage in the animal feed. Thus, it is necessary to have technological solutions for ensuring the safety and reducing the production costs of the digestible form of cassava leaves for raising animal (livestock, poultry and fish). With the increase of population as well as rapid economic growth in Viet Nam in the near future, the consumption for meat and, consequently, the demand for animal feed will increase. Substitution of cassava leaves in the animal feed would be an important solution for the coming years.

4. CONCLUSIONS

Viet Nam cassava value chain is characterized by a number of intermediaries or middlemen due mainly to poor infrastructure for transportation and small land allocation for cassava production, especially in the mountainous areas. By using the value chain analysis approach, it is possible to trace the movement of cassava through different stages from farm to fork and understand the magnitude as well as causes of wastes and losses occurred at each stage. The results are also a benchmark for finding solutions to reduce post-harvest losses of cassava along the value chain.

Among identified PHbP, cassava leaves are a promising source for animal feed industry to replace the high-price imported ingredients. However, due to high level of toxic cyanide compounds in the leaf, it is necessary to further process to eliminate or reduce to acceptable level of this substance. Several studies on the use of cassava leaves in animal nutrition have been carried out. However, it is necessary to investigate the assembling and production cost of the leaves as well as technological transfer for an acceptable price of cassava leaf products. The use of cassava leaves would play a significant role in the animal and animal feed industry of Viet Nam.

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