Value Chain Analysis and the Potential of Cassava-Based Bioethanol in Dak Lak Province, Vietnam

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ABSTRACT

Cassava (*Manihot esculenta Crantz*) is a versatile crop which plays a vital role not only in sustaining smallholders' livelihoods but also in increasing farmers' income in Dak Lak province, Vietnam. This study demonstrated the need for enhanced efficiency in the production of cassava. Thus, this report may lead to enhance the cassava value chain. Nevertheless, the stakeholders who participate in the cassava value chain are facing various disadvantages. Thus, finding out relevant solutions for gradually economic development farmers and stakeholders in order to increase the economic value of cassava are necessary. Furthermore, it can help farmers received more benefit from their main products as well as other actors in the cassava value chain. The study's aim is to explore how to improve and develop the value chain, to increase stakeholders' incomes and particularly, to ensure sustainable household livelihoods. The findings relating to the sharing of value added among the stakeholders showed that farmers created the highest value added but the intermediaries derived the most profit. In addition, relationships existed amongst different stakeholders ranging from input providers to the final users, which were overwhelmingly starch and ethanol factories. There was a local linkage between input suppliers and farmers, both spot-market and persistent relationships which exist between farmers and intermediaries. Furthermore, the distribution of both gross and net profits overwhelmingly favoured the traders and processors. However, intermediaries play an important role and the farmers would not secure full benefits without their support.

Moreover, many rural women, who face with the challenges of low rural incomes and gender inequality, improve their role in the farming system based on participation in the agricultural value chain thus enhancing agricultural productivity, household's income, and sustainable development. This study investigates some factors

which affect the participation in the production of cassava in Dak Lak province and decisions in relation to the cassava value chain from a gender perspective. The results show that men were prominent in all stages of cassava production. However, there was an equal gender dynamic in both cassava production and participation decisions as well as decisions relating to the quantity of cassava to be supplied for commercial purposes. This study draws attention not only to continue challenges to the role of female smallholder farmers but also to show how women's empowerment which is contingent on equity dynamics in the household as well as social norms in the community and wider society.

Finally, regarding cassava-based ethanol production, currently, encouraging the production of bioethanol from cassava has various benefits such as optimal land usage and generating sustainable livelihood for the farmer. Furthermore, these benefits especially need when the issues of greenhouse gas mitigation, deforestation, and fuel fossil shortage seriously at the global level. Cassava is becoming a major crop in Dak Lak province. It constitutes the most important candidate for poverty alleviation strategies and bioenergy production. Hence, cassava is noted to be an appropriate feedstock for bioethanol production. Principally this study was conducted to assess the potential of the available feedstock for the cassava-based bioethanol production. This study's result on the potential of cassava-based bioethanol production up to 11.84 million litres ethanol in the Dak Lak province, Vietnam. In addition, the bioethanol production potential was estimated based on the capacity of the household was fluctuated from over 3,500 to nearly 4,500 litres depending on particular districts.

Stemming from the reasons of the farmers and other stakeholders are to seek lucrative distribution channels which bring to higher economic value for the sustainable income of the household and assess the potential of cassava-based ethanol production in this area.

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I hope that this dissertation will be contributed a little part of academic knowledge for readers and bring users of the society in the future.

Ao Xuan Hoa

CONTENTS

CHAPTER I: INTRODUCTION 1
1.1 Overview of cassava value chain analysis........ 1
1.1.1 Value chain fundamental concepts 3
1.1.2 The commodity chain perspective of Filière 3
1.1.3 The framework of Michael Porter........ 4
1.1.4 The Global approach perspective........ 6
1.1.5 Cassava value chain analysis methods........ 9
1.1.6 Cassava value chain analysis 16
1.2 Overview cassava-based bioethanol production........ 23
1.2.1 Renewable energy in the global context 23
1.2.2 Overview of Bioethanol products based on cassava........ 24
1.2.3 The bioethanol production and relevant policies in Vietnam 28
CHAPTER 2. MATERIAL AND METHODS........ 30
2.1 Background and rationale........ 30
2.2 Research objective........ 31
2.3 Research question........ 31
2.4 Scope of the study 31
2.5 Significance of the study 31
2.6 Description of Dak Lak province overview and study site........ 32
2.7 Data collection and analyses 34
2.7.1 Methodology for cassava value chain through linkages among stakeholders........ 34
2.7.2 Methodology for cassava value chain and gender issue 38
2.7.3 Methodology for cassava and the potential of bioethanol production... 40
CHAPTER III: RESULTS........ 42
3.1 Cassava value chain and the sustainable livelihood of smallholder........ 42
3.1.1 Introduction........ 42
3.1.2 Review of Literature 43
3.1.3 Description of stakeholders in the cassava value chain........ 47
3.1.4 Cassava value chain distribution channel in Dak Lak province 50
3.1.5 Financial analysis of stakeholders in the cassava value chain........ 52
3.1.6 The relationships and linkages among cassava value chain stakeholders 63
3.2 Cassava value chain and gender perspective........ 64

3.2.1 Introduction 64
3.2.2 Explanation of the original and transformed variables used in the probit and OLS models 67
3.2.3 The production stage of the cassava value chain 69
3.2.4 The supply to market stage of the cassava value chain 72
3.2.5 The role of women and men as growers in the cassava value chain 75
3.3 The potential of cassava-based bioethanol production in Dak Lak province 76
3.3.1 Introduction 76
3.3.2 Cassava and its cultivation in Dak Lak province 78
3.3.3 The potential for cassava-based bioethanol production in Dak Lak 83
CHAPTER 4 DISCUSSION AND CONCLUSION 90
4.1 Discussion 90
4.1.1 Discussion about the advancing sustainable livelihood of smallholder through linkages among actors within cassava value chain 90
4.1.2 Gender issue in cassava value chain analyses 92
4.1.3 Discussion about the potential of cassava-based ethanol 98
4.2 Conclusion 99
4.2.1 Cassava value chain and smallholders' sustainable livelihood 99
4.2.2 Gender perspective in cassava value chain analyses 102
4.2.3 Bioethanol 102
REFERENCES 105
APPENDIX 119
1. Questionnaire (For household) 125
2. Questionnaire (For Collector) 128
3. Questionnaire (For Wholesaler/Trader) 130
4 Questionnaire (For Retailer) 132

LIST OF TABLES

Figure 1.1. Porter's Value Chain Source: (Porter, 1998) ... 5
Figure 1.2. Porter's value system Source: (Porter, 1998) ... 5
Figure 1.3. The roots of competitive advantage Source: (Porter, 1998) ... 5
Figure 1.4. Generic building blocks of competitive advantage ... 6
Figure 1.5. Four links in a simple value chain (Kaplinsky & Morris, 2001) ... 7
Figure 1.6. The six stages in common value chain (Dilip & Rajeev, 2016) ... 8
Figure 1.7. The core tools in value chain analysis method (Berg et al., 2009) ... 10
Figure 1.8. Map of the general value chain (Stamm & Drachenfels, 2011) ... 12
Figure 1.9. Value chain analysis based on multi-dimensions of issue ... 14
Figure 1.10. A holistic approach to value chain analysis (UNIDO, 2008) ... 15
Figure 1.11. Enabling environment approach to value chain analysis ... 15
Figure 1.12. The region of cassava export and import in the world (Fao, 2014) ... 16
Figure 1.13. The overview of cassava in the world in 1961-2017 ... 17
Figure 1.14. The value chain of high-quality cassava flour ... 17
Figure 1.15. The cassava value chain in Nigeria (Daniels et al., 2011) ... 19
Figure 1.16. The yield of cassava 1961-2017 in Vietnam (FAO, 2019) ... 21
Figure 1.17. The cassava area by region 2000-2012 in Vietnam (Phuc, 2015) ... 21
Figure 1.18. Level of physical losses by value chain stage (Naziri et al., 2014) ... 22
Figure 1.19. Cassava area situation in 1995-2008 in some provinces (GSO, 2018b) ... 23
Figure 1.20. The structure of world energy resource (World Energy Council - WEC, 2013) ... 23
Figure 1.21. Structure of global use of ethanol (Zobaa and Bansal, 2011) ... 24
Figure 1.22. Biofuels derived from biomass rich in oils, sugars and starch ... 26
Figure 1.23. Cassava fuel ethanol system boundary in Thailand (Lan et al., 2007) ... 27
Figure 2.1. The location of the study area ... 34
Figure 2.2. The Area, Production and Yield of cassava in Dak Lak province in 2011 – 2017 ... 34
Figure 3.1 The Area, production and yield of cassava in Dak Lak 2011-2017 ... 46
Figure 3.2. Transportation in the cassava value chain (Photo by author) ... 49
Figure 3.3: Dak Lak cassava value chain map ... 51
Figure 3.4: The percentage share of the main inputs into the dried chip cassava value chain from the farmers' perspective ... 53
Figure 3.5: The sensitivity analysis of farmers' income based on the price and yield of cassava ... 54
Figure 3.6: The major indicators analysis of dried chip cassava per ton from the collectors' perspective ... 56
Figure 3.7: The major indicators analysis of dried chip cassava per ton from the trader' perspective ... 58
Figure 3.8: The structure of cost and output of starch cassava per ton from starch factory perspective ... 59
Figure 3.9: Value added and gross profit sharing among the stakeholder in CVC ... 62
Figure 3.10: The net profit sharing among stakeholder in cassava value chain ... 62
Figure 3.11. The area under cassava in Dak Lak province, 1995-2017 ... 80
Figure 3.12. The area, production and yield of cassava 2011-2017 (GSO, 2018b, 2018e) ... 80
Figure 3.13. The value added among stakeholders in the starch and ethanol distribution channels ... 82
Figure 3.14. Sensitivity analysis of farmer's income and ethanol factory's gross profit ... 83
Figure 3.15. The main cassava areas and ethanol plants in Vietnam (Le et al., 2013) ... 84
Figure 3.16. The cassava-based ethanol production process (Yu & Tao, 2009) ... 86
Figure 3.17: Framework to cassava value chain analysis ... 89

LIST OF FIGURES

Table 1.1. Biofuel productivities for energy crops in the world (FAO, 2008) 25
Table 3.1. Socio-economic characteristics of respondent at the study sites 48
Table 3.2. Major indicator analysis of fresh cassava value chain per hectare 53
Table 3.3. Major indicator analysis of fresh cassava value chain per ton from the . collectors' perspective 55
Table 3.4. Major indicator analysis of fresh cassava value chain per ton from the traders' perspective 57
Table 3.5. Financial analysis of the operation of the Dak Lak ethanol factory per ton 61
Table 3.6. Explanation of the initial variables used in the probit and OLS models 67
Table 3.7. Explanation of variables transformed for the probit and OLS models 69
Table 3.8. Probit model estimates for women's decisions to participate in the production stage of the cassava value chain 70
Table 3.9. Ordinary least squares estimate for the quantity of cassava produced by women and men in Dak Lak province (the level of production participation of women) 72
Table 3.10. Probit model estimates for farmer's decision to participate in the market 73
Table 3.11. OLS estimates for the quantity of cassava sold by farmers in Dak Lak province (level of market participation of farmers) 74
Table 3.12. The percentage of male and female participation in cassava cultivation 75
Table 3.13. The area, production and cassava yield at the study site 81
Table 3.14. The potential of ethanol production based on cassava at the study site 87

LIST OF ABBREVIATIONS

CIRAD	Centre International Research Agricultural and Development
UNDP	The United Nations Development Program
CFE	Cassava for Ethanol
GDP	Gross domestic product
GPr	Gross Profit
IFAD	International Fund for Agricultural Development
II	Intermediate Input
ILO	International Labour Organization
INRA	Institute National Research Agriculture
ITC	International Trade Centre
NPr	Net Profit
ODA	Official Development Aid
OLS	Ordinary Least Squares
UNCTAD	The United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
VA	Value Added
VCA	Value Chain Analysis
VCD	Value Chain Development
VIF	Variance Inflation Factor
WEC	World Energy Council

LIST OF PUBLICATIONS

I. List of papers published as Author

1. Advancing smallholders' sustainable livelihood through linkages among stakeholders in the cassava (Manihot Esculenta Crantz) value chain: The case of Dak Lak Province, Vietnam. Applied Ecology and Environmental Research. https://doi.org/10.15666/aeer/1702_51935217 © 2019 ALÖKI Kft, Budapest, Hungary (ISI, Q4, IF = 0.72).

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3. Dong. L. K, Sinutok. S, Hoa. A. X, Anh. N. T, Thinh. N.V, Hai. L. V, Manop. P, Techato. K. Overview of improving patrolling efforts Vietnam: A case study of station in Pu Hu Nature Reserve. Applied Ecology and Environmental Research 16(3):2845-2859. ISSN 1589 1623 (Print). ISSN 1785 0037 (Online). DOI:

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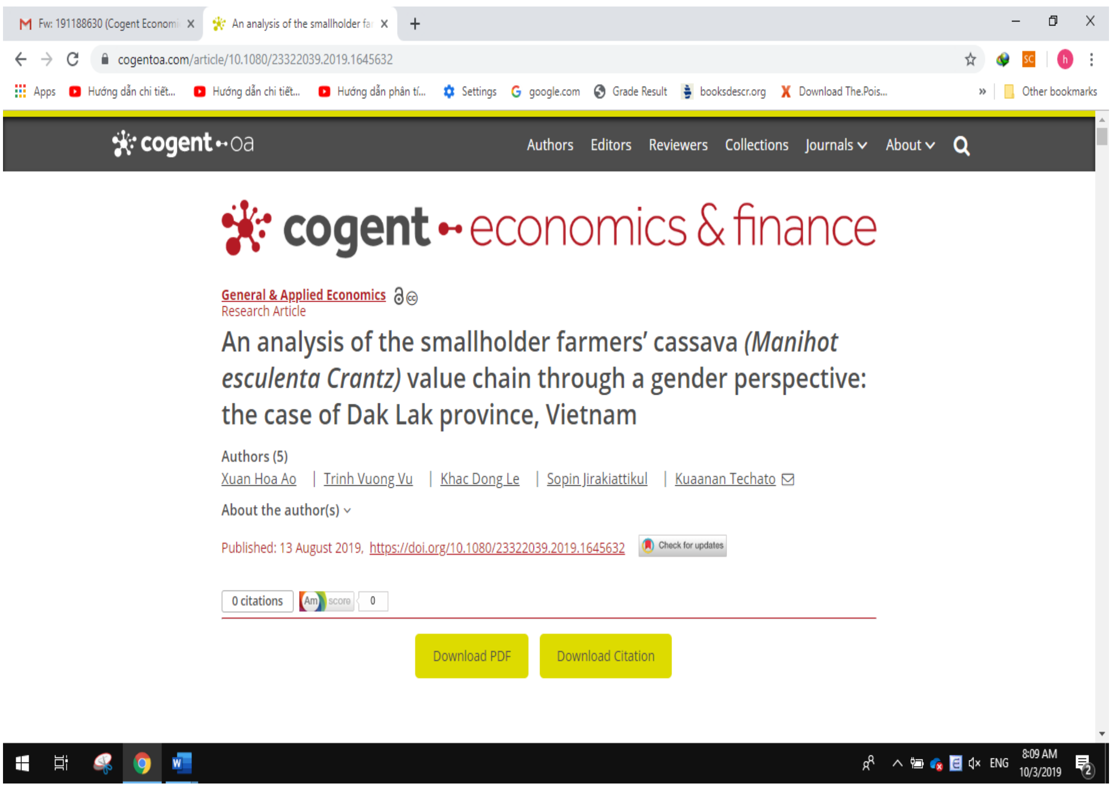
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An analysis of the smallholder farmers' cassava *(Manihot esculenta Crantz)* value chain through a gender perspective: the case of Dak Lak province, Vietnam

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CHAPTER I: INTRODUCTION

1.1 Overview of cassava value chain analysis

This chapter will provide with a comprehensive overview of the development throughout the value chain stream in current decades. Value chain concept would be clarified clearly to what kinds of mention research value chain analysis have been applied. The value chain analysis concepts have been derived from two original arguments, encompassing the French 'Filière concept' and Wallerstein's concept of a commodity chain (Klein & Sauer, 2008). In the 1960s the Filière concept was researched and developed by the Institute National Research Agriculture (INRA) and the Centre International Research Agricultural and Development (CIRAD). This method was determined a handbook for agricultural research. Whereas, Wallerstein had developed the definition of commodity chains enclosed in the world systems knowledge in the 1970s (D. Kumar & Pradesh, 2016). In addition, Gereffi and others, who referred to the global commodity chain based on the concept of the basic commodity chain. These authors have been sought to make clearly dynamics of the distribution of value chain activities in a capitalist world economy. Taking into account, the value chain also refers to a full range of activities that were required for production (or a service), through the different steps to final consumption behaviour. A value chain occurred when all actors cooperate to maximize the creation of value in the chain (Kaplinsky & Morris, 2001b). Moreover, the value chain was also identified in two definitions. The narrow meaning is that the value chain means the wide range of activities performed by a firm to produce a particular output. In contrast, the broad meaning approach was understood associated with the complex extended of activities implemented by different stakeholders (primary producers, and middleman such as processors, traders, service providers, etc.) to take a raw material to the final product, which was retailed in the market (Daryanto, 2014). According to broad mean, this concept derived from the production system of the original materials and would be moved to connect with other enterprises participated in trading, assembling, processing, etc. The issues of organization and coordination are encompassed by the concept of the value chain, as well as the strategies and the strong relationship of the numerous actors in the chain. Three major research point of views in the value chain literature were well-defined (Daryanto, 2014) such as the Filière approach, the conceptual framework developed by Porter (1985) and the last opinion was the global approach that proposed by Kaplinsky et al, (Kaplinsky & Morris, 2001b). In the 1960s the Filière concept was researched and developed by (INRA) and (CIRAD) and was determined a handbook for agricultural research. In the mid-1980s, Michael Porter concerned competitive advantages within specific activities of firms where could be created by breaking down their activities into value-added (Porter, 1980). Gereffi et al were mentioned about global commodity chain. Likewise, other scholars had carried out four core components including input-output, territorial (international), governance structure and institution framework in the 1990s (Kaplinsky & Morris, 2001b). The value chain definition was continued in 2002 by Messner underworld economic triangle aspect. Messner mentioned on the assumption that stakeholders, governance and regulation systems identified the arrangement of activities. Besides, there was integration into the chain to enhances entire areas or cluster respectively, was represented by (Klein & Sauer, 2008).

In conclusion, the value chain had been increasing with many perspectives, which were standing in different background. Hence, this concept to be more interesting. The value chain was not only mentioned the value added but the environment side also provided the basis for all essential inputs and energy as well as the capacity to dispose of emissions and waste. Therefore, the "environmental value chain" was interested in the public sector. The awareness of consumers has increased, and the environmental *impact of goods had become the main aspect of environmental policy programs.*

1.1.1 Value chain fundamental concepts

In recent years, various definitions of value chain derived from scholars with a specific point of views. Nevertheless, the most common perspective is focusing on three major research streams. Firstly, the Institute of National Research Agriculture (INRA) and the Centre International Research Agricultural and Development (CIRAD) mentioned the Filière approach. Secondly, Michael Porter developed the conceptual framework and Finally, a perspective which was proposed by (Raphael Kaplinsky, 1998), (Geref, 1999; Gereffi, 2001; Gereffi & Korzeniewicz, 1994) and (Gereffi & Korzeniewicz, 1994), was the global approach.

1.1.2 The commodity chain perspective of Filière

Filière means thread or chain, in addition, the flow of commodities, which was used to identify actors and activities were represented by the map (Daryanto, 2014). According to Filière approach had primary characteristics of perspective such as this method focused on quantitative technical relationships and physical issues, also giving a sum up in flowcharts of commodities chain and drawing of transformation (Khai, 2013). Moreover, there were two strands of commodity chain analysis, was the economic and financial evaluation. Focusing on income generation and distribution among stakeholders, and cost and benefit-sharing between local and internationally traded components were mentioned. Additionally, assessment of the role of the value chain on the national economy as well as it had been contributed to gross domestic product (GDP). The “Filière” approach had been emphasized the interplay of objectives, constraints and results of each stakeholder in the chain. The author had interested in individual and collective strategies. The French scholars set up analysis tool to analyze the value added in the agricultural sector based on vertical integration point of view. The initial method had been emphasized the input and output of local economic effectiveness. During the 1980s, the author was mentioned political economy dimension as well as technical quantitative relationships in value chain analysis.

In conclusion: This method that can help calculate as well as analyze the cost of each actor in the cassava value chain. The income creation of stakeholders and sharing cost and benefit between local and internationally traded components were researched. Moreover, it is also assessed the role of the cassava value chain economic structure of locality and its contribution to local household's income situation.

1.1.3 The framework of Michael Porter

According to Porter's framework, competitive advantages of individual firms were concerned, within many questions including how the firm asserted that its position in the relationship among suppliers, buyers and competitors in the market? (Porter, 1998) and this scholar had referred to the strategy of the lowest cost and to give the highest market price of firm production (Dilip & Rajeev, 2016). The main features of Michael Porter's framework had found the firm's competitive advantage by disaggregating. In a range of activities and competitive advantage found into one (or more) of such activities as well as enterprise competitiveness, which could be analyzed by looking at the value chain, including different detailed activities. The last feature was valued chain analysis mainly purpose at supporting management decision and executive strategies (Bhattacherjee, 2012). Besides, he had separated between crucial activities, was contributed to value added to the products or services in the production process. On the other hand, the support activities would be indirectly impacted by the final valuable product (Daryanto, 2014).

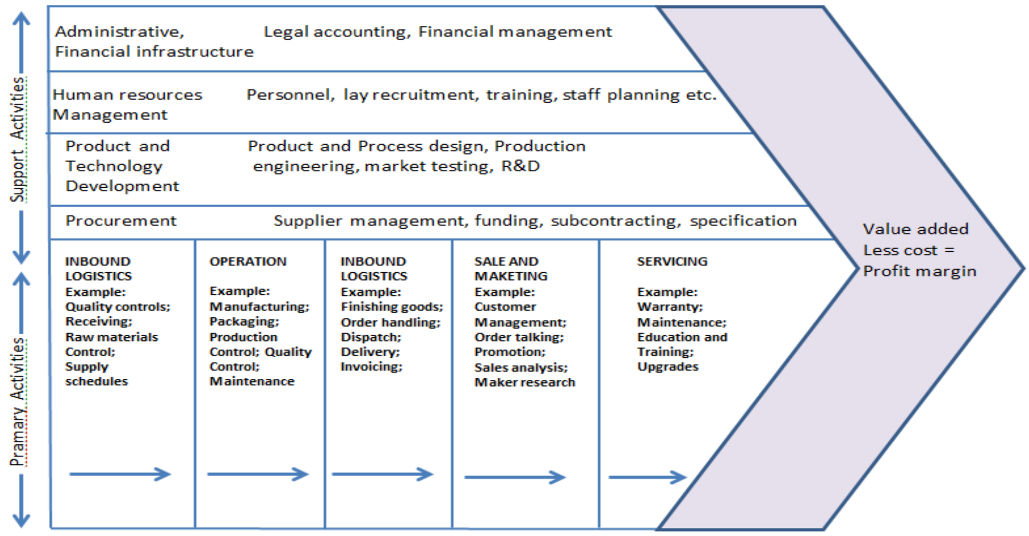


Figure 1.1. Porter's Value Chain (Porter, 1998)

Furthermore, there were various activities, which were carried out a channel in the chain. The scholar had drawn the distinction among different stages of the process of the supply chain that was called primary activities. Additionally, the scholar has described administration, financial infrastructure, and human resource management and the last thing was known namely production and technology development in his idea of the value chain.

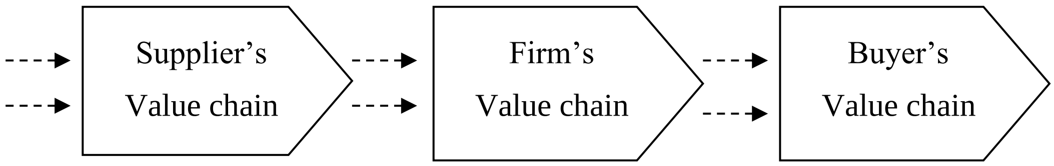


Figure 1.2. Porter's value system (Porter, 1998)

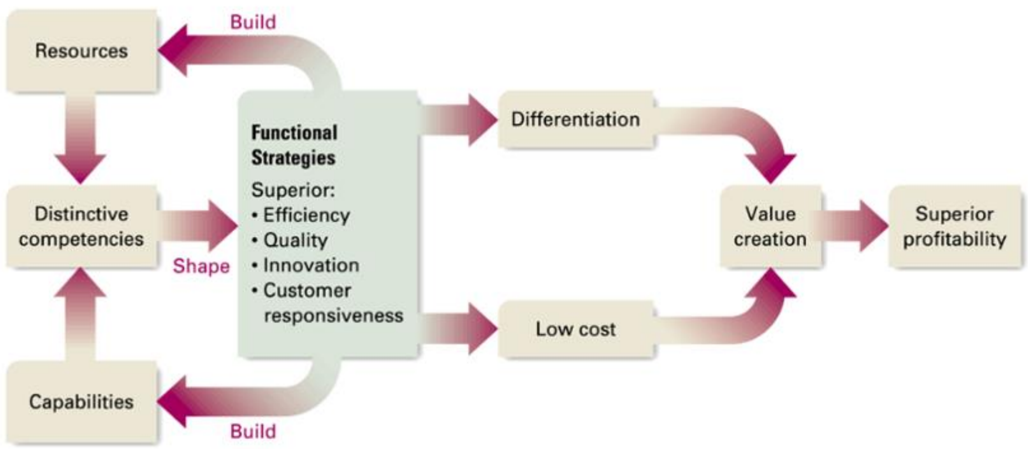


Figure 1.3. The roots of competitive advantage (Porter, 1998)

Porter argued that, competitive advantage strategy based on cost leadership and differentiation. In term of cost leadership, the author asserted that competitive advantages derived from such as efficient scale, standardization as well as to design for lowest production cost (Porter, 1998). In addition, Porter also focused on to control overheads, research, and development in order to avoid marginal customers. Furthermore, regarding differentiation issue which was related to quality, innovation, credibility, brand name, reputation, and environmental posture and services also was concentrated, was that customer or integration (Daryanto, 2014).

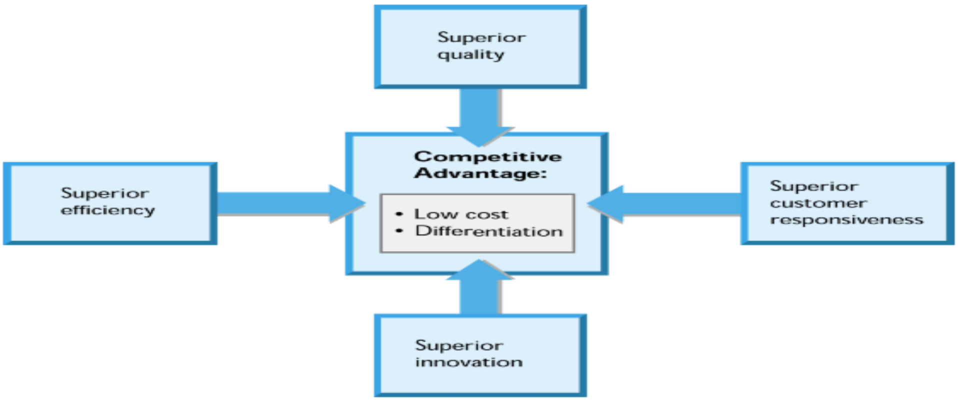


Figure 1.4. Generic building blocks of competitive advantage (Porter, 1998)

In conclusion: cassava value chain analysis based on Porter's framework on competitiveness is a useful method that can be shown the relationship between the farmer and other actors in the value chain. The actors will be self-assessment their resource, in order to carry out reasonable strategies in production activities. On the one hand, each stakeholder should be known how to get as much as a benefit based on their advantages competitive. In contrast, according to cost leadership and differentiation in each plant, the bioethanol plant should be finding some good strategies to produce bioethanol depends on their capacity.

1.1.4 The Global approach perspective

Currently, this method is a popular way to examine globally integrated and to estimate the determinants of the global's income distribution of firms and countries under pressure of globalization. This argument was proposed by (Gereffi & Korzeniewicz, 1994). Beside of these opinions, Kaplinsky and Morris (2001) argued that value chain analysis would be helped to answer the gap of incomes in inter-country and between nations was more and bigger, was too because of globalization (Berg et al., 2009). In addition to that, to analyze the total value chain creating the rewards different stakeholders in the chain achieved those. Moreover, this method also recognized how to firms, regions and governments were connected to the rest of the world economy (Dilip & Rajeev, 2016). On the other hands, as can be seen from figure 1.5, there are four links in the simple value chain. It is not only linked inside each step but also in turn influenced by the constraints in these downstream links in the chain.

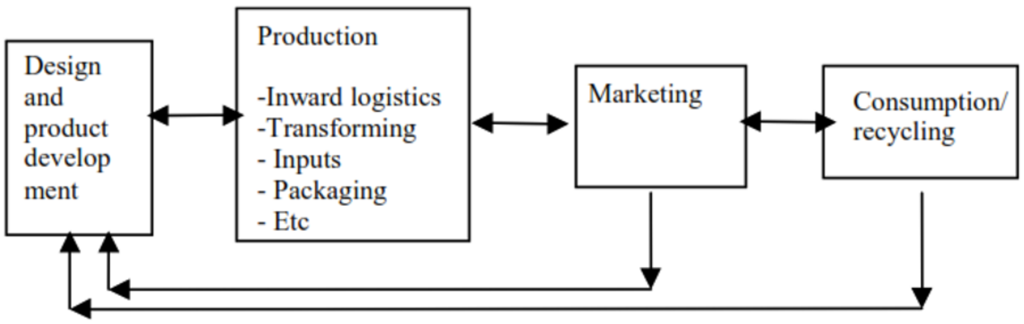


Figure 1.5. Four links in a simple value chain (Kaplinsky & Morris, 2001)

Certainly, the value chains are increasingly complicated in reality. For one thing, there is a tendency to be many more links in the chain. This is because each particular market decides goods and service.

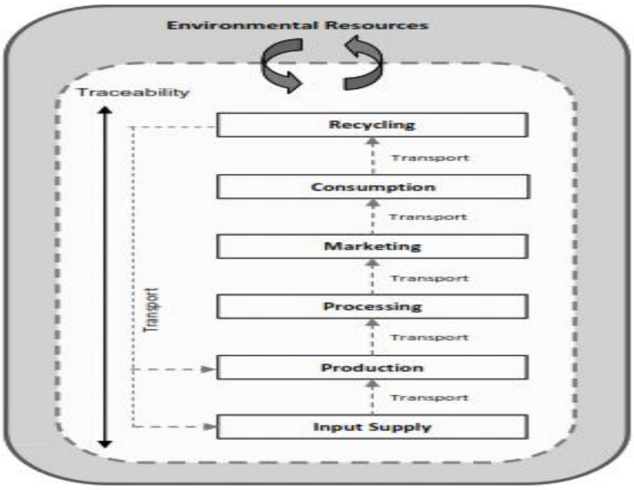


Figure 1.6. The six stages in common value chain (Dilip & Rajeev, 2016)

Depending on the distribution channel, products and service would be transported through several steps before it reaches the final consumer (Kaplinsky & Morris, 2001). According to Kaplinsky and Morris's definitions, the most common description of value chain included six stages, as can be seen in (Fig 1.6). As shown in this figure, the value chain was mention as a 'vertical' value chain. However, the point of view could also be 'horizontal' by establishing so-called clusters, for example, to mention similar enterprises in the same region. In reality, there could be multiplied links within a chain and various links to other chains, e.g. using the same input suppliers.

In the sum of the method also recognized how firms, regions, and governments were linked to the world economy. To compare between bioethanol product that was being produced and the volume of bioethanol import in term of the price. If the price of cassava-based bioethanol in the domestic market is higher than the import price, what should they do? Furthermore, the Vietnamese government and bioethanol plant should or stop to import bioethanol instead of supporting bioethanol production. Cassava production sector can be assessed output and the potentials in relation to the world supply and demand by global value chain approach.

1.1.5 Cassava value chain analysis methods

1.1.5.1 Making the value chain work better for the poor person

According to making markets work better for the poor method (M4P) (Berg et al., 2009), the aim of the method was to provide for the reader with an easy to follow set of tools for value chain analysis, focused on poverty reduction. This method was also to link the gap between value chain analysis and pro-poor development. This method contains a set of eight value chain analysis tools follow as: the first tool was namely prioritizing value chains for analysis, this step needs to be selected the most effective value chains to be analyzed among the various choices available. This process has four main stages within the choices under pressure scarce resource. The setting of weighting criteria was used in the value chain. Ranking of the product and final decision based on all determined by the ranking obtained. The second tool was namely mapping the value chain: we could make value chain analysis would be cleared through the picture, whatever we wanted to say and analysis and encounter more comprehensible. This stage could be getting a better understanding of link among stakeholders and processes in a value chain. The third tool for mapping flows of products, information, and knowledge. This step can be shown the flow of goods, services, or information is passed on among different stakeholders. These flows through every chain also still either invisible or visible products. Tangible and intangible go through, be beginning raw material to final goods or service. Participation of poor people plays an important role in this part of the mapping (Berg et al., 2009). The fourth tool was namely mapping the volume of products, number of actors and jobs. Some factors should be revealed to make closely related to mapping the product flow in value chain mapping. The aim of the step was to have an outlook of the volume of the different channels within the chain. Two more dimensions will be counted was that the number of stakeholders as well as job opportunities. The specific dimension that can be referring to deal with is the number of poor actors in the value chain. The following by the fifth tool was displayed the mapping the geographical flow of the goods or service. It also illustrated the place, where products have been cultivated and transported to the final consumer through each of middle-actors. Next to, the sixth tool, it could be clearly seen mapping the value at different levels of the value chain. The monetary flow was the most straightforward depicted and it would be added to every stage over the chain. Other economic indicators were given in this period namely revenue, cost structures, profit, and return on investment and so on. The seventh tool so-called mapping relationships and connection between value chain actors presented actors relationship. This step had three typologies was that spot market relation, persistent network relations and horizontal integration. Finally, is the eighth tool was mapping business services that analyses into the value chain. There was a potential risk within the value chain that related to value chain was not enough to mention likes core information or intervention outside the value chain itself.

	CORE TOOLS				ADVANCED TOOLS			
	Tool 1	Tool 2	Tool 3	Tool 4	Tool 5	Tool 6	Tool 7	Tool 8
Dimension	**Value Chain Identification**	**Mapping**	**Margin/ Cost**	**T+K+U**	**Income Distribution**	**Employment Distribution**	**Governance and services**	**Linkages**
Participation of the poor	√	√		√	√√√	√√√	√	√√
Employment + working environment	√	√	√	√√	√	√√√	√	
Wages + Income	√	√	√√		√√√	√	√	
Access to assets	√	√	√	√√√				√
Access to info + tech	√	√	√	√√√			√√√	√√
Access to infrastructure	√	√		√		√	√√	
Access to services	√	√					√√	√√
Security and vulnerability	√	√	√	√	√√	√√√	√√	
Empowerment	√	√					√√	√√√

Figure 1.7. The core tools in value chain analysis method (Berg et al., 2009)

1.1.5.2 The value chain for pro-poor development methods

According to Wageningen University and Research (Sietze Vellema, 2010), there were six steps in the value chain analysis methods. As the research program, the value chain due to pro-poor development builds on initiatives that need to be developed to become a system approach to competitive business strategies. This method referred to governance and institutional as well as efficient strategies that be able to link between with enabling policy and institutional environments. All steps were as following: First step was mapping the value chain and its actors and the second step identified key institutional factors influencing value chain. Next, the third step illustrated the synthesis of drivers, trends, and issues. The fourth step was described to explore future scenarios and vision. In the fifth step was distinguished three sub-steps was that firstly, to identify key opportunities, barriers, and underlying causes. Secondly, it was an identified option to overcome barriers and built on opportunities. The final step was group options and specified institutional implications and actions (Sietze Vellema, 2010)

1.1.5.3 Value chain development analysis method

Value chain analysis mostly often starts with the linear mapping of activities from the input suppliers at the production process to the final consumer of products or services. However, each method and different scientists approach was quite a divergence. Value chain development approach is one of the popular method in value chain analysis, which was explored by (Humphrey & Navas-Alemán, 2010), whose arguments were existing four different objectives of supporter interventions within supporting value chain development. It could be increased the efficiency of current links as well as to create new ones (Humphrey & Navas-Alemán, 2010; Stamm & Drachenfels, 2011). In addition to that, value chain development should be mentioned not only of the firms, which were part of processing but also that was closely related to the value chain. In this case, Hartwich and Kormawa (2009) had separated four different groups of stakeholders in a value chain that represented local and international markets (see fig 1.8).

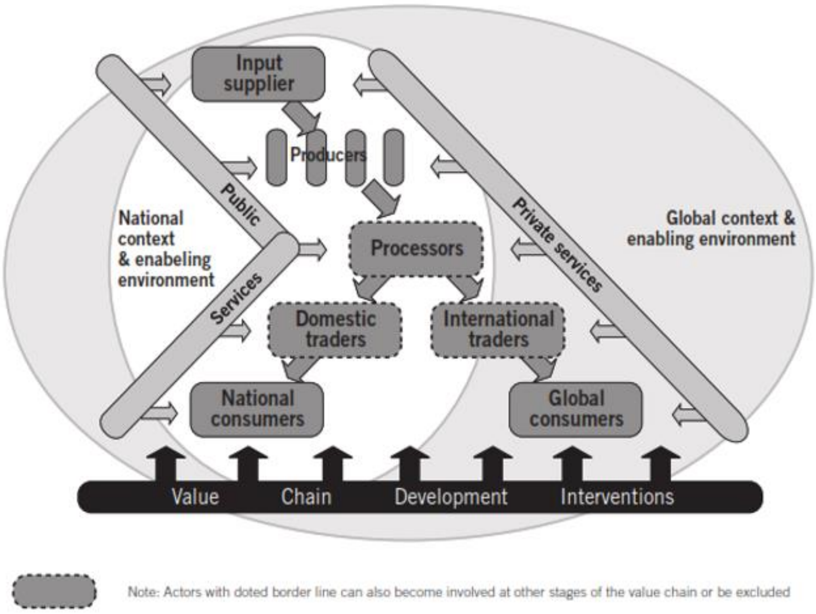


Figure 1.8. Map of the general value chain (Stamm & Drachenfels, 2011)

Value chain development approaches have developed over time. Currently, it needs is more complex interventions as working on the vertical linkages, was often no longer sufficient. Hence, it should be better whether it was combined vertical linkages and horizontal level in assessment strategies on different levels in the value chain. Up to now, there are seven agencies that have been attractive and ongoing researching into value chain development approach (Stamm & Drachenfels, 2011a). Briefly, an overview of the approaches was described understanding and approach to reach satisfactory approach as well as their experiment in value chain development. International fund for agricultural development (IFAD) referred to value chain development (VCD) was the best solution in order to address the constraints or bottlenecks in a particular agricultural product that could be brought smallholder farmer benefit. Considering, job creation and firm’s development have been proposed by an international labour organization (ILO). On the other hand, working conditions and amount of employment could be improved by focusing on the multiple-level value chain. Due to sustainable industrial development target of developing countries, the United

Nations Industrial Development Organization (UNIDO) has been used this method, which not only partners but also collaboration both public and the private sector. Hence, this was a good opportunity for interagency cooperation. The United Nations Development Programme (UNDP) was been concerning value chain development. This organization have dealt with an obstacle at multiple dimension and level, for example, micro-meso-macro size as well as both partnership process and public-private dialogue. Turning to, International Trade Centre (ITC), they also gave some organization tools to improve their situation. The organization and government of the nation were gain the best solution in order to improve the current situation by ITC. Basing on The United Nations Conference on Trade and Development (UNCTAD) (Stamm & Drachenfels, 2011a). This method has contributed to a better understanding of the issue of the value chain and its importance for development. This technical also supported to link between small and medium enterprises to transnational corporations. On the other hand, it could be made a diversity of products and services in order to enhance competitive capacity. FAO with its extensive knowledge and information systems as well as a specific expert in many fields can solve a difficult problem, which has been facing in developing and poor countries. This organization also can be carried out directly or indirectly solutions to improve value chain development for goods and services in various agricultural sub-sectors and livestock forestry and fishery with panel “farm to fork.”

1.1.5.4 Method of analyzing various dimension of the value chain

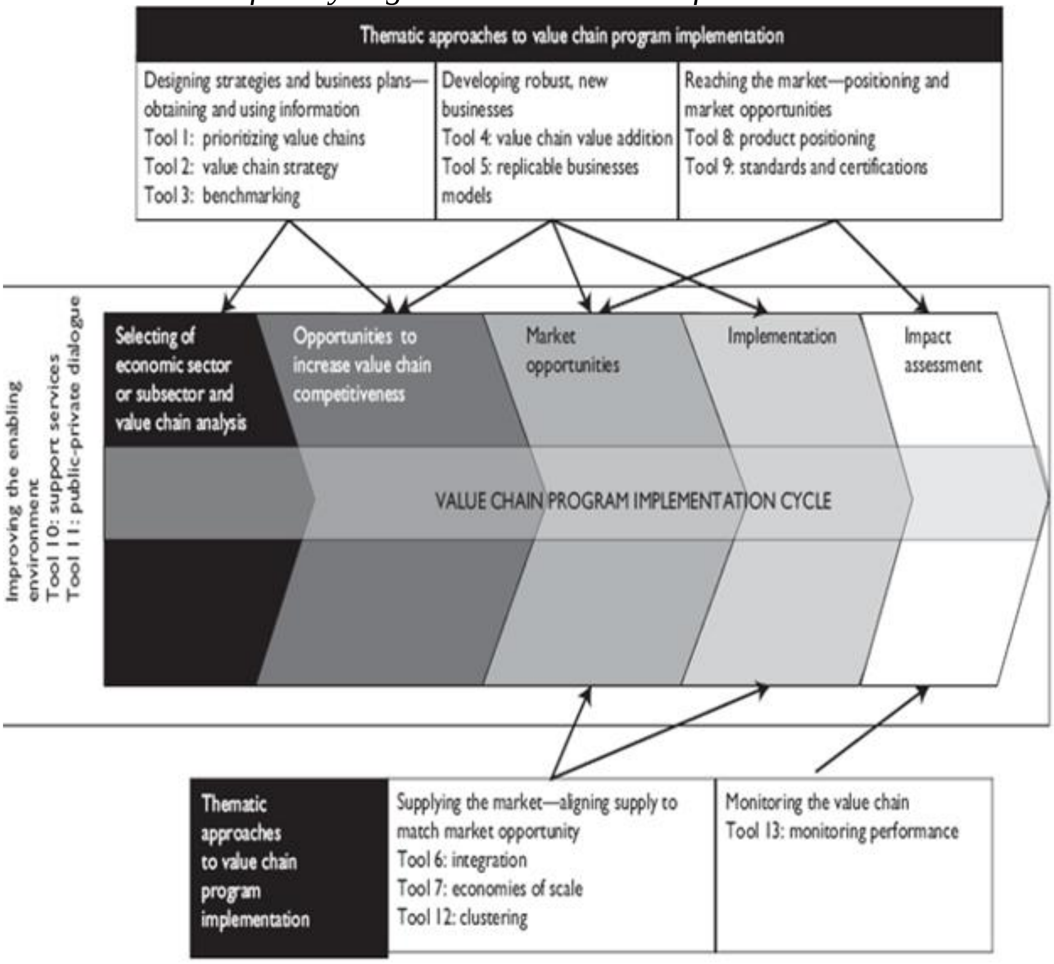


Figure 1.9. Value chain analysis based on multi-dimensions of issue
Source: J.E. Austin Associates, Inc. (Daryanto, 2014)

In this method, there are thirteen tools to descript the value chain as implementation cycles. Distinguish into fifth strategies comprise designing strategies and business plans obtaining and using information that contain three tools. Next to developing robust, new business strategies that strategies included the value chain and replicable business model tools. The third strategies referred to reaching the market as well as positioning and market opportunities. In addition, product positioning, standards, and certifications were also mentioned. The fourth and fifth were known namely supplying the market and monitoring the value chain respectively.

1.1.5.5 Method of a holistic approach and enabling environment to VC analysis

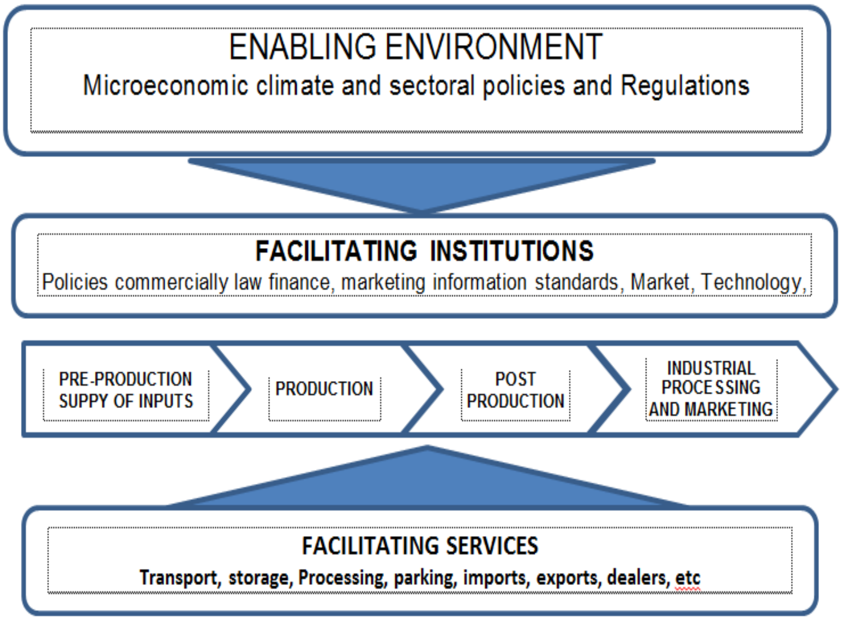


Figure 1.10. A holistic approach to value chain analysis (UNIDO, 2008)

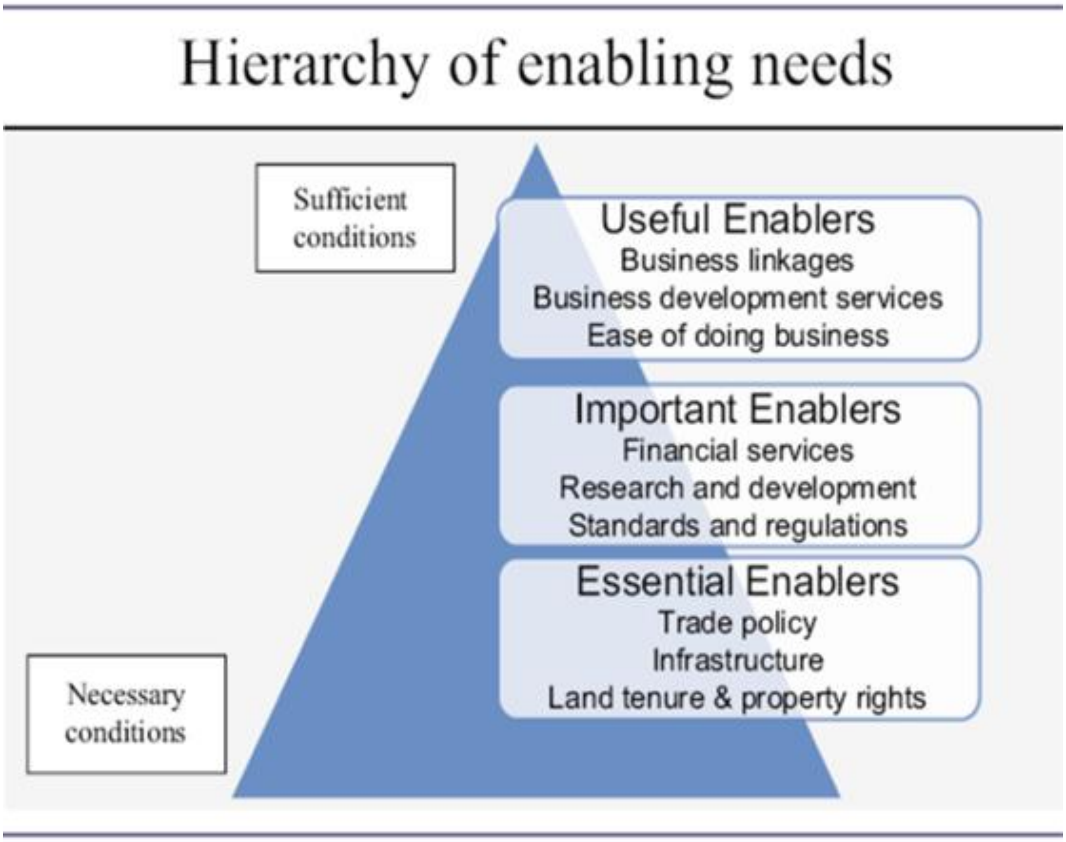


Figure 1.11. Enabling environment approach to value chain analysis

Source: Prof.Ralph D. Christy, 2008

1.1.6 Cassava value chain analysis

1.1.6.1 World cassava production

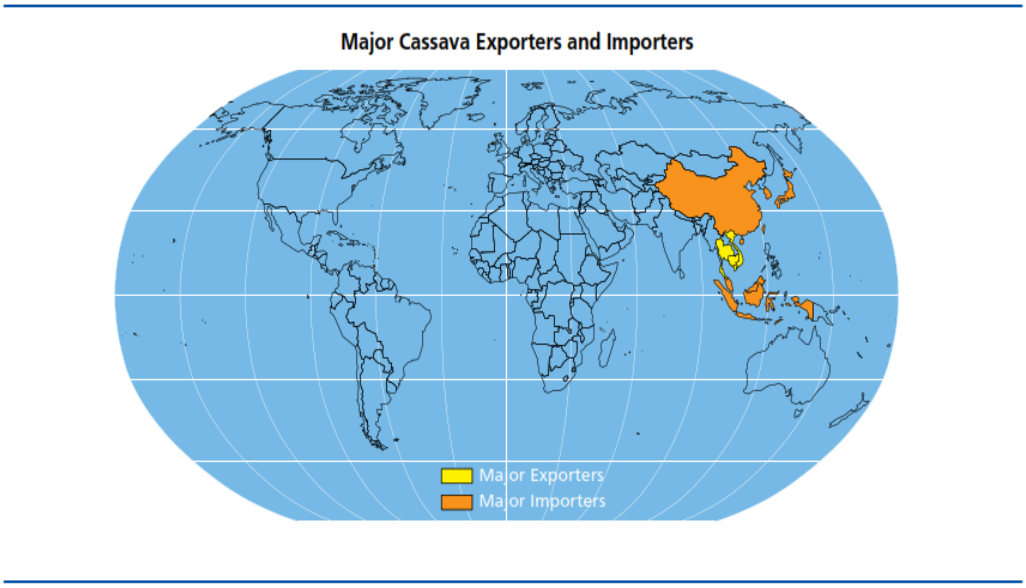
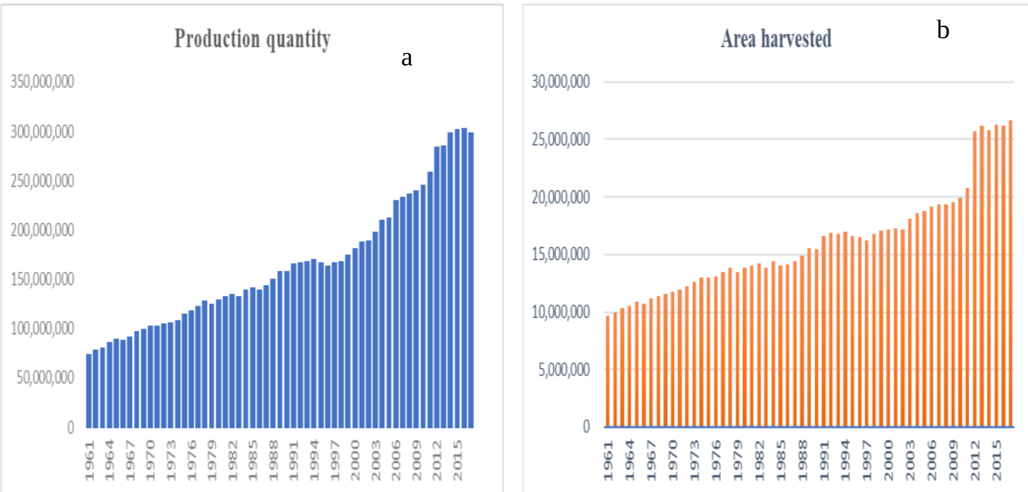


Figure 1.12. The region of cassava export and import in the world (FAO, 2014)

According to the prediction for global cassava production, the production of cassava was growth. Africa was the largest region where was planting with an upward trajectory (FAO, 2019). The value added of cassava was progressively concerning. Furthermore, cassavas have been known-well in the form of ethanol as a form of bioethanol and high quality of flour in the Asia region, where was to be an international market of cassava.



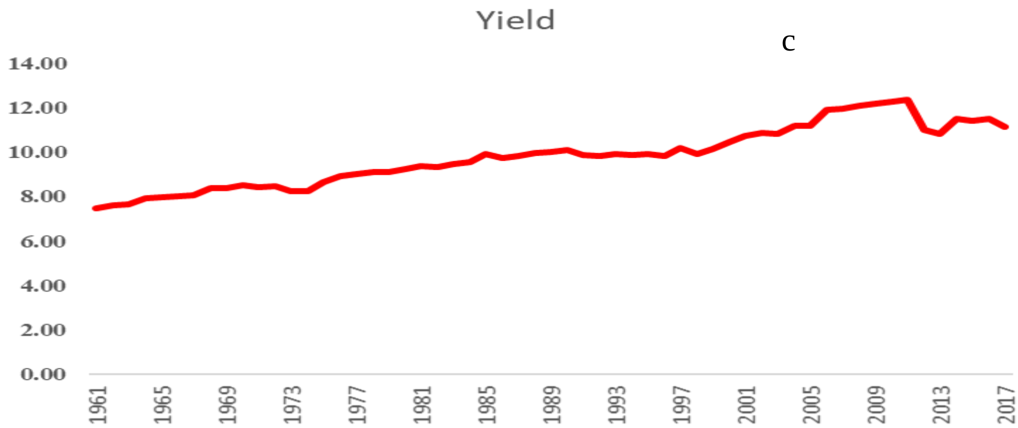


Figure 1.13. The overview of cassava in the world in 1961-2017 (FAO, 2014)

1.1.6.2 Cassava value chain in global scale

Cassava was a crucial source of food in Africa because it could be planted in infertile soil, also be able to resist with severe weather (McNulty & Oparinde, 2015a; Meridian Institute, 2013; Sanni, Onadipe, Ilona, Mussagy, & Abass, 2009). Nigeria was one of the leading countries about cassava quantity with over 20 per cent in total global supply (FAO, 2014).

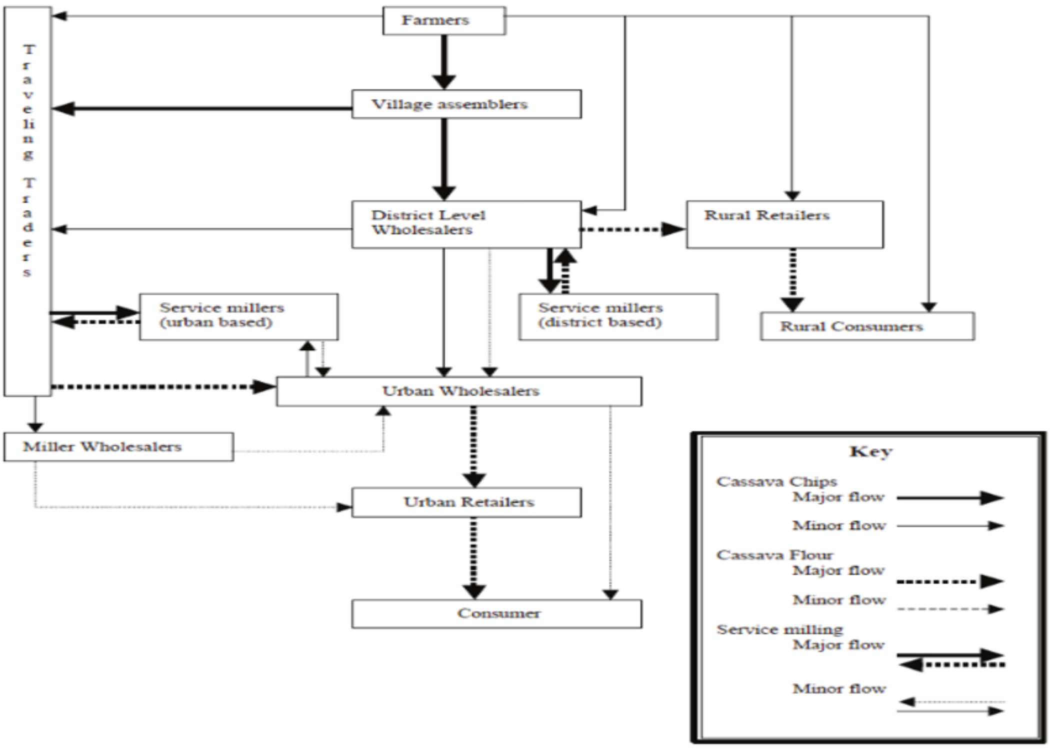


Figure 1.14. The value chain of high-quality cassava flour

Source: Collinson et al., 2000

According to a global perspective, the above authors proposed internal activities, which could be improved efficiency of the cassava value chain. Labour force, new technologies, logistics issues, participatory of agents and multiple networks interact in order to generate value for the local economy (Trienekens, 2011). Utilization of available resources was not only creating high value-added products but also bring benefits to the organization environment. Value-added could be attained fair benefit for stakeholders within the cassava value chain in this region (Mcnulty & Adewale, 2015).

Additionally, Naziri et al, who studied the cassava value chain under the diversity of post-harvest losses in four countries between two continents, were Thailand and Vietnam in South-East Asian, and Sub-Saharan African including Nigeria and Ghana (Naziri et al., 2014). In this study, the author revealed postharvest losses at different stages of cassava value was due to cassava cultivated method, process, consumption as well as the relationships and linkages among the value chain stakeholder. On the other hand, there were no “one-size-fits-all" solutions for dealing with postharvest losses. It depends on specific characteristics of the different value chains. In this study, in Ghana, they estimated from 16% to 28% to be affected by economic losses. This is because cassava roof was spoilage by longer distances from the production site to final consumption. Follow by Nigeria, where was estimated that was a range of about 10%-30% of cassava roots suffer economic losses due to breakages and deterioration within harvesting and distribution. In Nigeria, therefore, the researchers provided an entire picture for farmers, processors, traders, input suppliers, and another stakeholder, as a guide for both investment and improvement in cassava cultivation. In another research, Daniels et al, mentioned of cassava value chain analysis with valuable data, for example, it was a range of 70,000- 120,000 number of small cassava producers, including from 0,8 to 0,95 million middleman, 46 small-medium processing industries and a large processing industry (Daniels et al., 2011).

The area harvested was approximately 0.2 to 1ha/household and with 8 to 10 tonnes of average yield of cassava. Turn to, the income and employment for Nigerian farmers as well as other actors. In which, producer's side, there were over million jobs to be created in the rural areas and 1.8 million farm families were earned with approximately US$450 per year in Nigeria. In addition, the strong market established in long-term of the cassava sector (Olukunle, 2013). However, Olukunle et al (2013), who found that the farmers had gotten the smallest percentage of total profit, compared to traders who received the largest profit.

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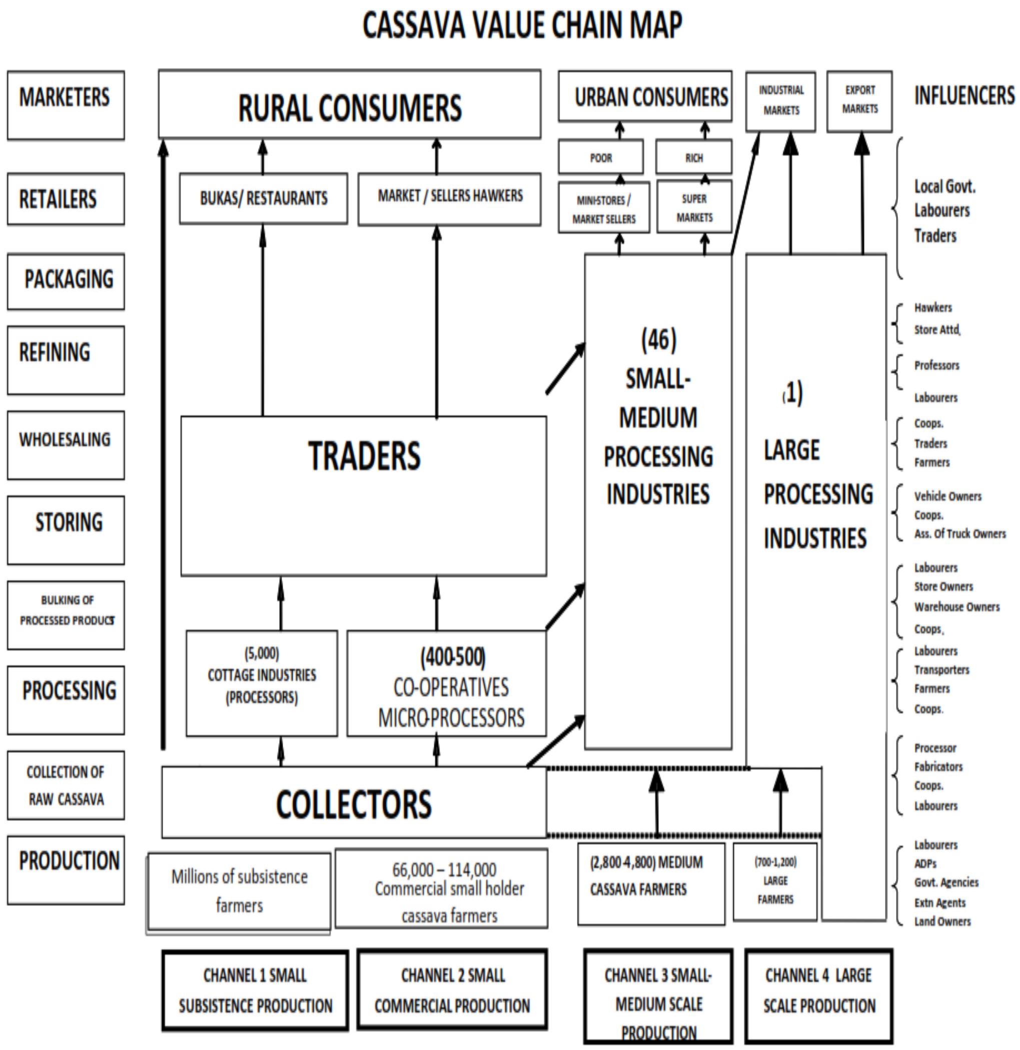


Figure 1.15. The cassava value chain in Nigeria (Daniels et al., 2011)

1.1.6.3 Agricultural value chain in Vietnam

The role of the value chain in the agricultural sector

Value chain analysis was significantly within the agricultural sector in developing a country like Vietnam. It can be explained clearly the benefits and drawbacks of firms and state companies specialize in production rather than services. Furthermore, the producers also know well, how to connect and gain profit by participating in the global market. The standards of quality and technological capabilities improvement are being more and more attended by enterprises and regions. Trade policies were played a vital role in final markets. Depending on the regulatory regime and specifics products, these products have a particularly preferential based on the international convention. Globalization has explained the distribution of benefits and income for all nations. It is also to find the best solution, which can be carried out to promote the individual and states firm to go up to their share of benefits. Globalization that is either good or harmful for the poor people. It is extremely difficult to assess the good or bad sides of globalization. Moreover, globalization was defined as the pervasiveness and also was no longer too much in barriers to information, factors as well as ideas that were mentioned on a global scale (Kaplinsky and Morris, 2001).

Cassava value chain in Vietnam

Cassava rank was the third in terms of production after rice and corn. Cassava area harvested reached 560,000 ha, with an average yield of 17.63 tonnes ha^{-1} and production of 9.87 million tonnes annual quantity (Hieu, 2016). In recent years, the production and yield of cassava have increased gradually in Vietnam. This is because of the expanding of the area and application of hybrid varieties. The farmer has cultivated with hybrid varieties and local varieties by 70% and 30% respectively (Cuong, 2014; Phuc, 2015) with popular local varieties so-called KM 94. The average yield of cassava in 2017 was over 19 tonnes/ha, was more two times greater than in 2000, with approximately 8.4 million tonnes (FAO, 2019)

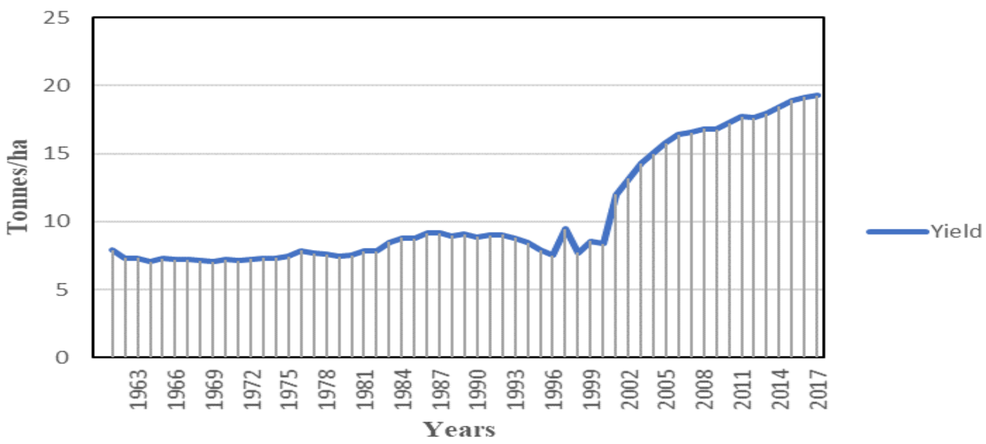
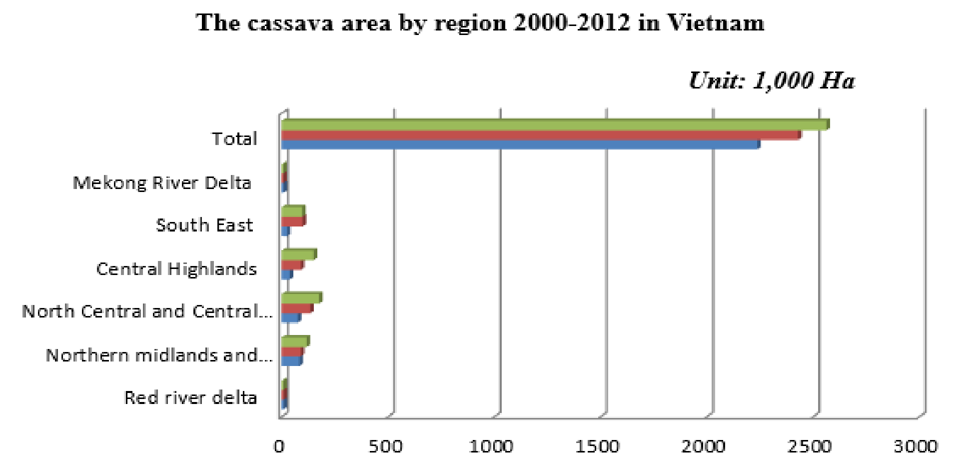


Figure 1.16. The yield of cassava 1961-2017 in Vietnam (FAO, 2019)



	Red river delta	Northern midlands and moutain areas	North Central and Central coastal area	Central Highlands	South East	Mekong River Delta	Total
2012	6.7	117	174.9	149.5	96	6.5	2562.6
2005	8.5	89.4	133	89.4	98.8	6.4	2430.5
2000	8.3	83.7	75.5	38	24.4	7.7	2237.6

Figure 1.17. The cassava area by region 2000-2012 in Vietnam (Phuc, 2015)

In addition, Nguyen et al (2005), who revealed the entire picture of the cassava value chain and relationship among stakeholders in this chain. In this study, the author examined the role of governance as well as their operations and share of benefits. As a result, the profit share was unfair among actors. The farmers gained low profit while middleman got almost profit in the cassava value chain (Olukunle, 2013).

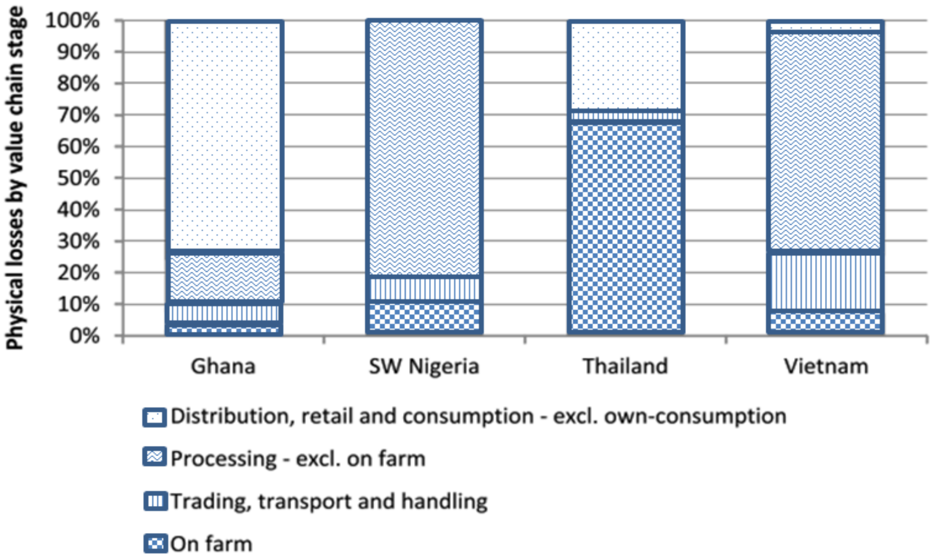


Figure 1.18. Level of physical losses by value chain stage (Naziri et al., 2014).

Likewise, the diversity of postharvest losses in cassava value chains in some developing countries, the authors revealed that the losses of post-harvest of cassava were due to large farm size; mechanized harvesting; and lack of poor locals' people as well as small plot size. The kind of losses is known-well such as breakages and deterioration of roots (Naziri et al., 2014). Vietnam is one of the tropical countries. It is unsurprisingly for cassava which has been being a vital crop of Vietnam (General statistic office of Vietnam, 2017). As can be seen clearly in figure 2.22; Cassava cultivation area and production were increased sharply in period 1995-2016 in Phu Yen Province, from approximately 3,000ha to over 25,000ha. Cassava area growth of Binh Dinh Province was also less than compared to Phu Yen Province. Ninh Thuan Province was highest cassava planted area compared to among 3 provinces. Cassava starch factory and processing and cassava procurement stations were created because of increasing both production and cassava's yield.

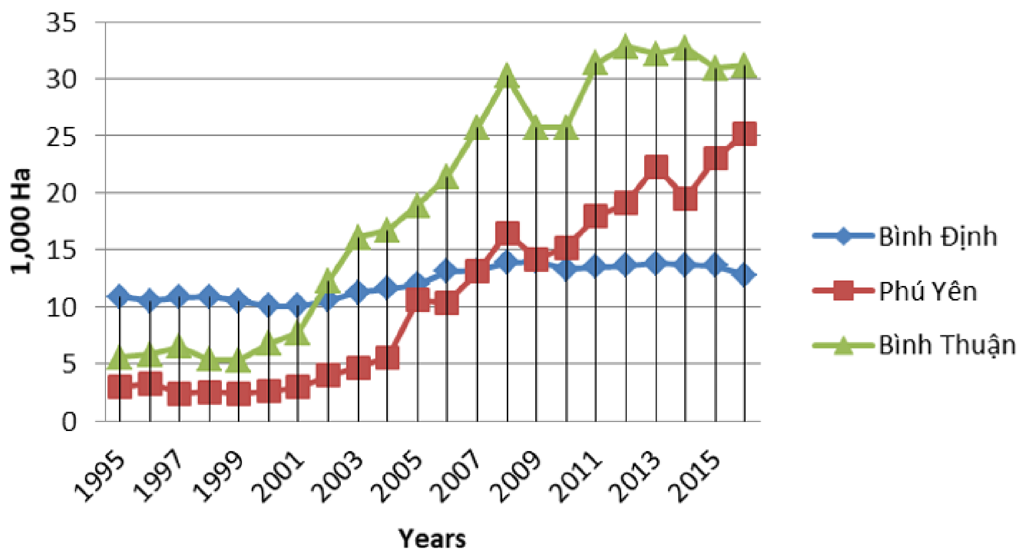


Figure 1.19. Cassava area situation in 1995-2015 in some provinces (GSO, 2018b)

1.2 Overview cassava-based bioethanol production

1.2.1 Renewable energy in the global context

Globalization and integration of global economies are no doubt. It has been bringing numerous advantages for Vietnam's economy and the rest of the world. All of the countries should be opened economic as well as policies, such as removing tariff and non-tariff barriers is step by step, enhancing technology and scientific cooperation among continents within the 4G industry revolution eras.

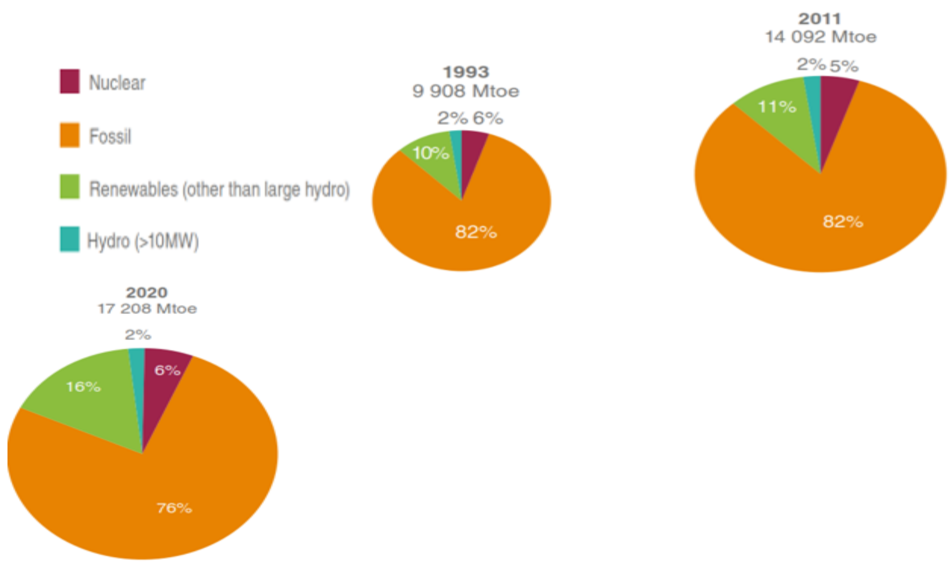


Figure 1.20. The structure of world energy resource (World Energy Council - WEC, 2013)

Most of the countries' challenge to face was that extremely shortage of energy resource in short-run. Renewable energy resource was an efficient solution in short-term and long-term also. This figure showed the structure of world energy resource, which fossil fuel accounted for the biggest percentage between the period 1993 and 2020 with 82% and 76% respectively. Renewable energy and nuclear energy were increased over the year. This energy resource usage will be an increase of 10% between 1993 and 2020 was associated with higher go up about 6% in the associated with renewables, was fluctuated from 5% to 6% in this period respectively by nuclear energy.

1.2.2 Overview of Bioethanol products based on cassava

Ethanol is defined it is a colourless liquid, which is a small bright blue flame when it was burning and can be found in some agricultural product such as cereals, sugar cane or biomass also. A chemical formula is C_2H_5OH. It can produce wine, liquor and beer. And can be clarified three kinds of uses: food, industrial and biofuel, as can be seen clearly in the figure 1.21 below:

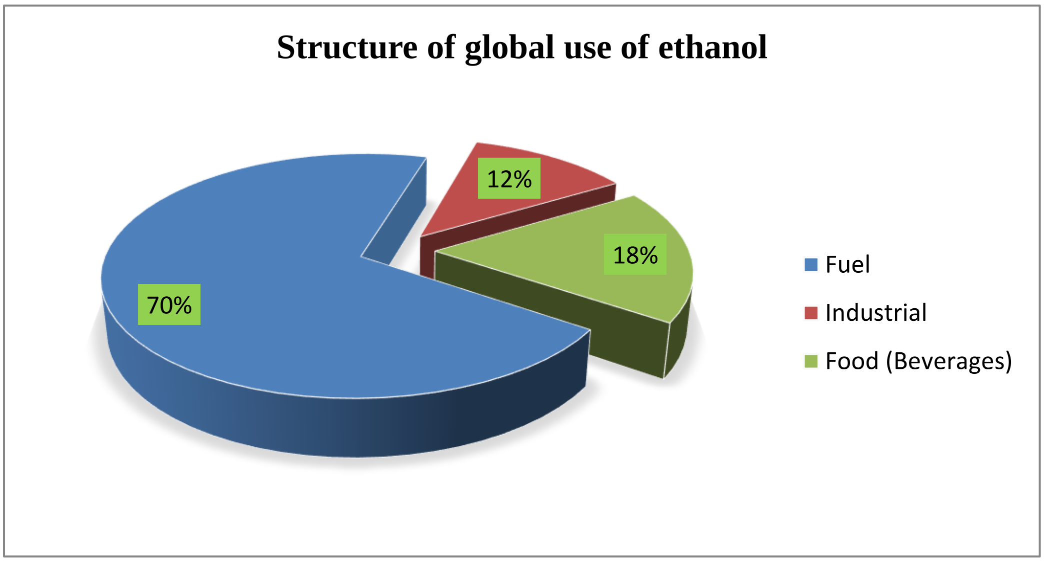


Figure 1.21. Structure of global use of ethanol (Zobaa and Bansal, 2011)

Otherwise, alcohol can be produced from simple sugar by yeasts and bacteria. Ethanol was known such as fuel, especially in the 1970s many countries were interested in the bioethanol sector was due to the oil crisis. At the same time, Brazil had been mixed ethanol and gasoline with percentage 78 and 22 respectively. A decade later, the car which can be run exclusively on bioethanol was produced in this country. Cassava is tropical crops which have significant advantages over biofuel crops cultivated in temperate climates. Solid and liquid wastes also used to create methane through anaerobic digestion. The light, sandy loam soil which had medium or less fertility and good drainage were the most suitable land for cassava crop based on Khanna et al, 2010. In recent year, the cultivation of cassava had been rapidly increasing to produce alcohol within the bioethanol fuel project by Diercke's research in 1981. Indeed, Table 1.1 shows that the different types of biomass with sugar, high oil or starch contents, and technologies have been used to convert into biofuels energy. It could be reached of conversion efficiency and biofuel yield were 180 litres/tonne and 2,070 litres per hectare respectively.

Table 1.1. Biofuel productivities for energy crops in the world (FAO, 2008)

Crop	Global/national estimates	Biofuel	Crop yield (tonnes/ha)	Conversion efficiency (litres/tonne)	Biofuel yield (litres/ha)
Sugar beet	Global	Ethanol	46.0	110	5060
Sugar cane	Global	Ethanol	65.0	70	4550
Cassava	Global	Ethanol	12.0	180	2070
Maize	Global	Ethanol	4.9	400	1960
Rice	Global	Ethanol	4.2	430	1806
Wheat	Global	Ethanol	2.8	340	952
Sorghum	Global	Ethanol	1.3	380	494

Additionally, energy resource comes from the cut-off stems and leaves of cassava be able to generate methane biogas by using anaerobic fermentation. Therefore, conversion applied science focus on the transition of biomass high in lignocellulose. It can be seen clearly the range of biofuels which can be created by high lignocellulose base on various conversion technologies.

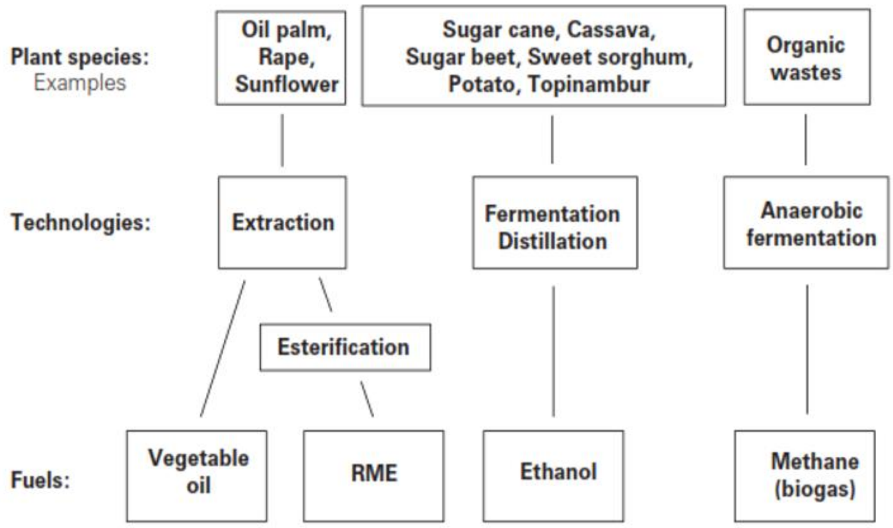


Figure 1.22. Biofuels derived from biomass rich in oils, sugars and starch
Source: El Bassam, 1993

According to Lan et al, who had done research on cassava fuel ethanol potential in Thailand (Lan et al,. 2008). These authors found that the Thai government could be gained with a total yield of 3.4 million litres per day from 12 cassava ethanol plants. They also carried out research about cassava-based ethanol with cassava for ethanol (CFE) system approach included three major stages such as cassava processing, ethanol conversion process and transportation. In this study, researchers revealed both net energy value and net renewable energy values were higher than the result of China case study with about 8.80 MJ/L and 9.15 MJ/L, respectively. In this case, the authors' argument, the cassava-based ethanol production was suitable for shortage of global energy in the context of Thailand.

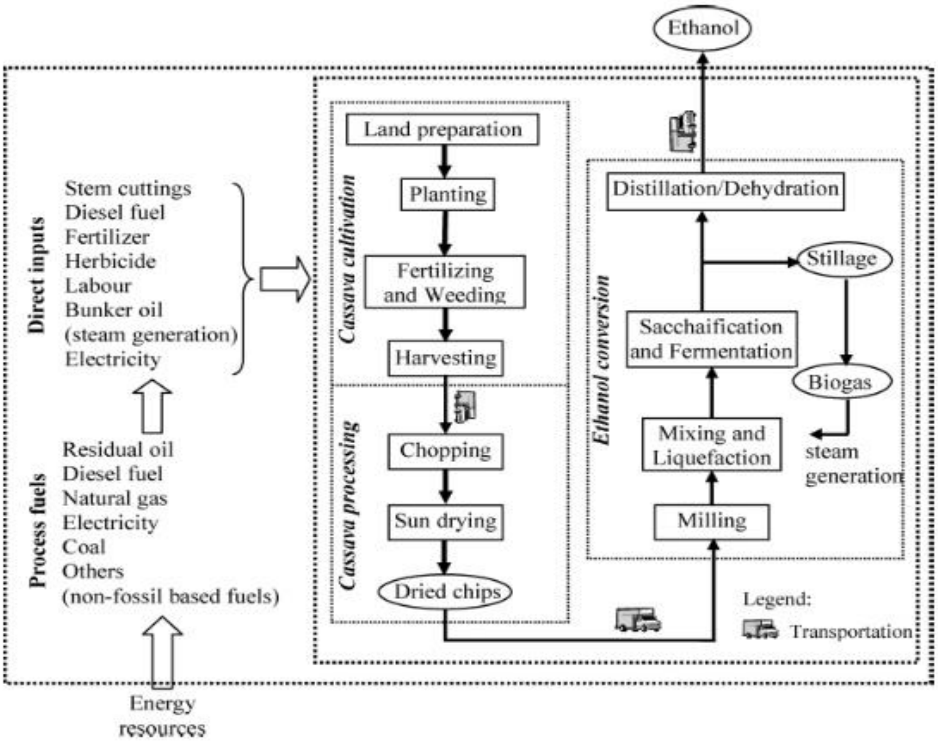


Figure 1.23. Cassava fuel ethanol system boundary in Thailand (Lan et al., 2007)

In another study, dealing with the energy crisis, the Indonesia government applied many solutions to overcome the energy crisis. As a result, renewable energy resource was a good direction. The huge potential biofuel was not only diversification energy supply it also was a burden on government expenditure in the long term. In this study, the researcher compared to cassava-based ethanol, so-called E10 with gasoline (Restianti & Gheewala, 2012). As a result, the price of E10 was lower than gasoline per litre. Nevertheless, there is a weakness, that the biofuel’s competitiveness is less than fossil fuel because of the oil subsidy of government. In addition, there is a conflict between energy policy and food security. According to Pingmuanglek et al. (2017), cassava was a crop with a wide range of purposes such as food, animal feed and fuel in Thailand. Nonetheless, it just had only 2% to be used to produce ethanol production in total cassava production, (OAE, 2013). Hence, cassava was a promising crop for ethanol-producing due to ethanol could be produced from starch (Yu & Tao, 2009). In Indonesia ethanol case, for example, one of the renewable energy with a huge potential to be developed, the target of government can supply about 5% within total petroleum demand in 2006-2010 period (Restianti & Gheewala, 2012). E10 with 10% mixed between cassava-based ethanol with gasoline impact on the environment. In term of cost, the selling price of ethanol is less than gasoline however if its calculation by external cost the cost of gasoline will higher approximately 210 Rupiah (Rp) compared to E10 per functional unit caused by environment burden. Regard to the technology to produce bioethanol, there were several studies mentioned about conversion technology from cassava to ethanol. In Hamelinck's study, authors showed the result was that not only got the highest efficiency but also used not complex technology as well as lower initial investment cost in cassava-based ethanol production (Hamelinck, 2007). With 30% starch cassava the cassava tuber is one of the best solutions to produce ethanol by fermentation processing. In this study, depending on the kind of cassava chip and fresh cassava, in order to produce by 1-litre ethanol need to consume from 5 to 6 kg of fresh roots (containing 30% starch) and 3 kg of cassava chips (14% moisture content). In other words, they could be produced 150 litres and 333 litres of ethanol by 1 tonne fresh cassava and dry cassava respectively. Furthermore, ethanol plant operation may be caused environment, surface and underground water and air pollution.

1.2.3 The bioethanol production and relevant policies in Vietnam

In December 1997 in Japan, Kyoto Protocol has given addressed the issue of climate change and as well as built up greenhouse gas emission mitigation targets for intensive industrialized nations (Kumar et al., 2003). In current years, one of the most valuable energy powers is biomass in Vietnam. This energy resource comprises approximately 38% of the total energy demand. Whilst, traditional fuels accounted for 37.8% of the total energy consumption. On the one hand, fuelwood is the main factor of biomass that contributed over 80% in traditional energy supply. Vietnam is probably reached high biomass industrial sector which comes from agricultural residues, animal waste as well as municipal solid waste because Vietnam is an agricultural-dominated nation with huge potential in agricultural residue sector. According to Vietnamese government's biomass product development strategies in 2050 vision, biomass energy is one of the most an important energy power in the industrial sector and other multiple sectors are being increased in the structure of national energy consumption total. On the other hand, according to decision No. 177/2007/QD-TTg in 2007 of Vietnamese Prime Mister, biofuel has been encouraged by the Vietnamese Government (GoV). Otherwise, the socio-economic development strategies and projection in the period 2015-2025, the leader of Vietnam also support bioenergy including carrying out advantages conditions in order to study and develop. Hence, there are many policies such as to implement projects on feedstock and conversion technologies and tax incentives for biofuel investments. The supporting policy focuses on two biofuel products are gasohol (E5) and biodiesel (B5). Which constituted 5% ethanol blended with 95% gasoline and 5% biodiesel blended with 95% diesel respectively. The purpose of output was produced 250 thousand tonnes and further can reach 1.8 million tonnes in 2025 corresponding to 1% and 5% respectively in demand for energy use. In addition, the national energy development strategy up to 2020, with 2050 vision under by decision No.1855/QĐ-TTg issued on 27th December 2007. The aim of the decision was to invest in new and renewable energy namely bio-energy and nuclear power. Hence, the best solution on development investment is prioritized to allocate of concessional credits for development support fund from international organization including official development aid (ODA) and other foreign bilateral loans for energy projects such as those on the exploration and development of new and renewable energies and bio-energy.

CHAPTER 2. MATERIAL AND METHODS

2.1 Background and rationale

There are various perspectives on value chain analysis, each author and organization also a specific way to analyze. There are plenty of handbooks on value chain analysis have been published. The aim of this chapter is referred to as the particularly beneficiary group. Some of them are a clear focusing on in order to analyze the impact of the value (Michael et al, 2010). In term of cassava value chain, the processing stage, the initial capital requirement is low and the return on investment is so fast, compared to other agro-products. Besides, cassava has more advantages of investment and expansion of processing capacity than other cops. The extensive farming system is the mostly method to apply in cassava cultivation. The quantity of cassava is increased mainly due to the expansion of the area. In comparison with other commodity crops, cassava is considered to be easy to apply with the poor people this is because it does not require large initial capital and high levels of intensive cultivation (Phuc, 2015). Recently, the area of cassava has been continuously expanded and has changed its role to industrial crops from food crops in Vietnam. This is, therefore, the arable land is emerging issue. Consequently, the local authorities have to concern in land use planning. According to biofuel policy of Vietnam with two decisions including: First, (decision 1855/QĐ-TTg; 27th Dec, 2007) the National energy development strategy with 2050 vision, the purpose to boost the development of new and renewable energies, bio-energy in order to meet the requirements of socio-economic development; and the another was the national program for development renewable energy so-called bio-fuels up to 2015, with 2025 vision according to decision No 177/2007/QD-TTg on 20th Nov, 2007. To develop and use biofuel as an alternative resource to replace partially conventional fossil fuels, which is more and more depletion. In sum up, this research will be a focused on the value chain as well as the potential of cassava-based bioethanol production in Dak Lak province.

2.2 Research objective

To analyze cassava value chain in Dak Lak province

To assess potential cassava-based bioethanol production in Dak Lak province

To propose appropriate solutions in order to improve cassava value chain

2.3 Research question

How to enhance cassava value chain in Dak Lak Province?

What is the potential of cassava-based bioethanol production in Dak Lak?

What are the policies recommendations for not only local authority but also the stakeholders?

2.4 Scope of the study

Cassava has been planted in some districts namely Ea Kar, Krong Bong and Ea H'leo, where the major areas of cassava production in Dak Lak province. The research will conduct in Cu Kty, Hoa Son and Cu Pui (Krong Bong district), Ea Sar and Ea Pal (Ea Kar district), and Ea Tir and Ea H'leo (Ea H'leo district). Consequently, the study referred to the cassava value chain in Dak Lak province in this area. The role of stakeholders and the relationship among actors within the cassava value chain are mentioned. In addition, the scope of the study is also found out the potential of bioethanol production derived from cassava in term of cost-effectiveness. To measure potential of bioethanol production based on cassava, the particular criteria including area, the yield and the cassava output is also assessed. The finding out optimal solutions which can be improved cassava value chain.

2.5 Significance of the study

This research can help all stakeholders such as farmers, consumers, traders, investors, and the other actors, who need to find information for individual purposes in cassava value chains.

This study also gives currently knowledge about cassava products market. Functioning and identifying the pros and cons of the marketing systems. The governmental and non-governmental organization will be designed appropriate intervention to improve the efficiency of the value chain. On the other hand, the aim of the study will determine the advantages and disadvantages of cassava-based bioethanol production in Dak Lak province.

Furthermore, the result of the study also would serve as reference documents for relevant research works in further research. It can be shown a comprehensive picture of the cassava value chain in Dak Lak. The result of the research is a valuable recommendation for local authorities and policy-makers related to reasonable policies for cassava sustainable development in Central Highland in the future.

2.6 Description of Dak Lak province overview and study site

Dak Lak province is located in the Central Highlands between longitude 107°28'57" and 108°59'37" east and between latitude 12°9'45" and 13°25'06" north (Fig. 2.1). It occupies an area of 13,125.37 km^2 (Dak Lak, 2018). Currently, the population is over 1.8 million people with a provincial population density of over 137 people per square kilometre. There are 47 ethnic groups living in the province, the largest; of which, the Kinh account for about 70% of the people, with other ethnic minority communities including Ede, Thai, Tay, M'nong, and Nung people representing the remaining approximately 30%. The climate of the province is separated into two sub-regions with the North West being quite hot and dry in the dry season, while the climate in the south-east is cool and pleasant. The Krong Bong district is located in the south-east and the Centre of the district is 55 km from Buon Ma Thuot city in the north-west of the province (Krong Bong, 2018). Krong Bong has an area of 1,257.49 km^2 and a population of 90,126 people. It is affected by the tropical monsoon, and its climate, which has two distinct seasons, rainy and hot, is not only impacted by the generally high altitude but is also influenced by the Cu Yang Sin mountain, which rises to over 2,400 m. Ea Kar district was established on 13th September 1986 under decision No. 108/1986/QĐ-HĐBT of the Vietnamese government. It is 52 km from Buon Ma Thuot city, along the No. 26 National Highway. It is located to the north of Dak Lak province. and has a land area of 1,037.47 km^2 and the population density is over 138 inhabitants per square kilometre. Cassava is one of the staple crops produced to meet the material needs of the local industry and it is the largest producer among agricultural crops in Dak Lak province (Ea Kar, 2017). Ea H'Leo district is the northern gateway of Dak Lak province. The district is approximately 80 km from Buon Ma Thuot city and was separated from Krong Buk district on 8th April 1980 under government decision No.110/QĐ-HĐBT. It has an area of 1,335.12 km^2 and a population of 125,123 people. Cassava is a prominent crop in the region (Ea H'leo, 2018). The study reported was conducted by surveys in three districts, Ea Kar, Krong Bong and Ea H'leo which are prominent areas of cassava production in Dak Lak. The major source of household income is from cassava, other cash crops and cattle husbandry. The average area planted to cassava by households is from 0.5 ha to 3.5 ha and the average yield is approximately 20 tonnes/ha. Most of the households growing cassava consist of northern ethnic minorities such as the Ede, Dao, Tay and Nung.

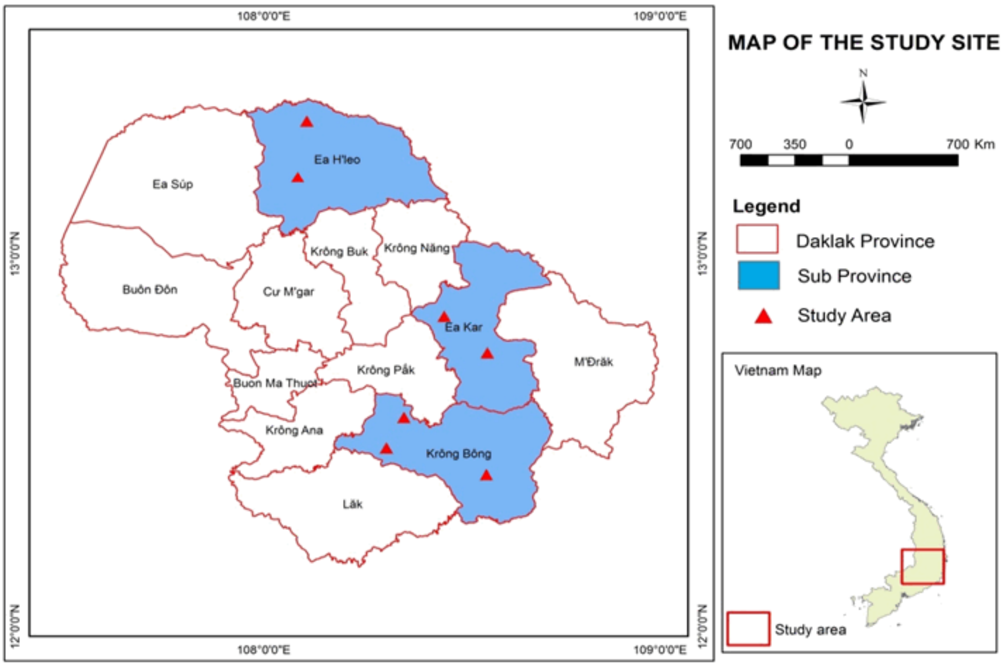
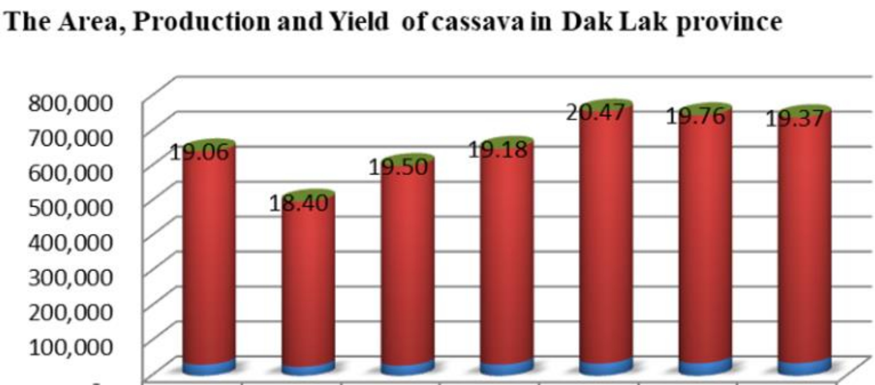


Figure 2.1. The location of the study area



	2011	2012	2013	2014	2015	2016	2017
Yield (Ton/Ha)	19.06	18.40	19.50	19.18	20.47	19.76	19.37
Production (Ton)	610,000	472,800	571,300	617,600	720,700	709,400	703,300
Area (Ha)	32,000	25,700	29,300	32,200	35,200	35,900	36,300

Figure 2.2. The Area, Production and Yield of cassava in Dak Lak province in 2011 – 2017

2.7 Data collection and analyses

2.7.1 Methodology for cassava value chain through linkages among stakeholders

2.7.1.1 Data collection

The study was conducted using a case study approach, which is one of several methods of conducting social science research (Yin et al., 2009). Data collection was conducted with the aid of structured questionnaires (Fonji, Temegne, & Ngome, 2017). Data relating to household characteristics (Mukete et al., 2018a) came from a household survey, interviews with key informants and focus-group discussions with heads of household and actors in the cassava value chain. The cross-sectional design enabled the researchers to address the study objectives and this method was adopted farmworkers save time during the data collection process (Kothari, 2004a; B. Masamha, Uzokwe, Ntagwabira, Gabagambi, & Mamiro, 2017). This method has been employed in a number of previous studies of the cassava value chain and related issues (Komen, Mutoko, Wanyama, Rono, & Mose, 2010; B. Masamha et al., 2017; Son, Lam, Fahrney, Thi, & Thuy, 2016). The researchers selected seven communes from the three districts, Krong Bong, Ea Kar and Ea H'leo, using the multi-stage sampling method. In each commune, a questionnaire-based survey was conducted to collect relevant data from stakeholders in the cassava value chain based on visits to households. In this study, the interviews covered at least 70% of the households in each commune, where the farmers grow cassava. The questionnaire employed consisted of a mixture of open and closed-ended questions. It was written in English then translated into Vietnamese before being used to interview the indigenous people (Echato & Echato, 2018). To complement the survey data, both primary and secondary data were collected from stakeholders who directly participate in the value chain, including from input providers, traders and processors (Blessing Masamha, Thebe, & Uzokwe, 2018a). Both in-depth interviews using a semi-structured questionnaire (Coulibaly, Arinloye, Faye, & Abdoulaye, 2014b)(Coulibaly, Arinloye, Faye, & Abdoulaye, 2014b) and direct observation in the field were also applied in this study (Coulibaly et al., 2014). The in-depth interviews were conducted with key informants, including directors of local cassava starch factories (Son et al., 2016), input suppliers, cassava growers, collectors, traders, in Cu Kty, Hoa Son and Cu Pui (Krong Bong district), Ea Sar and Ea Pal (Ea Kar district), and Ea Tir and Ea H'leo (Ea H'leo district). These key informants were surveyed using a different questionnaire, which covered core processes (Naziri, Quaye, Siwoku, Wanlapatit, Phu, et al., 2014) traded quantities and prices of inputs as well as the selling price of cassava in the local market compared to other areas. Focus group discussions with cassava farmers were conducted during 2018 in the seven different communes included in the study. Field trips were used to gather primary as well as secondary data. The basic unit for this research was the household farmer which was defined as a group of people living together in the same house and taking part in the same daily activities (Mukete et al., 2018a). The populations of the study were the cassava growing household farmers in Dak Lak Province. Goal-directed sampling, a commonly used sampling approach was adopted, with the sample of participants being selected based on preselected criteria appropriate to a specific research question (Mack, Woodsong, M.Macqueen, Guest, & Namey, 2005). The total sample size was 300 households across the seven communes, and 20 both collectors and traders, and key informants were interviewed as well as the owner of a cassava starch factory in the area.

2.7.1.2 Statistical analyses

Both qualitative and quantitative methods of analysis were applied in this study to understand the roles and actions of the major's actors (Apata, 2013a). The analysis of the data from the questionnaire-based survey involved coding, data entry and analysis using the SPSS Version 20 statistical program (B. Masamha et al., 2017; Mukete et al., 2018a) and Microsoft Excel. Frequencies and means for socio-economic and demographic data were described based on descriptive statistics (B. Masamha et al., 2017). The qualitative data from the in-depth interviews with stakeholders and focus group discussions were analyzed by specific content analysis in order to identify and examine the most important topics (Blessing Masamha et al., 2018a). A value chain details the many activities that are required to take a product or service through the different phases of production and delivery to the final consumers, and its disposal after use (Kaplinsky & Morris, 2001). The analysis of the cassava value chain was based on the value-chain analysis method (VCA) (Naziri, Quaye, Siwoku, Wanlapatit, Phu, et al., 2014) and value-chain upgrade solutions were computed in this study using a quantitative method. The VCAs were designed using techniques to determine specific relationships and linkages at different stages among actors who participate in the cassava value chain. Analyzing supply stages, marketing and trading relationships between actors in chain analysis has become a key tool since it can enable an understanding of the whole chain (Meaton, Abebe, & Wood, 2015). This study identified major aspects of the cassava value chain in Dak Lak province. The production cost, intermediate input (II) value added (VA) and other economic parameters, including gross profit (GPr), net profit (NPr). These were evaluated based on specific actors' perspectives. Revenues were calculated according to the following equation:

$$\text{Revenues} = (Q * P) + \text{income from by-products}$$

where Q = quantity sold and P = price paid by the buyer (Purcell et al., 2008) Components of the total value generated by the value chain such as output value (Y) and product value were also calculated using the Q * P formula, based on analytical frameworks for value chain analysis proposed by international organizations such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, 2007). Value added (VA) was calculated to measure the new wealth created by a productive activity and thus the creation of wealth and the contribution of the production process to the growth of the economy. VA was calculated according to the following equation:

$$VA = Y - II$$

where Y = total sales (output) value and II = intermediate input such as fertilizer, pesticide and seedlings.

Profit elements were calculated as follows:

$$GPr = VA - (\text{wages and salaries} + \text{interest charges} + \text{taxes})$$

$$NPr = GPr - \text{depreciation}$$

GPr expresses the economic gain, or loss, to an actor once all current production costs have been met. NPr indicates the economic gain or loss taking into account the predictable costs of the actual investment.

2.7.2 Methodology for cassava value chain and gender issue

2.7.2.1 Data collection

Data collection was conducted using structured questionnaires (Fonji et al., 2017). Data relating to the characteristics of individual households (Mukete et al., 2018a) was obtained through a survey of households and by interviewing key personnel in local authorities, as well as focus group discussions. In order to meet the research objectives, suitable measures were designed based on a cross-sectional methodology (Kothari, 2004b; Blessing Masamha, uzokwe, Ntagwabira, Gabagambi, &Mamiro, 2017). The three districts selected for the study, Krong Bong, Ea Kar and Ea H'leo, were surveyed based on a multi-stage sampling method. In each district, communes were selected randomly based on the aims of the study. A total of seven communes were thus selected and, in each commune, a survey was conducted based on household visits using the structured questionnaire, in order to collect pertinent data. The total sample size was 300 households all of whom were engaged in the cultivation of cassava. Key personnel in the local authorities were also in-depth interviewed using a semi-structured questionnaire (Coulibaly, Arinloye, Faye, & Abdoulaye, 2014c).

2.7.2.2 Analytical methods

Quantitative data were analyzed using the IBM SPSS Statistics 20.0 software package using probit and ordinary least squares (OLS) regression models (Arega et al., 2007; Blessing Masamha, Thebe, & Uzokwe, 2018b; Sebatta, Mugisha, Katungi, Kashaaru, & Kyomugisha, 2014). A two-stage Heckman model was adopted as an appropriate model to test decision-making associated with the cassava value chain and was used to determine the factors affecting females' decisions to participate (Sebatta et al., 2014) and their level of participation in cassava production and the cassava market (Blessing Masamha et al., 2018b). The model employed a two-step process consisting of analyzing: (1) woman's decisions about whether or not to participate in cassava cultivation and the cassava market. (2) The level of farmers' participation in cassava farming and the cassava market (Zamasiya, Nelson, Kefasi, & Shephard, 2014). In the Heckman model, the first stage equation of the model adopted a probit model to estimate the effect of the factors influencing the decision about whether or not to participate as well as the extent of market participation (Blessing Masamha et al., 2018b; Sebatta et al., 2014; Zamasiya et al., 2014). The female farmers' participation in both production and marketing were adopted as the dependent variables based on a dichotomous measure of 1 if a woman was willing to engage in cassava cultivation and 0 otherwise. The equation used for the probit model was proposed by (Blessing Masamha et al., 2018b), as follows.

$$Y^* = \beta_0 + \beta_i X_i + \mu \qquad (1)$$

Following Sebatta et al (2014), the Heckman model was calculated as:

$$y_{1i} = 0 \text{ if } Q_i \le 0$$
$$y_{1i} = 1 \text{ if } Q_i \ge 0 \qquad (2)$$

Where; y_1 is the binary response and Q_i is the quantity of cassava cultivated by a woman.

The participation equation was then rewritten in the following form:

$$Y_1^* = \beta_{1i} X_{1i} + \varepsilon_{1i} \qquad (3)$$

Where; Y_1^* is a latent variable, which is the utility a farmer gets from participating in the market

The dichotomous model was stated as:

$$Y = \begin{cases} 1, \; if \;\; farmer\, sell\, any\, cassava \\ 0, \qquad\qquad\qquad otherwise \end{cases} \qquad (4)$$

In the case of the probit model in the first step, the estimation was conducted as follows:

$$\Pr(Y_1) = f\left(x_1, x_2, x_3 \ldots . e\right) \qquad (5)$$

where; $\Pr(Y_1)$ is the probability of a farmer making a decision to sell cassava into a market or not, and x_i etc. are the variables specified in Table 1 and e the normally distributed error term.

In the second stage Heckman model, the levels of participation were calculated using OLS and estimated to test the effect of the hypothesized factors based on the amount of cassava cultivated or harvested. The theoretical model can be presented as:

$$Q_i = f\left(y_1, y_2 y_3 \ldots\ldots\ldots\ldots y_n\right) \qquad (6)$$

Where; Q_i is the volume of cassava produced; y_n denotes independent variables. The variance inflation factor (VIF) indicator was calculated to check for multicollinearity between the independent variables in the empirical estimation procedure and the Breusch-Pagan/Cook-Weisberg method was used to test the heteroscedasticity of the model (Greene, 2002).

2.7.3 Methodology for cassava and the potential of bioethanol production

2.7.3.1 Data collection

Data collection was conducted by structured questionnaires. Data related to household characteristics were obtained from a household survey (Mukete et al., 2018b). In addition, the survey was designed to collect both primary and secondary data. Besides, the in-depth interviews were conducted with key informants, including directors of local cassava starch factories as well as manager of ethanol plants (Son et al., 2016). The study was conducted in seven communes of districts, the multi-stage sampling method was applied. The total sample size was 300 households across the seven communes based on a margin of error level of 5%, a confidence level of 95%. Using these details with the Raosoft sample size calculator found on www.raosoft.com (Mkandawire, 2016).

2.7.3.2 Statistical analyses

The study was applied to both qualitative and quantitative methods. The analysis of the data from the questionnaire-based survey involved coding, data entry and analysis using the SPSS Version 20 statistical program (B. Masamha et al., 2017; Mukete et al., 2018b) and Microsoft Excel. The descriptive statistics mainly included averages; median and percentages, frequencies and means for socio-economic and demographic data (B. Masamha et al., 2017; Mkandawire, 2016).

CHAPTER III: RESULTS

3.1 Cassava value chain and the sustainable livelihood of smallholder

3.1.1 Introduction

Cassava (*Manihot esculenta Crantz*) is a perennial drought-resistant crop cultivated mainly in dry areas, which contributes significantly to the nutrition and livelihood of many farmers (Sewando, 2012). This crop is a versatile plant that is used in the production of a large number of products ranging from traditional food products to livestock feeds as well as having uses in the industrial sector as a raw material for ethanol and starch and its numerous derivatives (Pingmuanglek et al., 2017). The Vietnamese cassava value chain is characterized by numerous intermediaries due to inadequate commercial infrastructure as well as a fragmented pattern of land use for cassava production (Thao et al., 2013). As a result, cassava has a lower value compared to other crops in the same region. Dak Lak province is in the middle of the Central Highlands where four other provinces, Gia Lai, Kon Tum, Lam Dong, and Dak Nong are also located (Dak Lak, 2018). In Dak Lak, cassava is grown as a cash crop by rural households and the income earned from cassava plays a vital and increasing role in farmers' livelihoods (Son et al., 2016). The area cassava plantations in Dak Lak province has grown from 30,732 ha in 2014 to 36,300 ha in 2017 (GSO, 2018b). and the yield of cassava during that period fluctuated only slightly from 18.3 to 18.8 tonnes per hectare (GSO, 2018e). Cassava farmers also face various challenges stemming from a lack of access to modern inputs and improved varieties, as well as the problems relating to the local infrastructure and a lack of access to credit (Njukwe et al., 2014). Hence, improvements in the productivity of cassava, the processes used, their products, in the means of distribution in the value chain would lead to an improvement in output (B. Masamha et al., 2017). This would, in turn, contribute to an increase in household income which would lead to increased spending in areas such as education and health services as well as other aspects of daily life. (Rutherford, Burke, Cheung, & Field, 2016). Nevertheless, unpredictable cassava prices in developing countries have tended to increase the vulnerability of farming household incomes (Ouma & Jagwe, 2010). In addition, the farmers have limited to connection with the market as well as a lack of comprehensive information. Consequently, building relationships among stakeholders in the cassava value chain and increasing cassava productivity is necessary in this region. The aim of the study is to improve and develop the cassava value chain, increase stakeholders' income and particularly, to find out the appropriate strategies to ensure sustainable household livelihoods.

3.1.2 Review of Literature

Cassava is a crucial source of food in Africa because it can be planted in infertile soil and is also able to resist severe weather (McNulty & Oparinde, 2015b; Meridian Institute, 2012), and it is, for instance, a vital staple crop in Liberia (Coulibaly, Arinloye, Faye, & Abdoulaye, 2014a). Africa is one of the leading cassava producing regions contributing over 56 % of the total global supply (FAO, 2017). It has been proposed that labour, transportation systems and novel technologies, as well as the coordination of agents, are all factors by which the efficiency of the cassava value chain could be improved (Trienekens, 2011b). The cassava market is primarily based on the cassava tuber and products made from it. However, cassava leaves also offer an additional source of nutrition although there have been few studies to date of their benefits or of how they are consumed and whether there is a wider market for them (Andersson, Lodin, & Chiwona-Karltun, 2016). The utilization of locally available resources such as cassava, not only creates value-added products but also brings benefits to the local society, with benefits accruing to all stakeholders within the cassava value chain in the region (Mcnulty & Adewale, 2015). (T. O. Olukunle, 2013) found that income and employment for farmers in Nigeria could be created from the cassava value chain as well as other actors in the value chain with over one million jobs being created in rural areas of Nigeria and an increase of approximately US$450 per year in the income of 1.8 million participating farm families. However, although a strong long-standing market has been established in the cassava sector. It was found that the farmers gained a smaller percentage of the total profits, compared to traders who received the largest part of the profit. According to Naziri et al. (2014) studied the cassava value chain and the diversity of post-harvest losses arising in four countries on two continents, Thailand and Vietnam in Southeast Asia, Nigeria and Ghana in sub-Saharan African. They found that post-harvest losses at different stages of the cassava value chain were due to cassava cultivation, processing and consumption methods and the relationships and linkages among the value-chain stakeholders. However, they suggested that there was no “one-size-fits-all" solution for dealing with post-harvest losses but those solutions depended on the specific characteristics of different value chains. They estimated that in Ghana, economic losses due to partial spoilage of cassava root were between 16 and 28% caused by the long distance between the production site and the place of final consumption. Similarly, in Nigeria, economic losses suffered by cassava root due to breakage and deterioration during harvesting and distribution were estimated to be between 10 and 30%. Daniels et al. (2011) were able to provide a complete picture of the value chain in Nigeria including farmers, processors, traders, input suppliers and other stakeholders. In Cambodia, the yield of cassava is from 8 to 10 tonnes per hectare with the average area under cassava being 0.2 to 1 ha/household. A study of the cassava value chain was conducted by the IBC (Inclusive Business for promoting sustainable Cassava smallholders) project in Tboung Khmum province and the study particularly examined government policy (SNV Cambodia, 2015) as well as examining gender-related aspects of the value chain. The linkages among stakeholders were analyzed with the aim of improving knowledge as well as proposing appropriate measures for further strengthening the cassava value chain. In recent years, the productivity and production quantity of cassava in Vietnam has increased and it now ranks third in terms of agricultural production after rice and corn. The area planted to cassava has reached 560,000 ha, with an average yield of 17.63 tonnes/ha and a production of 9.87 million tonnes annually (Hieu, 2016a). This is because the area in which cassava is grown has been widened and hybrid varieties have been applied with farmers now cultivating 70% hybrid varieties including KM94 and 30% local varieties (Phuc, 2015). The average yield of cassava in 2016 was approximately 19 tonnes/ha (FAO, 2017), which was more than double that in 2000 (8.4 tonnes/ha). Nguyen et al (2005) presented a complete picture of the cassava value chain and also the relationship among the stakeholders in the chain. The study also examined the role of the government as well as their operations and the sharing of benefits between stakeholders in the value chain, finding that as (T. O. Olukunle, 2013) noted in Nigeria, the farmer received an unfairly small share of the benefits while intermediaries obtained most of the profit in the cassava value chain. According to (Naziri, Quaye, Siwoku, Wanlapatit, Phu, et al., 2014) study of postharvest losses, there were differences between the northern and southern parts of Vietnam. In the North, production was mostly by small-scale farmers while in the south, it was characterized by both larger scale production and processing units normally consisting of from 20 to 30 hectares. That study found that post-harvest losses mainly occurred on large sized and small-sized plots because the local people lack of knowledge as well as in harvested. The kind of losses experienced were breakage and deterioration of roots as were found in other areas studied. Vietnam is a tropical country and it is unsurprising that cassava has become one of its most vital crops (GSO, 2018a). In Dak Lak Province the area planted of cassava increased from 32,000 ha to over 36,300 ha between 2011 and 2017, with the average cassava yield fluctuating around 19 tonnes/ha and the total production reaching a peak of 703,300 (Fig 3.1) tonnes in 2017. The province is, therefore, a region where cassava is one of the most prominent crops. The study reported discusses the major aspects of the cassava value chain in Dak Lak Province. Firstly, it systematically identifies and maps the stakeholders participating in the distribution channel and marketing of cassava and details the profit and cost structures. Secondly, it identifies the sharing of benefits between the various actors and analyzes the gross and net profits within the chain. It also examines how and by whom benefits could be gained from enhancing the relationships among the actors and organizations involved. Thirdly, it examines ways in which the cassava value chain could be upgraded by improvements in cassava productivity (Naziri, Quaye, Siwoku, Wanlapatit, Phu, et al., 2014). Finally, it highlights the role of relationships and coordination mechanisms in improving farming-related policies in order to enhance the cassava value chain and to increase the earnings of farmers.

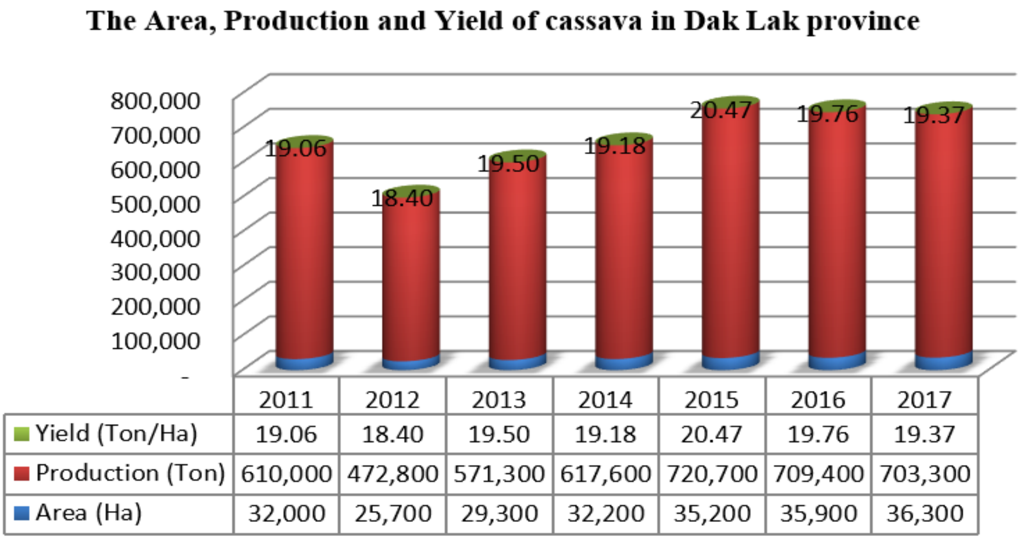


Figure 3.1 The Area, production and yield of cassava in Dak Lak 2011-2017

3.1.3 Description of stakeholders in the cassava value chain

3.1.3.1 Input Provider

The study found that there were both backward and forward linkages in the cassava value chain. Input providers were backwards-linked from the farmer. Thus, input providers were important actors who supply agricultural products to meet farmer demands for items such as seedlings, fertilizer and pesticide as well as being a source of informal credit for agricultural activities. A good relationship between providers and farmers has the potential to improve the value chain by giving farmers access to informal credit without them needing to resort to the banking system or other sources of credit, and can help small-scale household farmers to pool their resources to deal with activities which cannot be done by individual farmers.

3.1.3.2 Farmer

This is the first actor in the chain and they are mostly located in rural areas where an inequitable infrastructure has developed, with the farmer being at a disadvantage by needing to supply fresh cassava to the buyer (Njukwe et al., 2014). Table 3.1 shows the socio-economic characteristics of household farmers across the study sites. The average age of the respondents is one of the major factors that affect the chain with 82.33% being over 35 years of age and 71.67% having received at least secondary formal education. Furthermore, it was notable that males represented almost 90% of the respondents suggesting that cassava production is overwhelmingly dominated by men. In addition, most of the farmers (92.32%) had more than 5 years' experience of cassava cultivation. The fresh cassava produced by farmers is mostly sold locally to large traders or factories as well as to other collectors at both the village market and the farm gate. However, this spot linkage only exists during the harvest period. The seedlings for the cassava varieties cultivated in the region are derived from multiple sources such as producers' own farms or those of neighbours, local seeding centres or from donations by international organisations conducting research about cassava cultivation. The land is generally prepared with a machete, hoe or dibble and the cassava plant cutting is inserted vertically, horizontally or at an angle (El Bassam, Khanna, Scheffran, & Zilberman, 2010). Some farmers who own larger areas prepare their land using tractors.

Table 3.1. Socio-economic characteristics of respondent at the study sites

Profile		COMMUNE							Total	%
		CUKTY	CUPUI	EAHLEO	EAPAL	EASAR	EATIR	HOASON		
Gender	Female	3	7	5	5	4	5	3	32	10.67
	Male	41	35	40	38	38	37	39	268	89.33
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**
Age of the respondent	< 25	0	0	0	0	1	0	1	2	0.67
	> 55	8	5	8	7	5	11	13	57	19
	25-35	3	14	7	9	12	1	5	51	17
	35-45	17	19	16	14	13	20	11	110	36.67
	45-55	16	4	14	13	11	10	12	80	26.66
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**
Level of formal education	0	1	6	5	2	3	3	2	22	7.33
	1	10	15	6	9	9	9	5	63	21
	2	26	18	27	28	23	24	29	175	58.33
	3	7	3	7	4	7	6	6	40	13.34
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**
Number of years of cultivation by farmer	< 5	1	10	9	5	5	6	2	38	12.67
	> 15	12	4	15	7	6	8	11	63	21.00
	10-15	18	14	14	21	18	19	18	122	40.67
	5-10	13	14	7	10	13	9	11	77	25.66
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**

Transportation of the harvested cassava from the field may be by truck, motorbike or bicycle, but is mostly accomplished by a tractor-pulled trailer known locally as xe cay (fig 3.2). Cassava is widely grown as a mono-crop by small-scale farmers on fragmented land (0.1 to 4.5 hectares) for food purposes and for use in the industrial sector. Nevertheless, larger-scale inter-cropping models are also practised by a small number of household farmers who sell their produce to processing factories. Cassava production is labour intensive (B. Masamha et al., 2017) so it is one of the best options to improve a farmer’s livelihood in a rural area where there is an excess of labour available.

3.1.3.3 Collectors and traders

Collectors can be grouped based on the quantity of cassava which they buy, namely local, small and large and they include local people as well as those who come from a different region. They play a vital role in the linkage between the cultivation and consumption of fresh and dried-chip cassava. Depending on the buying capacity of the collector, the cassava is collected by different means. Local collectors usually gather directly from both small-scale cassava farmers and from indigents who collect the cassava residue from the harvested fields in or near the village. Larger collectors are able to buy fresh cassava from previous actors in the value chain as well as providing information to those other actors. Most of the product is then sold to starch or ethanol factories with a small volume being delivered to the Tay Ninh Province cassava factory.

Figure 3.2. Transportation in the cassava value chain (Photo by author, 2018)

3.1.3.4 Processors

Most of the cassava produced in Dak Lak is bought by starch or ethanol factories in each district. There are seven starch factories in Dak Lak province with capacities ranging from 150 to 250 tonnes of cassava starch per day, all of which are owned by the Dak Lak Starch Cassava Company. In addition, cassava is used as a raw material by Dai Viet company, which was established in 2010, and is one of the biggest ethanol factories in Vietnam with an installed capacity of 54,000 tonnes of ethanol per year. The factories buy cassava in the form of dried chip or fresh root from small collectors as well as from traders and farmers who have large cultivation areas. Thus, most of the cassava tubers are transported to factories by collectors or traders, (Son et al., 2016). In addition to its industrial use, fresh cassava is also processed into cassava chips by small-scale chip producers for use both animal husbandry in household and by animal feed companies. There is also a small amount of cassava root used for human consumption including in the form of local traditional cakes known as Banh Trang or Bot Loc.

3.1.4 Cassava value chain distribution channel in Dak Lak province

Currently, there are a number of distribution channels for cassava derived from cultivation by farmers to the final customer. However, there are only two major channels and these have an effect on the income of the households surveyed in this study. Firstly, the cassava is supplied to starch companies in order to produce starch (Son et al., 2016) for the export market (85%) with the rest (15%) for the domestic market. The second channel is to the ethanol factory which uses cassava as its feedstock to produce ethanol for a diverse range of domestic consumers (fig. 3.3). Based on our findings, it was estimated that 97% of the total cassava production is sold in fresh-root or dried chip form for industrial use with the rest being used to meet household requirements.

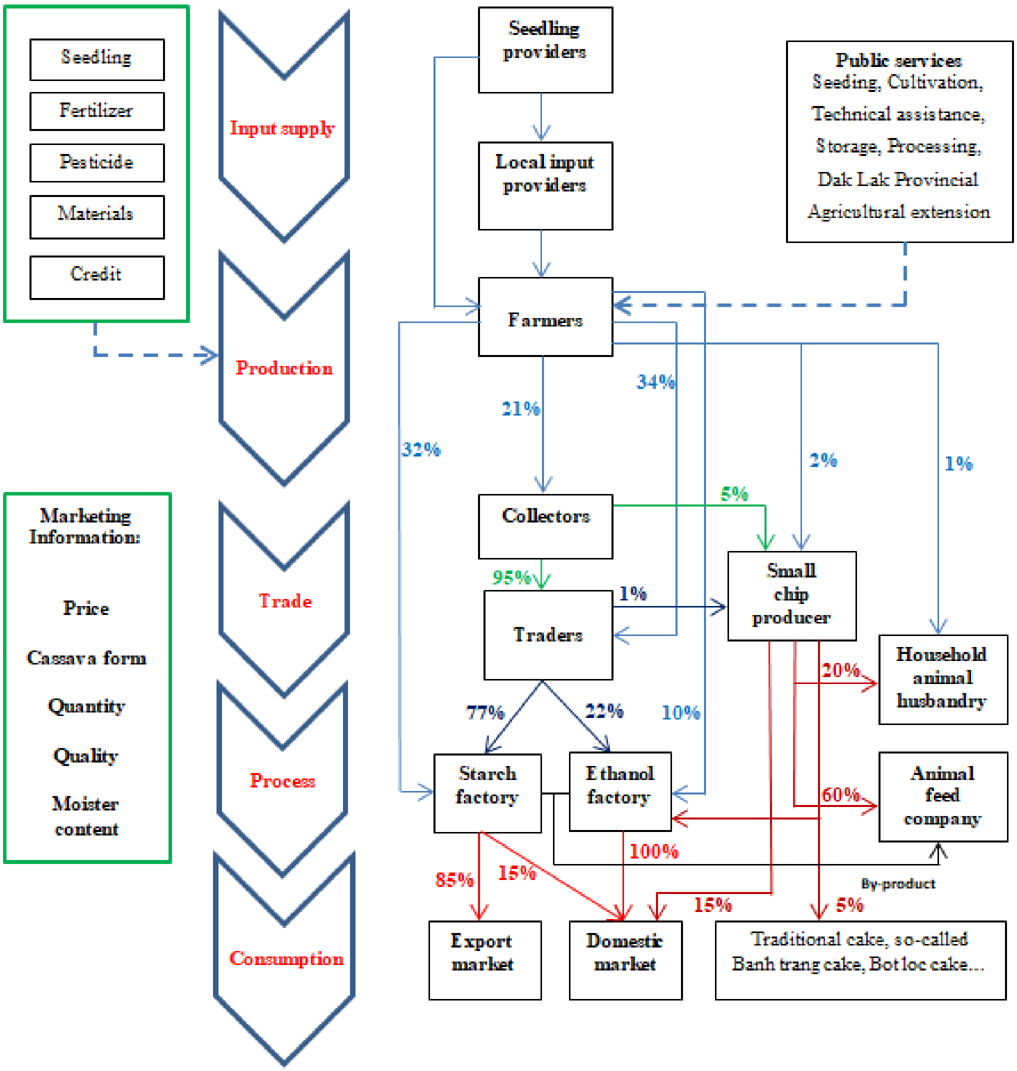


Figure 3.3: Dak Lak cassava value chain map

In the first distribution channel, the fresh cassava tubers are either sold by the farmer to intermediaries (collectors, 21% and traders, 34%) and then sold to a starch factory, or are supplied directly by the farmer to the factory (32% - all percentages based on total production) to produce starch. In the second distribution channel, the farmers sell either directly to the ethanol factory (10% of total production) or through traders (22%) (fig. 3.3).

In addition, small chip producers and household animal husbandry account for 2% and 1% of total production respectively.

3.1.5 Financial analysis of stakeholders in the cassava value chain

3.1.5.1 Cassava growers

The yield of cassava production in the study site fluctuated in a range of 20 to 25 fresh root tonnes/ha. However, in exceptional cases, the yield was as low as 5.5 tonnes per hectare. This is because some households make an inadequate investment in growing cassava. Moreover, the low fertility of the land and the use of poor-quality varieties also contribute to low productivity. The average yield was approximately 20 tonnes of cassava tubers per hectare. The conversion rate was 50%, and the farmer can thus obtain around 10 tonnes of dried chip cassava from the fresh quantity harvested. The producers had various options to sell their products to buyers. Depending on individual farmer's targets and market price information, the cassava growers sold 21%, 34%, 32% and 10% of their produce respectively to collectors, traders, starch factories and the ethanol factory. In terms of the price obtained for cassava, there is great variability depending on the price of exported starch (Son et al., 2016). In this study, the total farmer's income was VND47.895 million or US$2,048 per hectare (US$1 = VND23,390). The price of cassava was approximately VND2 million per tonne and the average yield was around 23.64 tonnes ha^{-1}. In the value chain analysis of cassava, the cost of intermediate inputs represented 8.52% of the total income of the producers, of which the highest percentage (over 50%) related to seedlings (VND4.081 million) (Table 3.2).

The value added was calculated to be VND43.814 million (US$1,873) which accounted for 91.48% of the total production and this confirms that cassava is a favourable crop, which contributes to household farmer income with high economic efficiency, producing a GPr of VND28.618 million per hectare with low intermediate input costs. In the case of chip cassava, the value added was calculated to be VND49.109 million (US$2,100) which represented 92.33% (fig 3.5) of the total production.

The NPr was VND29.593 million (US$1,265) which accounted for 55.64% (fig 3.4) per hectare.

Table 3.2. Major indicator analysis of fresh cassava value chain per hectare

Exchange rate. 1US$ = 23,390 Vietnamese dong (VND) (HSBC, 2018)

Item	Value (VND 1,000)	Value USD	Proportion %
Output	**47,895**	**2,048**	**100.00**
Intermediate input	**4,081**	**174**	**8.52**
Seedlings	2,257	96	4.71
Fertilizer	1,000	43	2.09
Pesticide	239	10	0.50
Transporting	556	24	1.16
Fuel	29	1	0.06
Value added	**43,814**	**1,873**	**91.48**
Land preparation	3,338	143	6.97
Planting labour	3,570	153	7.45
Fertilizer labour	214	9	0.45
Weeding labour	1,702	73	3.55
Pesticide labour	133	6	0.28
Harvesting labour	6,019	257	12.57
Transport labour	97	4	0.20
Interest	122	5	0.25
Gross Profit (GPr = NPr)	**28,618**	**1,224**	**59.75**

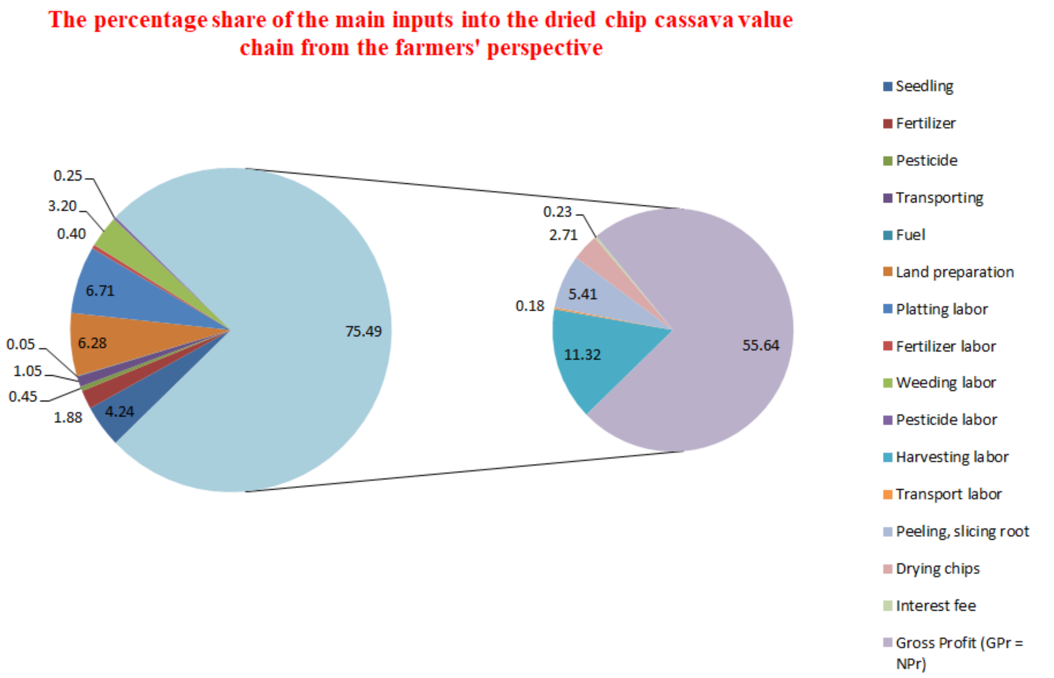
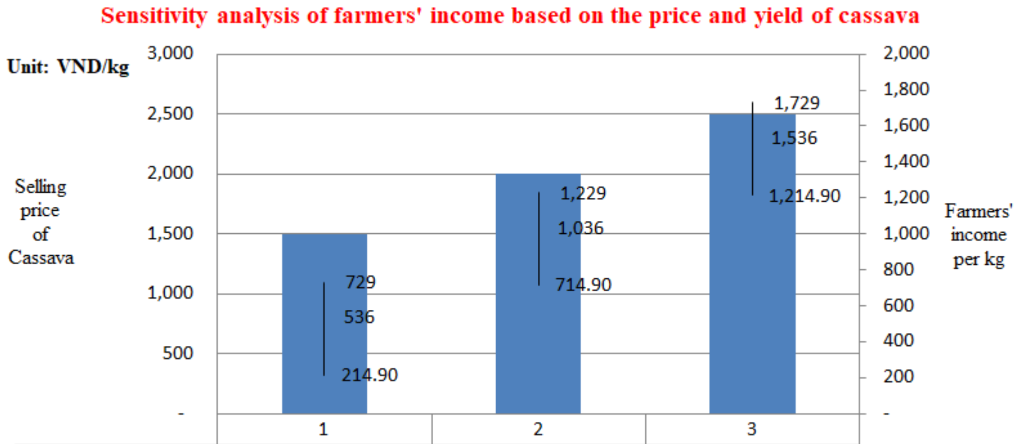


Figure 3.4: The percentage share of the main inputs into the dried chip cassava value chain from the farmers' perspective

Although the total cost incurred also involved incurring an additional VND4.320 million (US$67) per hectare for peeling and drying the fresh cassava. However, both the income and profit received by the producers was higher for chip cassava than for fresh cassava since chips attract a higher price than fresh cassava, selling for VND4,500 per kg compared to VND2,026 per kg respectively.



	1	2	3
■ .	1,500	2,000	2,500
Low productivity	215	715	1,215
Average productivity	536	1,036	1,536
High productivity	729	1,229	1,729

Figure 3.5: The sensitivity analysis of farmers' income based on the price and yield of cassava

Furthermore, processing cassava into dried chips at the farm level provides employment for the indigenous people and thus helps to deal with rural employment, which is a growing problem in the region, and also helps to diversify the farmers' income. Finally, the farmer is able to negotiate the selling price with other actors in the value chain. Because they can store their product in dried chip form for a longer period in order to wait for the optimal market price (Viet, Quoc, Gia, & An, 2013). The study found that based on different market price and productivity scenarios, the producer can always gain profit from their production. This is an advantageous situation and one that is attractive to household farmers who participate in the cassava value chain. In the worst-case scenario with both a low selling price and productivity, the farmers GPr was VND215 per kg, while the producer's GPr was VND1,729 per kg (fig 3.5) for the best-scenario with a lucrative market and high productivity coinciding.

3.1.5.2 The collector perspective

Table 3.3. Major indicator analysis of fresh cassava value chain per ton from the collectors' perspective

Item	Value (VND1,000)	Value USD	Proportion %
Output	**2,400.00**	**102.61**	**100.00**
Intermediate input	**2,252.00**	**96.28**	**93.83**
Cassava root	2,025.00	86.58	84.38
Transportation	226.00	9.66	9.42
Communication	1.00	0.04	0.04
Value added	**148.00**	**6.33**	**6.17**
Labour wages	47.50	2.03	1.98
Interest	12.85	0.55	0.54
Handling	25.00	1.07	1.04
Gross profit (GPr)	**62.65**	**2.68**	**2.61**
Depreciation	1.12	0.05	0.05
Net profit (NPr)	**61.53**	**2.63**	**2.56**

The analysis of the financial situation from the collector's perspective shown in, table 3.3 indicates that the amount expended by collectors for fresh cassava was approximately VND2,338/kg of which, the cost of fresh cassava accounted for the highest proportion of approximately 85%, followed by transport costs accounting for 9.42%. At this stage, the value added was created less than farmers with 6.15% compared to most over 90% in dried chip cassavas. However, a large quantity of produce was purchased by the collectors and the GPr and NPr of VND62,650 and VND61,530 per ton respectively were both higher than those earned by the farmer. According to Viet et al. (2013), it is normal for an amount to be deducted from the price paid by collectors to cover impurities in the cassava supplied by the farmer.

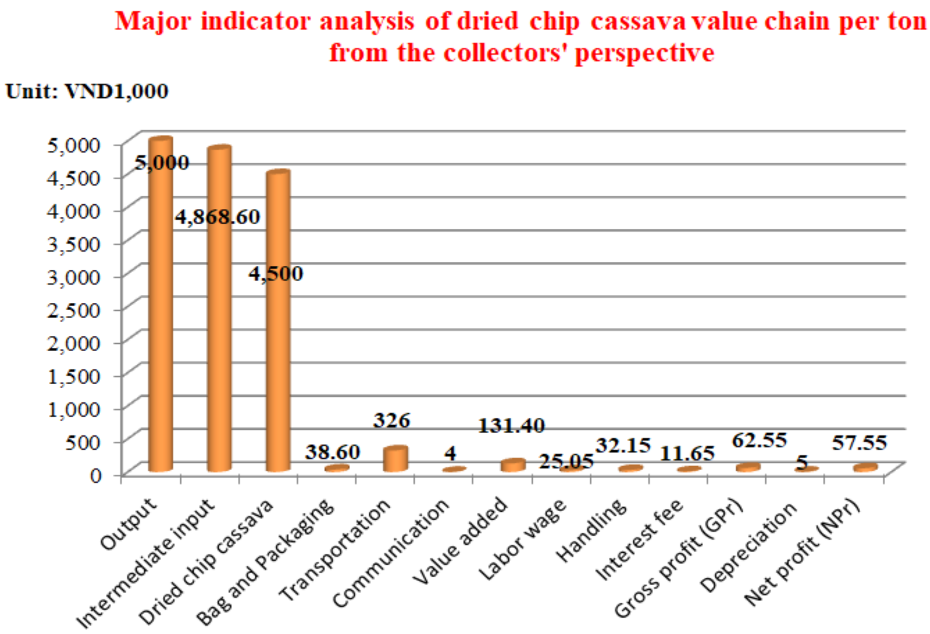


Figure 3.6: The major indicators analysis of dried chip cassava per ton from the collectors' perspective

This ranges from 7 to 10% of the purchase price depending on the time after harvesting as well as the moisture content and this finding was supported by our study. The quality of cassava tubers deteriorates depend on the harvesting season, the length of cultivation and the time to storage. Moreover, the collector is usually faced with having to provide finance due to delays in payment by the starch factories and this will also affect the purchase price paid to the farmer. The business pattern is also similar for the sale of dried chips by farmers to traders, and starch and ethanol factories. The GPr and NPr are actually little different from the fresh root model at VND62,550 (US$2.67) and VND57,550 (US$2.46) per tonne, respectively. However, in the case of dried chips, the collectors have more opportunity to locate the best market for their produce. The quality of cassava tubers depends on the harvesting time and length of storage. Generally, the percentage of starch reduces proportionally based on the length of storage by as much as 10% after a matter of days. In addition, the processing factories often postpone payments to collectors for several weeks because the factories face short-term financial constraints. The collectors do not have any other options although their business activities are affected by this problem. One of the reasons is that the purchasing system in this area has not yet developed and the local market for cassava is excessively dependent on demand from the processing factories.

3.1.5.3 The trader perspective

Table 3.4. Major indicator analysis of fresh cassava value chain per ton from the traders' perspective

Item	Value (VND1,000)	Value USD	Proportion %
Output	**2,850.00**	**121.85**	**100.00**
Intermediate input	**2,676.50**	**114.43**	**93.91**
Cassava root	2,400.00	102.61	84.21
Transportation	275.00	11.76	9.65
Communication	1.50	0.06	0.05
Value added	**173.50**	**7.42**	**6.09**
Labour wages	69.00	2.95	2.42
Interest	0.65	0.03	0.02
Tax	0.42	0.02	0.01
Handling	27.50	1.18	0.96
Gross profit (GPr)	**75.93**	**3.25**	**2.66**
Depreciation	10.00	0.43	0.35
Net profit (NPr)	**65.93**	**2.82**	**2.31**

The traders' business pattern is similar to that of collectors, with traders buying some fresh cassava as well as dried chip from producers in February and March but also obtaining most (95%) of their cassava from collectors in both root and chip forms (fig 3.3). The quantity purchased ranges between 20 and 25 tonnes per day with this figure reaching a peak of 40 to 50 tonnes per day during the harvesting season. It is notable that the purchase price paid by traders is very similar to that paid by collectors who buy cassava directly from farmers.

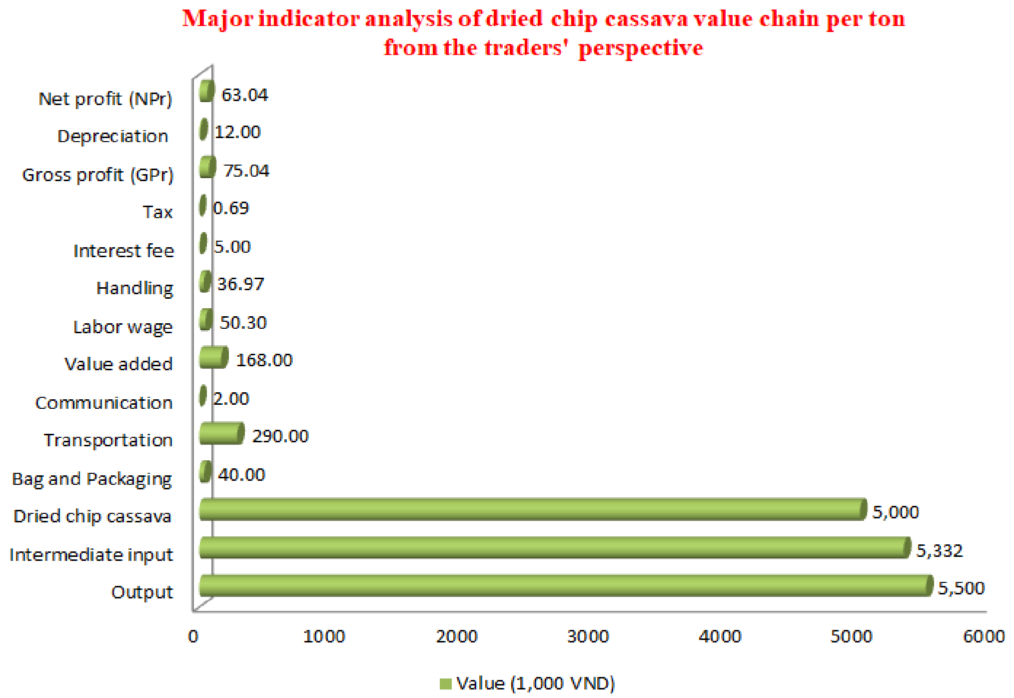


Figure 3.7: The major indicators analysis of dried chip cassava per ton from the trader' perspective

Furthermore, traders usually negotiate with farmers in order to fix the price of cassava before it is harvested. However, changes in the market can affect this practice and, for instance, if the market price is greater than the price fixed before harvesting, then the purchase of the cassava will be concluded based on the market price. In contrast, if the market price is lower, the sale will be concluded based on the price fixed which represents a fair-trading relationship between these actors in the cassava value chain. The average selling price of fresh and dried chip cassava were VND2.85 million (US$121.85) and VND5.5 million (US$235.14) per ton, respectively, and the gross profit gained was VND75,930 (US$3.25) (Table 3.4) per ton for cassava root and VND75,040 (US$3.21) per ton for dried chip cassava (fig. 3.7). Nevertheless, traders play a vital role through their relationship with the farmer because they usually facilitate the supply of intermediate inputs, such as fertilizer, pesticide and herbicide, as well as financing the living costs of household farmers. The farmers can borrow money from the traders in order to deal with day-to-day demands which they have to face, including the cost of food, education and health care.

3.1.5.4 The starch factory perspective

The feedstock used by starch factories is mostly derived from traders (77%) as well as directly from producers (32% their production). The intermediate cost to produce 1 tonne of cassava starch is approximately VND11.2 million (US$479.5) (fig 3.8). The conversion rate for fresh cassava is approximately 3.5 tonnes of cassava to produce 1 tonne of cassava starch (Viet et al., 2013) and the factory is also left with a pulp residue for which there is a market after processing. Hence, the gross profit derived by the factory was found to be approximately VND1.14 million per ton (US$48.57) including the revenue from both cassava starch and pulp residue. However, there is great variability in the price of cassava starch depending on the export price of starch (Son et al., 2016). Thus, the total cost and profit have been unstable over the years. This is a difficulty that most cassava starch factories are currently facing.

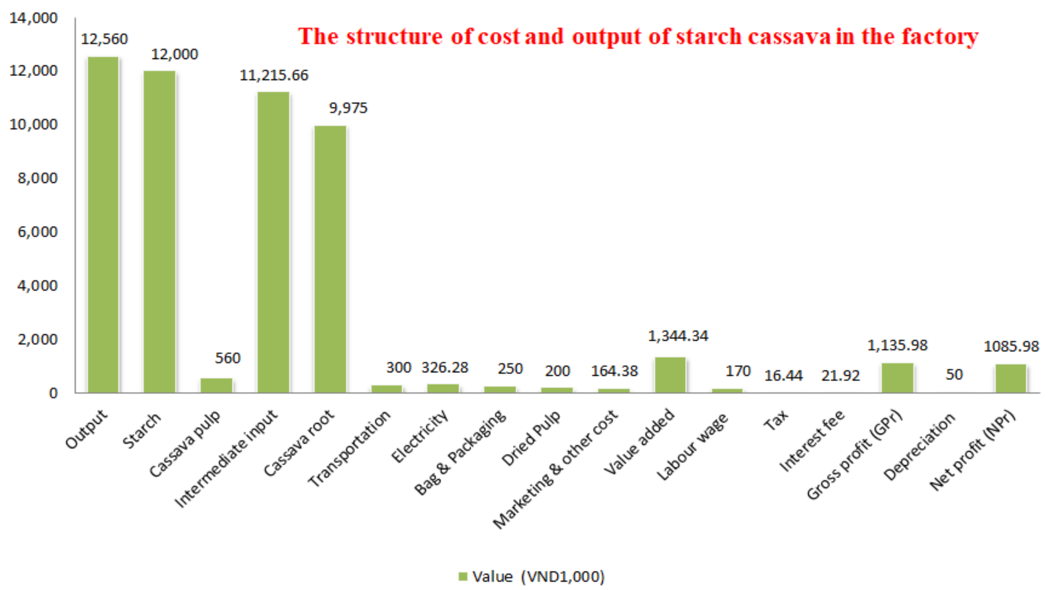


Figure 3.8: The structure of cost and output of starch cassava per ton from starch factory perspective

3.1.5.5 The ethanol factory perspective

The production capacity of the ethanol factory in this area is approximately 54,000 tonnes per year or around 4,500 tonnes per month based on market demand. The ethanol produced is used for numerous purposes in industries including food, cosmetics, and pharmaceuticals as well as others. There is a large quantity of cassava available to the factory and there is the potential to export its product to the Chinese market as well as to other overseas markets. However, currently, the total production of the ethanol factory is used domestically since its current processing costs are not competitive with that of similar products from other countries, particularly with those in Brazil which dominates world ethanol processing. Table 3.5 shows that the production cost in the Dak Lak ethanol factory is around VND15.74 million (approximately US$673) per ton while the price of ethanol processed in Brazil is currently US$600 per ton at Ho Chi Minh City port in Vietnam. Therefore while the factory currently earns a GPr of nearly US$29 per ton based on current production costs, according to Mr Dao Trong Tuan (personal communication), who is the chairman of the board of directors of the Dak Lak ethanol factory. It will be very difficult to be competitive with prices in the global market in the near future without government support. The ethanol products produced in the ethanol factory are therefore at a disadvantage compared to ethanol at the global market scale, largely because of the small-scale farming by which the raw material is produced, a lack of advanced cultivation technology, and the provision of short-term subsidies from the Vietnamese government. Table 3.5 indicates how the value added is shared among the stakeholders comprising the farmers, the ethanol and starch factories, and the collectors and traders who obtain approximately 38%, 28%, 27%, 4% and 3% respectively. From these figures, it can be seen that the greatest value-added is created by the farmers which are fair based on their contribution to the value chain among the stakeholders.

Table 3.5. Financial analysis of the operation of the Dak Lak ethanol factory per ton

Item	Value (VND1,000)	Value USD	Proportion %
Output	**16,565.26**	**708.22**	**100.00**
Ethanol	15,900.00	679.78	95.98
Cassava pulp	560.00	23.94	3.38
CO2	105.26	4.50	0.64
Intermediate input	**15,200.00**	**649.85**	**91.76**
Cassava root	12,540.00	536.13	75.70
Transportation	500.00	21.38	3.02
Electricity	480.00	20.52	2.90
Energy	1,200.00	51.30	7.24
Dried pulp	180.00	7.70	1.09
Marketing and other cost	300.00	12.83	1.81
Value added	**1,365.26**	**58.37**	**8.24**
Labour wages	420.00	17.96	2.54
Interest	277.78	11.88	1.68
Tax	22.22	0.95	0.13
Gross profit (GPr)	**667.48**	**28.54**	**4.03**
Depreciation	324.69	13.88	1.96
Net profit (NPr)	**342.79**	**14.66**	**2.07**

Shifting to cassava cultivation from other crops is considered as an appropriate strategy in poverty alleviation for household farmers in rural areas. In the cultivation phase, it is the farmers who as the producers commit almost all the resources required to produce fresh and dried chip cassava. In addition, the farmers are also the stakeholders who gain the highest percentage of NPr (48%). However, the absolute value of both their GPr and NPr was the lowest among the stakeholders in the chain due to the volume of cassava that is provided by each farmer. In contrast, while the value added by collectors and traders accounted for less than 5% of the cassava value chain their absolute profit was higher than that of the farmers since they are undertaking cassava transactions representing from 30 to 40 tonnes per day while most household farmers harvest less than 30 tonnes per hectare per year.

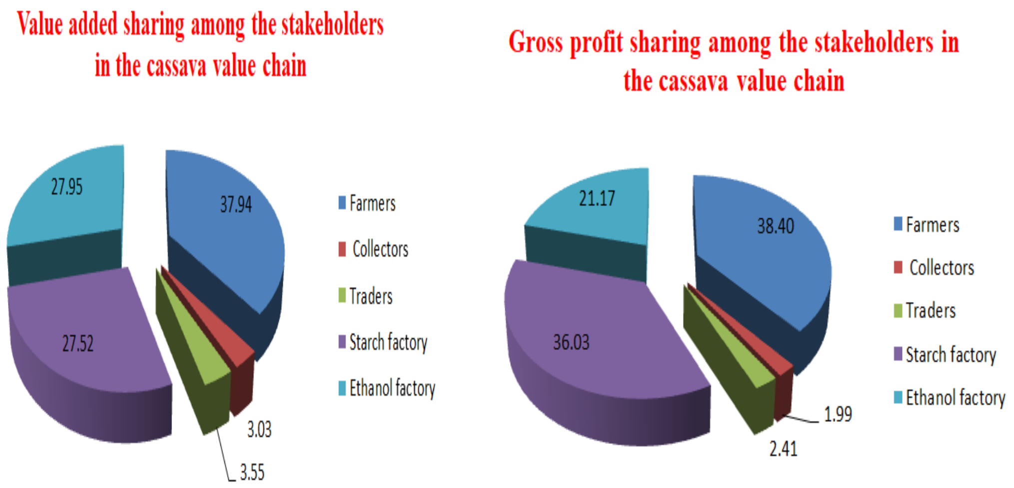


Figure 3.9: Value added and gross profit sharing among the stakeholder in cassava value chain

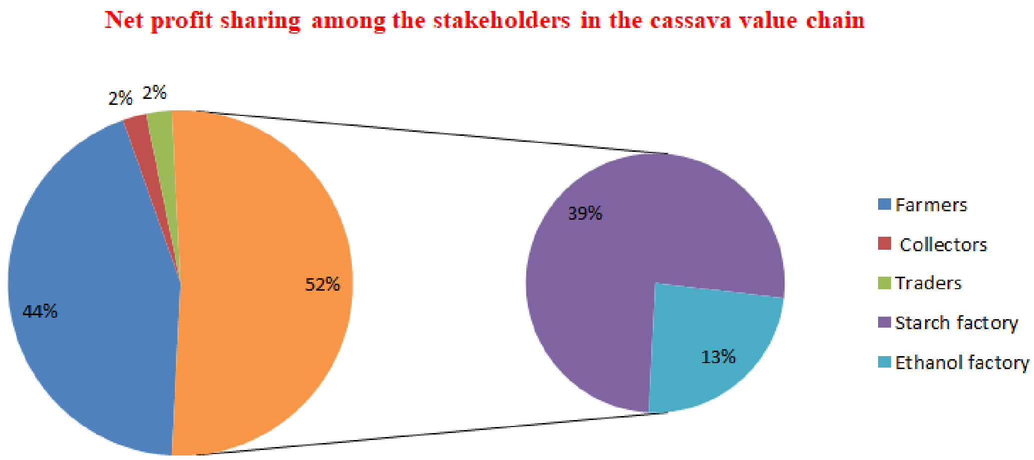


Figure 3.10: The net profit sharing among stakeholder in cassava value chain

With regard to the starch and ethanol processing factories, it is undeniable that they obtain the greatest absolute benefit from the cassava value chain since they are responsible for processing the largest volumes of cassava into products which they can sell. Moreover, they must meet the market demands of consumers and the value of the cassava will be increased through processing it as a raw material into starch, ethanol and other products. Hence, in order to in, increase the value of cassava, appropriate strategies involving linkages and collaboration among these actors is vital.

3.1.6 The relationships and linkages among cassava value chain stakeholders

Relationships exist amongst actors at different process stages in the cassava value chain by which input providers are connected with producers (farmers), farmers are connected with intermediaries and finally by which farmers and processors in the guise of both starch and ethanol factories are linked. Further, each of the actors has indirect relationships at each stage of the chain. The findings, of this study, identify a local relationship between input suppliers and farmers, which manifests its importance in the cassava planting season. However, this relationship does not solidify linkages since farmers generally prefer to change the location of their purchases every year. In addition, poor farmers cannot afford to buy input materials such as fertilizer and pesticide which might improve cassava productivity. Linkages between farmers and intermediaries are manifested as both spot-market and persistent relationships. On the one hand, the farmers can sell their products to any collector or trader who will pay the highest price. However, there is a potential risk in cassava value chain transactions that the selling price may be unstable over time. Buyers will always try to find any reason to reduce the purchasing price and sellers are under pressure to sell since the quality of cassava deteriorates rapidly and fresh cassava can only be preserved for two days after harvesting (El Bassam et al., 2010). This is a disadvantage for farmers who live far from the market particularly if the local infrastructure in their area is poor. On the other hand, the intermediaries can assist farmers not only by providing necessary input materials but also by extending informal credit to them. This, therefore, creates a persistent linkage; and generally, the buyer and seller meet, come to an agreement which is confirmed in a contract. In this relationship, therefore, there is a higher level of trust and some level of interdependence. Hence, the farmer and collector or trader are responsible for agreeing both the quantity of cassava and the price to be paid which is formalized by a contract agreed for each succeeding season. This linkage, therefore, tends to ensure a sufficient volume of cassava for forwarding actors in the value chain (i.e. end-users). Moreover, the farmers will be assured of a sufficient volume of production from which they can support their occupation and that of their families. Thus, both actors gain benefit from persistent relationships.

3.2 Cassava value chain and gender perspective

3.2.1 Introduction

Agriculture is an important component of a national economy (Singh-Peterson & Iranacolaivalu, 2018) and the Vietnamese economy, contributing approximately 18% to the gross domestic product (GDP) and 47% to total employment (Ho, Nguyen, Adhikari, Miles, & Bonney, 2017). Women play an undeniably important role in the agriculture sector (Sell & Minot, 2018), and constitute 43% of the agricultural labour force in developing countries (FAO, 2011). In the case of Vietnam, farming and other agricultural activities are the principal sustainable livelihood strategies of most Vietnamese people (Kerkvliet & Porter, 1995). Among the cash crops important in Vietnamese agriculture, cassava production plays an important role in poor people’s livelihood (Ho et al., 2017), and the country has an area of approximately 535 thousand hectares planted to cassava (GSO, 2018c), with the yield of cassava growing by 9.94 million tonnes in 2018 (GSO, 2018d). Some recent studies have suggested that there are differences in the perceptions of women and men relating to many issues in society worldwide.

Men are prominent in relation to both basic human rights and in terms of their voice in their households and communities (World Bank, 2012). Hence, men have more opportunity to access knowledge as well as markets and have an advantage over women who are generally more vulnerable. As a result, men are more involved in cash-crop activities, giving them the advantage of higher income (Sell & Minot, 2018). However, evidence from studies shows that the role of women who attend to the welfare of the household can be improved by both men and women making decisions (Sell & Minot, 2018). Thus, the value chain approach to agricultural products can be applied to deal with intra-household gender inequality (Blessing Masamha et al., 2018a).

Men are not dominant in making-decision in the cassava market, which may be because the men who live in rural areas may simultaneously have other employment in non-farming activities from which they earn income (Foster & Rosenzweig, 2004; Lanjouw & Murgai, 2009; Minot, Epprecht, Thi, Anh, & Trung, 2006; Stifel, 2010; Wouterse & Taylor, 2008). In addition, Radel et al. (2012) argued that women play a subordinate role while men take the leading position as well as being the main labour force in the household (Claudia Radel, Schmook, McEvoy, Méndez, & Petrzelka, 2012) and that positions and responsibilities were decided by gender. However, many studies that have considered gender have focused exclusively on modern value chains because they studied agriculture value chains in high-value cash crops, for example, tomatoes, cashew nuts, cocoa and avocado (Jeckoniah, Mdoe, & Nombo, 2013; Oduol et al., 2013). Therefore, there has been little analysis of the effect of the traditional roles of genders in the cassava chain at the household level (Blessing Masamha et al., 2018a), such as the relationship between male and female roles. Both Mcnulty and Adewale (2015) and Olukunle (2013) asserted that farmers receive fewer profits than other actors in the cassava chain. Moreover, Dolan (2001) found that there was discrimination against female farmers in contract farming patterns compared to men in the gardening export sector in Kenya (Dolan, 2001) and exploitation of female farmworkers in African horticulture was also reported by (Barrientos, Dolan, & Tallontire, 2001, 2003). However, Maertens and Swinnen (2009) reported that women have substantial influence and play an important role in modern supply value chains (Maertens & Swinnen, 2009). Among agricultural economists, agricultural supply on a global scale has been a controversial topic for some time (Goetz, 1992). Gender inequality in agriculture reflects a complex set of problems relating to control over resources, control over decision making, labour, and support from kin (Kerr, 2005). Apata (2013) found that 53% of the labour force in the agricultural sector of developing countries is made up of women, who play an indispensable role in agricultural production (Apata, 2013b). Therefore, the gender gap is closing and this may be because women's participation in economic activities is more active than before. Further, Sarkar et al. (2019) suggested that for a woman to decide whether or not to work is a complex issue that involves social norms, educational attainment, and responsibilities to care for dependents (Sarkar et al., 2019) such as children and the elderly. However, Garikipati (2009) argued that women seem to be involved in agriculture whenever possible (Garikipati, 2009). In a project in Southeast Asia, conducted by Netherlands Development Organisation (2015) to promote inclusive business for the sustainable growing of cassava by smallholders (SNV Cambodia, 2015) gender-related aspects of the cassava value chain in Cambodia were examined in order to propose plausible strategies.

Additionally, there has been no empirical research analyzing the role of gender in the cassava value chain in Vietnam, where most studies of the cassava value chain have focused on the cost and benefit dimensions of cassava, Son et al. (2016) reported on the productivity and yield of hybrid cassava, varieties cultivated in Vietnam (Son et al., 2016) and examined the relationship between production and consumption as well as the relationship among the actors in the cassava value chain (Viet et al., 2013), in which middlemen play a vital role. Moreover, Son et al. (2016) noted that the rural household income derived from cassava plays a vital role in the livelihood of the farmer. However, the findings reported in the present paper are fundamentally different from those of previous related studies since they highlight the contribution of rural women to food security and natural resource management in spite of inequality and discrimination (Doss, Meinzen-dick, Quisumbing, & Theis, 2018). The present study contributes to the existing literature in a number of ways and shows that many factors are involved in determining the dynamics of the participation of women in the labour force (Sarkar et al., 2019).

The main aim of the study is to assess the factors which affect women's decisions to participate in cassava cultivation and the level of that participation. In addition, the study sought to determine what factors influence the participation of farmers in the market and the level of their participation in the cassava value chain. This paper will provide important information for implementing well-informed policies relating to the cultivation of cassava in Vietnam (Lu & Horlu, 2019) as well as in relation to the role of gender in sustainable farming systems in rural areas.

3.2.2 Explanation of the original and transformed variables used in the probit and OLS models

Table 3.6. Explanation of the initial variables used in the probit and OLS models

Variable	Description	Measurement	Expected sign
Dependent	Dichotomous variable: female or male decision to cultivate cassava	female = 1 male = 0	--
Dependent	Volume of cassava produced	Kilograms	--
Dependent	Dichotomous variable: Farmers' decision to participate in market	1: sell any cassava 0: None	--
Dependent	Volume of cassava sold	Log (kilograms)	--
COM	Communes of the study site	1: Cukty; 2: CuPui; 3: EaPal; 4; EaSar; 5: EaHl'eo; 6: EaTir; 7: HoaSon	Indifferent
AGE	Age of household (HH) head	Years	Negative/ Positive
GEN	Gender of HH head	Female: 1; Male: 0	Indifferent
EDU	HH head's education level	Years spent studying	Indifferent
ETH	Ethnic group	Kinh group: 1; otherwise: 2	Indifferent

Variable	Description	Measurement	Expected sign
U18	People under 18 years old in HH	Number of people	Positive
M.HH	Total members in the HH	Number of people	Positive
MAL	Total males in the HH	Number of people	Positive/ Negative
FEM	Total females in the HH	Number of people	Positive/ Negative
CAS.ARE	The area of cassava cultivation	Hectare	Positive
LAN	The area of residential land	Square metre	Positive
CAS.QUA	The volume of cassava harvested	Tonnes	Positive
SEL.PRI	The selling price of cassava	VND	Positive
EXP.CUL	Cassava farming experience	Years	Positive
VAR	Cassava varieties	Varieties	Positive
LOA	Loans taken by farmer	Million VND	Positive
HOU.ARE	The HH area	Square meter	Positive
INT	Farmer has access to internet or not	Own Internet: 1; Otherwise: 0	Positive
MBIKE	Farmer owns motorbike or not	Own Mbike: 1; Otherwise: 0	Positive
LO.TRA	Farmer owns local transport or not	Farmer-owned: 1; Otherwise: 0	Positive

Table 3.6 shows the definitions of both the dependent and independent variable as well as the direction of the prior expectation and the values assigned in the probit and OLS models (Blessing Masamha et al., 2018b). In the analysis, the woman’s decision to cultivate cassava was determined based on a dichotomous gender variable. Table 2 shows the variables transformed using natural logarithms and in one case an inverse of the square root. Finally, in addition to the quantitative data detailed above, qualitative data were obtained from focus group discussions with farmers and key informants.

Table 3.7. Explanation of variables transformed for the probit and OLS models

Variable	Description	Measurement	Expected sign
Ln_AGE	Natural logarithm transformation of household head's age	Age in years	Positive
Ln_AGE_Sq	Natural log transformation of squared household head's age	Age in years	Positive
EDU_Sq	The squared of HH head's education level	Years spent studying	Indifferent
Ln_U18_Sq	Natural log transformation of people under 18-years-old Squared	Number of people	Positive
Ln_M.HH	Natural log transformation of number of members in the household	Log number of people	Positive
Ln_MAL_Sq	Natural log transformation of the number of males squared	Number of people	Positive
Ln_FEM_Sq	Natural log transformation of the square of the number of females	Number of people	Positive
LAN_Sq	The squared of the area of residential land	Square metre	Positive
Ln_LAN_Sq	Natural log transformation of the squared of the area of residential land	Square metre	Positive
Ln_CAS.ARE	Natural log transformation of the area of cassava cultivation	Log of hectare	Positive
Ln_CAS.QUA	Natural log transformation of the volume of cassava harvested	Tonnes	Positive
Ln_SEL.PRI	Natural log transformation the selling price of cassava	VND	Positive
Ln_HOU.ARE	Natural log transformation of the farmer's household area	Square meter	Positive
(1/LOA_Sqrt)	one over the square root of the farmer's loans	VND million	Positive

3.2.3 The production stage of the cassava value chain

3.2.3.1 Factors affecting women's decisions to participate in the production stage of the cassava value chain

Table 3.8 shows the results of the probit model analysis of the factors affecting women's decisions to participate in the cassava value chain. The goodness of fit of the model was assessed using McFadden pseudo R^2 which was 0.515. As can be seen, the head of the household had the responsibility for making the decision relating to cassava cultivation.

Moreover, various factors were found to significantly affect the head of household's decisions relating to cassava cultivation, consisting of the level of education of the farmer (EDU) and the education squared (EDU_Sq), land squared (LAN_Sq), and the inverse of the square root of the farmers' loans (1/LOA_Sqrt) ($p < 0.05$). The results of the probit regression model presented in Table 3, were not according to initial expectations since the land area squared variable (LAN_Sq) and the 1/LOA_Sqrt variable were found to have the highest negative effect based on significance coefficients of $p = 0.014$ and $p = 0.040$ respectively, whereas the original expectation was that the area of land (LAN) and the farmers' loans (LOA) would be positively related to decisions to cultivate cassava. The effect of these variables was therefore apparently influenced by the decision of women to participate in the cassava value chain.

Table 3.8. Probit model estimates for womens decisions to participate in the production stage of the cassava value chain

Variables	Coefficient	S.E.	p-value
COM	0.328	0.204	0.108
AGE	0.024	0.070	0.727
EDU	-11.793**	5.362	0.028
ETH	-2.376	1.538	0.122
U18	1.446	1.028	0.160
M.HH	0.058	0.356	0.870
MAL	-0.762	0.518	0.141
CAS.ARE	4.270	4.510	0.344
LAN	4.443	5.106	0.384
CAS.QUA	0.104*	0.062	0.095
SEL.PRI	0.001	0.001	0.396
EXP.CUL	0.138*	0.079	0.082
VAR	-0.672	0.537	0.211
LOA	-0.009	0.007	0.197
HOU.ARE	0.005	0.005	0.299
INT	0.569	0.787	0.470
LO.TRA	-0.450	1.334	0.735
U18_Sq	-0.478*	0.252	0.057
1/LOA_Sqrt	-30.940**	15.090	0.040
EDU_Sq	2.290**	1.093	0.036
LAN_Sq	-3.937**	1.602	0.014

-2 Log Likelihood = 33.6

McFadden pseudo R-squared = 0.515; Cox and Snell R-squared = 0.510 and Nagelkerke pseudo R-squared = 0.680

$*P < 0.10$; $**P < 0.05$; $***P < 0.01$

However, there is contrary is that the original variable such as the area of land (LAN) and the loan of the farmer (LOA) had positively related to deciding the cassava production of women. Furthermore, both the quantity of cassava (CAS.QUA) and the farmer's experience in cassava farming (EXP.CUL) variables were found to positively affect the participation of women in cassava cultivation and were significant at the 0.10 level ($p = 0.095$ and $p = 0.082$ respectively).

3.2.3.2 The level of women's and men's participation in the production stage of the cassava value chain

The quantity of cassava produced was the dependent variable in the OLS regression models for men and women and was logarithm transformed. Similarly, for women, the independent variables, U18, M.HH, MAL, and CAS.ARE were also logarithm transformed and the SEL.EXP variable was square-root transformed and for men the independent variables, AGE, U18, MAL, LAN and HOU.ARE were logarithm transformed. In both the female and male cases, the backward selection method was applied in order to eliminate unwanted variables from the OLS model at each successive stage (Blessing Masamha et al., 2018b).

After the OLS regression was conducted, the best fitting models were chosen. These indicated goodness of fit coefficient R^2 for women of 0.55 indicating that 55% of the variance in the quantity of cassava harvested could be explained by the model. For men, the R^2 was 0.67 indicating that 67% of the variance in the amount of cassava harvested could be explained by the model. The natural log transformation of the area of cassava cultivation (Ln_CAS_ARE) was a significant ($p < 0.001$) positive predictor at the 99% confidence level affecting the volume of cassava that was cultivated by women. This shows that the area of cassava strongly affects the level of women's market participation. This situation can be explained by the fact that arable land is available, not only for the cultivation of cassava but also for many other crops. In addition, cassava is often a marginal crop and there is no priority to grow it. Therefore, farmers, particularly women may decide to cultivate cassava if the household owns more land. (Household group discussion, in Cukty commune, 2018)

Table 3.9. Ordinary least squares estimate for the quantity of cassava produced by women and men in Dak Lak province (the level of production participation of women)

Model	Variable	Coefficients	S.E	p-value
Model 1 Female $R^2 = 0.55$ N = 158	(Constant)	2.668***	0.376	0.000
	INT	-0.086	0.105	0.410
	LO.TRA	-0.076	0.082	0.356
	Ln_U18	0.095	0.076	0.212
	Ln_M.HH	0.169	0.195	0.386
	Ln_MAL	-0.117	0.153	0.443
	Ln_CAS.ARE	1.017***	0.078	0.000
	SEL.PRI	-0.0002**	0.000	0.020
	Sqrt_EXP.CUL	0.122***	0.047	0.010
Model 2 Male $R^2 = 0.67$ N = 141	(Constant)	1.689**	0.822	0.042
	MBIKE	-0.147	0.102	0.151
	LO.TRA	-0.126	0.085	0.144
	Ln_AGE	0.431**	0.169	0.012
	Ln_U18	0.159**	0.072	0.028
	Ln_MAL	-0.283**	0.108	0.010
	Ln_LAN	1.160***	0.077	0.000
	SEL.PRI	0.0002	0.000	0.133
	Ln_HOU.ARE	-0.136	0.085	0.112

*P < 0.10; **P < 0.05; ***P < 0.01

3.2.4 The supply to the market stage of the cassava value chain

3.2.4.1 The main factors affecting the quantity of cassava sold on the market by the farmers.

Table 3.10 shows that the area of residential land of the household and the years of cassava cultivation experience of the farmer were positively and significantly affected with the decision to participate in the cassava market (p = 0.000 and p = 0.020) respectively) while the availability of the Internet to the farmer was negatively and moderately strongly associated with their decision to participate in the cassava market as suppliers (p = 0.062). The models' goodness of fit coefficients were judged to be adequate based on McFadden, Nagelkerke and Cox, and Snell pseudo R^2 values of 0.406; 0.464 and 0.174 respectively.

Table 3.10. Probit model estimates for farmer's decision to participate in the market

Variables	Coefficient	S.E.	p-Value
AGE	-0.024	0.015	0.112
SEL.PRI	-0.001	0.000	0.245
EXP.CUL	0.064**	0.027	0.020
LAN	3.227***	0.627	0.000
MAL	-0.152	0.173	0.380
FEM	0.001	0.146	0.996
LO.TRA	0.222	0.328	0.498
MBIKE	0.221	0.381	0.562
INT	-0.689*	0.369	0.062
EDU	-0.240	0.212	0.257

-2 Log Likelihood = 84.126
McFadden pseudo R-squared = 0.406; Cox and Snell R-squared = 0.174 and Nagelkerke pseudo R-squared = 0.464
*P < 0.10; **P < 0.05; ***P < 0.01

The farmers will shift from cassava to other crops if they have better information about the cassava market as well as the prevalence of cassava-specific diseases in a particular year, rather than engaging in continuous cassava cultivation. If the price of cassava is low that would affect the farmers' income derived from the cultivation of cassava. These findings were borne out by the group discussions with farmers. (Household group discussion in Ea Sar commune, 2018). The variables LAN, EXP.CUL and INT were found to be significant factors at the 90 to 99% levels in the probit linear regression model. Most farmers participated in the cassava market based on local markets, as well as on farm-gate sales. Other variables had either positive or negative effects on the farmers' market decisions although their effects were not found to be significant in the regression model. For instance, the FEM, LO.TRA and MBIKE variables were positive but not significant while AGE and SEL.PRI had negative but not significant effects on the farmers' decisions whether or not to participate in the market. Overall, the pattern of influence could be explained by the farmers not being able to control the price of cassava since it is dependent on the relationship between supply and demand in the market. However, farmers can change their cultivation behaviour once the cassava price has fluctuated dramatically although only in succeeding years after a price change becomes apparent.

3.2.4.2 The main factors affecting the level of market participation of farmers

The results shown in Table 6 indicate the level of participation of farmers as defined by the volume supplied to the market. The OLS regression model results indicate that the variable Ln_CAS.ARE was found to a positive and strongly significant influence on the level of farmers' market participation ($p = 0.000$). This is because farmers with more land will have a greater option to plant not only cassava but also other crops and will thus tend to dedicate more arable land to the cultivation of cassava. Both the variables Ln_U18 and the quadratic variable Ln_AGE_Sq had a positive and significant ($p < 0.05$) effect on the quantity of cassava sold by the farmers with p values of 0.011 and 0.017 respectively. Thus, the number of people less than 18 years old in the household, as expected, encouraged participation in cassava production, as did the age of the household head.

Table 3.11. OLS estimates for the quantity of cassava sold by farmers in Dak Lak province (level of market participation of farmers)

Variable	Coefficients	S.E	p-value
(Constant)	1.928***	0.513	0.000
MBIKE	-0.112	0.070	0.108
LO.TRA	-0.082	0.060	0.175
Ln_AGE_Sq	0.156**	0.065	0.017
Ln_U18	0.132**	0.052	0.011
Ln_MAL_Sq	-0.091**	0.041	0.029
Ln_CAS.ARE	1.049***	0.055	0.000
SEL.PRI	0.0002	0.000	0.199
Sqrt_EXP.CUL	0.051	0.034	0.132
VAR	-0.030	0.023	0.185

*$P < 0.10$; **$P < 0.05$; ***$P < 0.01$
$R^2 = 0.585$

This is because the age of the household head bears a strong correlation with their farming experience, and the level of the farmer's market participation is depended on the farmer's age therefore influenced by both the farmers' age and their experience of cassava cultivation. The main reason for this is that the farmers' experience can give them an advantage in accessing and interpreting market information as well as sharing experience (Sebatta et al., 2014). In contrast, the natural log transformation of the squared male variable (Ln_MAL_Sq) had a negative and significant effect on market participation ($p = 0.029$) indicating a decreasing marginal effect on cassava market participation as a supplier, based on the number of males in a household.

3.2.5 The role of women and men as growers in the cassava value chain

In this study, the cultivation of cassava tubers includes land preparation, planting, fertilizing and spraying pesticide, harvesting and carrying the end product to the residence.

Table 3.12. The percentage of male and female participation in cassava cultivation

Processing	**Mean (%)**	**S.E (%)**	**Median (%)**
LAN_PRE_M	78.01	1.31	90.00
LAN_PRE_F	21.99	1.31	10.00
PLANT_M	61.13	0.77	60.00
PLANT_F	38.73	0.81	40.00
FER_M	57.96	1.28	60.00
FER_F	41.89	1.27	40.00
PES_M	88.33	0.82	90.00
PES_F	11.67	0.81	10.00
HARV_M	67.11	0.78	68.00
HARV_F	32.90	0.78	32.00
CARRY_M	91.33	0.63	95.00
CARRY_F	8.52	0.57	5.00

Table 3.12 shows that men dominate all the processes in the production stages, especially, those of carrying the harvested cassava to the home, spraying pesticide and land preparation which were all predominantly male responsibilities, with men accounting for 91.33%, 88.33% and 78.01%

respectively. This is the case because those processes not only require physical strength but also farming experience and thus favour performance by men. On the contrary, in some processes in cassava cultivation, the percentage participation was similar between men and women; for instance, men were responsible for around 58% of the fertilizing of cassava compared to approximately 42% performed by women. However, in general, due to the limitations of their individual characteristics, low-skill, and lower levels of knowledge, women play a less important role in the cassava value chain than men. Nevertheless, women are involved to some degree at all stages of the cassava cultivation process from land preparation to finally carrying the fresh cassava to their home as well as to the market.

3.3 The potential of cassava-based bioethanol production in Dak Lak province

3.3.1 Introduction

Nowadays, the energy demanded by human activity is increasing due to increases in population (Ozoegwu, Eze, Onwosi, Mgbemene, & Ozor, 2017). Global biofuel demand has increased significantly over recent decades and many countries have implemented fuel blending mandates and emission goals as strategies to decrease greenhouse gas (GHG) emission in the transport sector (Ozoegwu et al., 2017). Therefore, the desire to decrease dependence on fossil fuels and the need to mitigate climate change is causing a growing demand for the production of liquid biofuels which may be produced from non-food crops, such as Jatropha curcas, or derived from food crops, such as sugarcane, corn, soybeans and cassava (Vang Rasmussen, Rasmussen, Birch-Thomsen, Kristensen, & Traoré, 2012). On the one hand, while fossil-fuel sources, such as coal, oil, natural gas etc. directly contribute to the dramatic increase in the level of GHG (Ezebuiro & Ogugbue, 2016) the use of bio-energy has both positive and negative impacts on society. GHG emissions can be reduced by their use, which can also contribute to increased energy security, the promotion of rural development, and provide inflows of foreign currency to countries able to export biofuels or their precursors. On the other hand, the use of crop-based raw materials also brings various drawbacks such as a decrease in regional food availability and accessibility, forest degradation and social conflicts, which are key contemporary controversies confronting the bioenergy sector (Acosta et al., 2014).

Energy is one of the most important sectors in the Vietnamese economy and an important dynamic in the process of national development, and Vietnam considers energy security as one of its top priorities (French Development Agency AFD, 2012). At the end of the first decade of the 21st century, 287 MW of renewable energy was being generated, comprising roughly 2 % of the total generation capacity of the nation. In order to meet rapidly increasing energy demand while also keeping in mind environmental protection, the Vietnamese government has set a clear strategy for the development of biofuel and national energy development by decisions no. 177/2007/QD-TTg and 1885/QD-TTg, respectively (AFD, 2012); Asia Pacific energy research centre (APERC), 2005; Le et al., 2013). Therefore, it would be advantageous to develop the cassava-based ethanol production sector in the future. Whilst ethanol contains approximately 34 % less energy per unit volume, it has a higher octane rating than unleaded petrol and as a result, engines can be operated more efficiently by allowing their compression ratios to be raised (Peters & Ward, 2016). Furthermore, cassava is a drought-tolerant plant, which is thus a potentially valuable source of feedstock for the production of bioenergy (Montagnac, Davis, & Tanumihardjo, 2009). Moreover, cassava has recently been promoted as a potential feedstock for ethanol production in Vietnam (Nguyen, Williams, & Paustian, 2017) because of its high yield and low input requirements (Adelekan, 2011).

Currently, most of the production of cassava in Dak Lak province in Vietnam is used either as the feedstock for starch production or for animal feed (Hoa, Techato, Dong, Vuong, & Sopin, 2019a). However, the value added through the distribution channel from the cassava farmer to the starch factory is lower than that produced by utilizing cassava as a feedstock for ethanol production. Therefore there has been recent interest shown in the feasibility of using cassava as a biofuel feedstock, particularly for bioethanol production (Anyanwu, Ibeto, Ezeoha, & Ogbuagu, 2015). One aim of the study described in this paper was to assess the potential supply of cassava for fuel-grade ethanol in Dak Lak province, which seems to have the potential to be an appropriate solution to the energy shortage faced by Vietnam.

3.3.2 Cassava and its cultivation in Dak Lak province

Cassava overview

Cassava (Manihot esculenta Crantz) is a perennial shrub of the family Euphorbiaceae which is cultivated for many purposes including for human food, animal feed, and as an industrial feedstock (Alves, 2002). Furthermore, cassava can grow well and reach a reasonable yield even though cultivated on infertile land, because it is tolerant of both drought and poor soils, where the cultivation of other crops is difficult (Kuiper et al., 2007; Ozoegwu et al., 2017). In addition, cassava grows best in tropical regions, where it is an important vegetable crop, in moist, fertile and well-drained soils located between 30°N and 30°S (Anyanwu et al., 2015; Ozoegwu et al., 2017). The harvesting period is normally between 8 to 10 months after planting and the harvested root length and weight are between 15 and 100 cm and 0.5 and 2.0 kg, respectively (Ozoegwu et al., 2017; Sayre, 2013). Based on a number of previous studies, the carbohydrate content of fresh cassava is in a range of approximately 35 to 38% (Kuiper et al., 2007; Lancaster, Ingram, Lim, & Coursey, 1982; Montagnac et al., 2009) and the protein content in fresh cassava is 1%, or 1.41% in dry cassava (Lancaster et al., 1982). In regard to its starch content, cassava is one of the crops with the highest amount of starch in both fresh and dry forms with a wide range of between 18–32.5% and around 80%, respectively (Pandey et al., 2000; Soccol, 1996). and it ranks fourth after rice, wheat and corn for its starch content (Prachayawarakorn & Tamseekhram, 2019). According to BeMiller and Whistler, (2009) the roots and tubers are constituted of 70-80% water, 16-24 % starch and about 4% proteins and lipids. Cassava is, therefore a major cash crop planted and sold by poor farmers more often than other staples particularly in view of its toleration of both drought conditions and poor soils (Kuiper et al., 2007; Ozoegwu et al., 2017) and its resistance to pests and diseases, as well as being a crop less restricted by type. However, cassava has some disadvantages, notably that the water and starch content of fresh cassava tubers has been noted to be reduced by long periods of cultivation in the same soil. Normally, the starch content starts to decrease after around two and a half years of cassava cultivation (Pandey et al., 2000) and this finding agrees with the findings of this study based on an in-depth interview with the director of the cassava starch factory in Ea Kar, Dak Lak province, Mr Pham Ba Sy, who indicated that the starch content in cassava roots can range from 18 to 30%).

Cassava production in Dak Lak province

Dak Lak Province is one of the provinces situated in the Central Highlands of Vietnam. The total area of agricultural land in Dak Lak is the second largest in this region at 1.2 million hectares (ha). Most of the cultivable land area is suitable for perennial crops including coffee, pepper, rubber, cassava, maize and sugar cane (CGIAR, 2016). The trend of cassava production in Dak Lak province has increased since 1995 up to the present and it can be seen from (fig. 3.11) that the area under cassava cultivation dramatically increased from around 5,000 to over 35,000 ha over the period from 2001 to 2017.

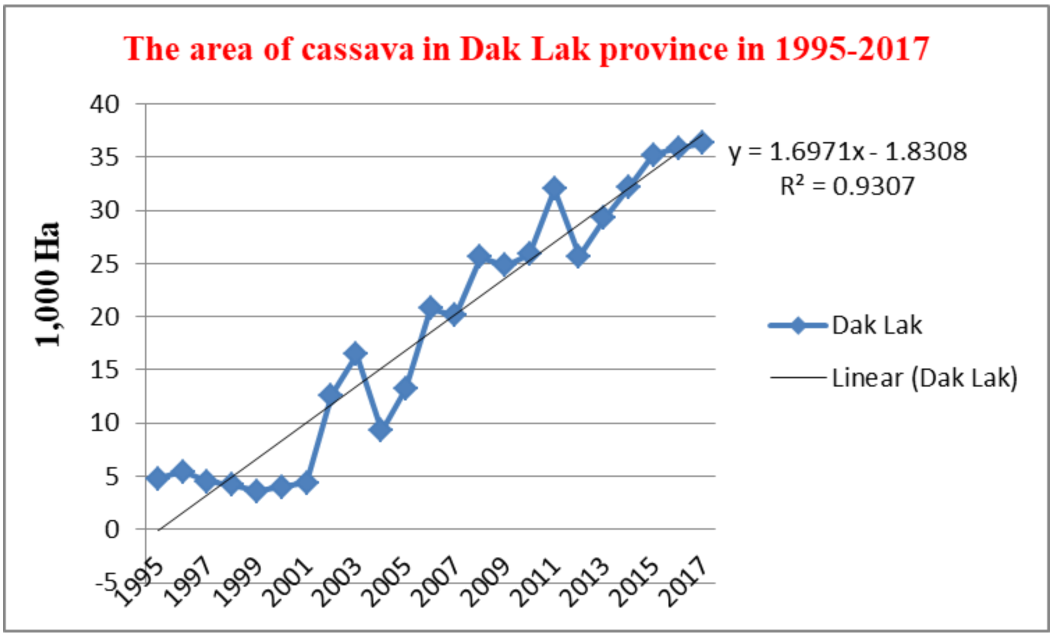


Figure 3.11. The area under cassava in Dak Lak province, 1995-2017

This rising trend has been principally caused by growth in the population and the population density (Ugwu, 1996) as well as the development of a cassava-based bioenergy industry. Vietnam is also now a major exporter of agricultural products with an annual total export value of 25 billion USD (Howeler, Kim, Mai, & Mai, 2018). In Vietnam, the area under cassava cultivation exceeds half a million ha and the export value of this product is about 800-950 million USD per year (Howeler et al., 2018).

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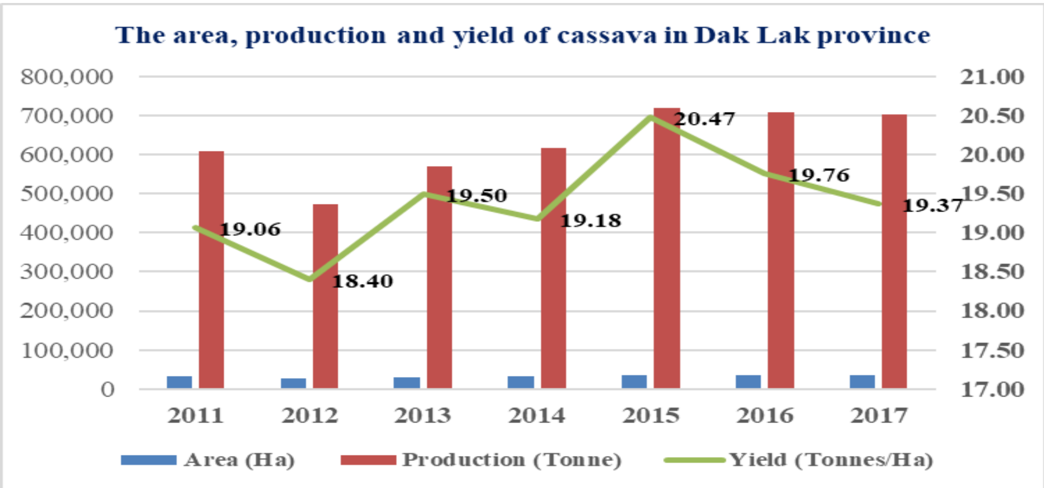


Figure 3.12. The area, production and yield of cassava 2011-2017 (GSO, 2018b, 2018e)

The study reported investigated the potential for bio-ethanol production from cassava-based on current cassava production levels in Dak Lak province. In addition, it highlighted the role of relationships and coordination mechanisms in improving farming-related policies in order to increase cassava productivity and improve farmers' livelihoods. The main cassava varieties grown in the region are KM 94, CAO SAN, MY LAI as well as other local varieties. The survey of households established that the average area of cassava cultivation per household was approximately 1.2 ha with an average yield of cassava of approximately 20 tonnes per ha, which is slightly above the average yield previously reported for Dak Lak province of 19.37 tonnes per ha and the average national yield of 18 tonnes per ha (GSO, 2018e). However, the cassava yield could still be improved if yields obtained elsewhere are considered, as new varieties such as HL-S10, HL-S11, KM140 and KM419 are reported to produce a fresh root yield of from 35 to 55 tonnes per ha (Howeler et al., 2018).

Table 3.13. The area, production and cassava yield at the study site

PROFILE		COMMUNES							
		CUKTY	CUPUI	EAHLEO	EAPAL	EASAR	EATIR	HOASON	AVERAGE
AREA	Mean	1.27	1.22	1.19	1.36	1.11	1.28	0.88	1.19
	SD	0.86	0.61	0.86	0.69	0.72	0.64	0.65	0.73
PRODUCTION	Mean	24.39	22.57	25.11	30.70	22.74	24.05	15.64	23.64
	SD	20.42	14.64	21.38	25.72	20.63	14.98	14.34	19.59
YIELD	Mean	20.17	19.29	20.51	21.91	19.93	18.88	17.61	19.77
	SD	10.17	9.29	8.49	10.06	9.51	8.56	7.47	9.12

Table 3.13 shows the area and production of cassava calculated based on the yield of cassava from the seven communes surveyed. The average area under cassava fluctuated from 1.1 to approximately 1.4 ha per household at the study site, although Hoa Son commune, exceptionally produced less than 1.0 ha per household.

There are therefore various distribution channels between the farmer and the final user, but this study revealed that there are two main channels which have an effect on household income. Most of the cassava cultivated is supplied either to starch companies (Son et al., 2016) or to ethanol factories, accounting for approximately 77 % and 22 %, respectively (Hoa, Techato, Dong, Vuong, & Sopin, 2019b).

The total value added was approximately VND3,520,000 (US$150.45) per tonne in the first (starch) distribution channel, while the total value added was higher in the second (ethanol) distribution channel at VND3,540,000 (Fig. 38) per tonne. It may, therefore, be more profitable overall for cassava to be supplied for bioethanol production rather than for the production of starch, although the additional value produced is marginal and currently accrues to the ethanol factory rather than to the farmer or intermediaries in the value chain

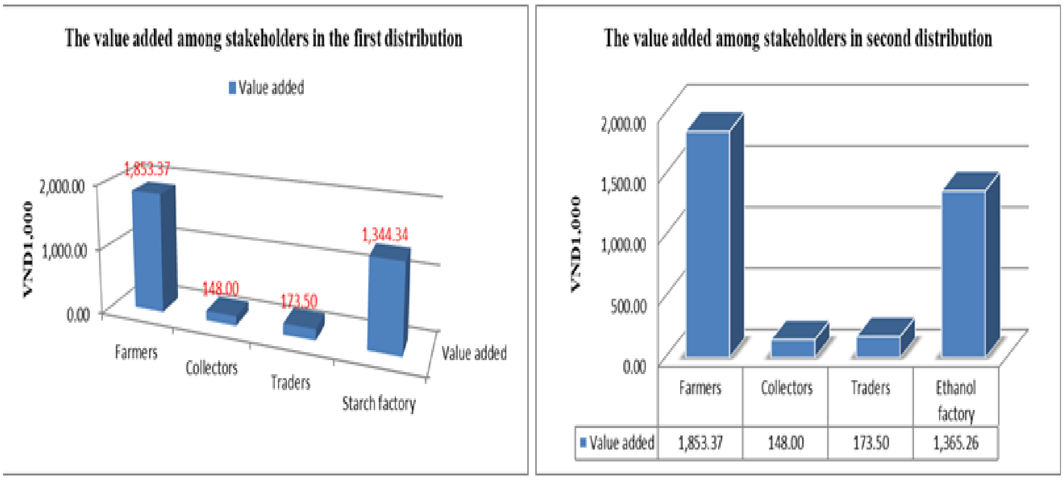


Figure 3.13. The value added among stakeholders in the starch and ethanol distribution channels

Moreover, as can be seen from (fig. 3.13), our findings reveal that the farmers' income and the ethanol factory's profit depend on both the market price and the level of production as well as on the quantity sold. Generally, both the farmer and the factory can expect to obtain a profit from the cassava produced and bought. However, in an exceptional scenario with both a low price and low productivity, the farmer could lose approximately

VND228,000 per tonne, while in contrast, for the best scenario with high productivity and a profitable market coinciding, the farmer's income would exceed VND2,000 per kg (fig. 3.13). Additionally, in the worst-case scenario with a combination of a 20 % decrease in quantity and a low selling price, the factory would incur a loss of anywhere from VND2.4 to nearly VND6 million per tonne (Fig. 3.13). However according to the best scenario in which a lucrative market and high productivity coincided, the ethanol factory's profit would exceed VND4.2 million per tonne.

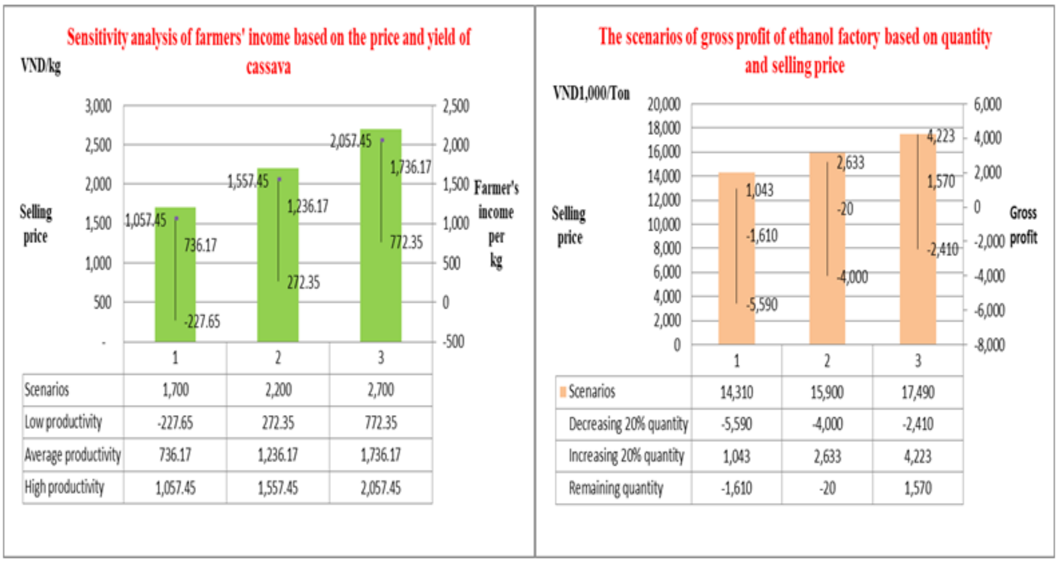


Figure 3.14. Sensitivity analysis of farmer's income and ethanol factory's gross profit

3.3.3 The potential for cassava-based bioethanol production in Dak Lak

Cassava-based ethanol production has developed rapidly in Vietnam (Le et al., 2013). Prior to 2010, eight ethanol plants were established with a total annual capacity of 680 million litres, of which 62 % was for biofuel with the remainder going to the alcohol, cosmetics, and pharmaceutical industries, or for export (Le et al., 2013; Ministry of Agriculture and Rural Development of Vietnam, 2008). In addition, seven of those ethanol plants are situated in the Central Highlands, the South Central Coastal and Southeast regions, the three main regions responsible for over

70 % of the total cassava output during the period, 2006 to 2010 (fig. 3.14) (Le et al., 2013).

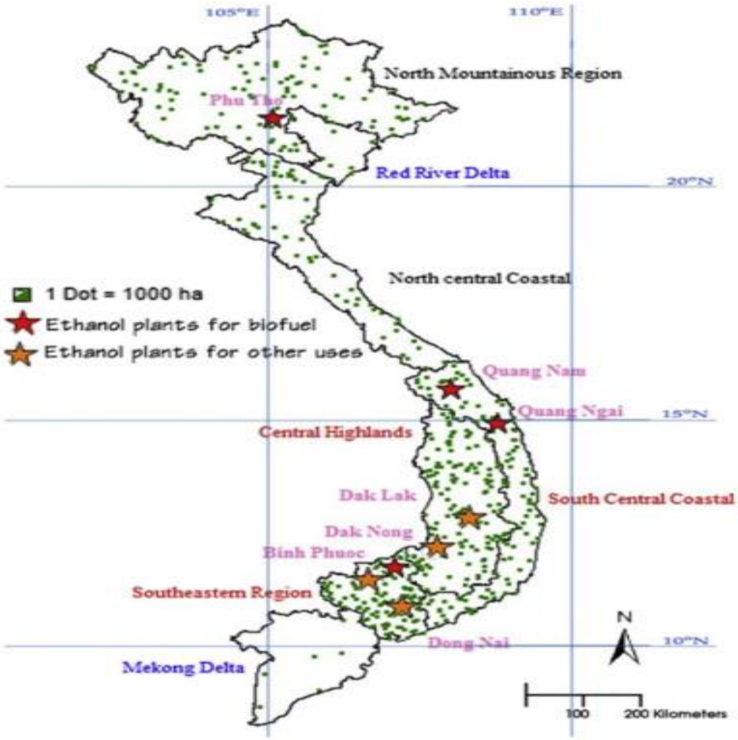


Figure 3.15. The main cassava areas and ethanol plants in Vietnam (Le et al., 2013)

Cassava-based ethanol production for a biofuel includes three stages, cassava cultivation, the conversion of cassava into ethanol and the final distribution of ethanol and blending with gasoline (Lan, Gheewala, & Garivait, 2007; Le et al., 2013) These three stages are described below.

Cassava cultivation

Cassava is cultivated in some provinces which suffer disadvantages in terms of economic development in Vietnam (Le et al., 2013). Cassava is normally cultivated in the early rainy season and is harvested from 7 or 10 months after planting (Lan et al., 2007). Some farmers who own larger areas conduct land preparation by tractor but land preparation is often carried out with a machete, hoe or dibble (Bassam, 2010) and weeding and harvesting are also generally done manually (Le et al., 2013). After being harvested both fresh cassava and dried chips can be sold to ethanol plants (Hoa et al., 2019). The conversion ratio from fresh root to dried chips is approximately 2 to 1, and the farmer can thus obtain roughly 10 tons of dried chip cassava from the fresh root harvested from 1 ha. This figure was derived from the survey conducted in this research as well as being corroborated by previous studies (Hoa et al., 2019; Leng, Wang, Zhang, Dai, & Pu, 2008; T. L. T. Nguyen, Gheewala, & Garivait, 2007)

Ethanol Conversion

Producing ethanol from cassava is done through the enzymatic liberation of sugars followed by the fermentation of the resulting sugars by yeast (Lan et al., 2007). Normally, the conversion of dried chips to ethanol involves four sub-processes: milling the cassava, liquefaction, saccharification and finally distillation and dehydration (Fig. 3.16). After the ethanol has been produced, by-products are left including dried biomass, which can be sold for animal feed production, and biogas and CO_2 which can be used as a source of supplemental energy and for other commercial purposes, respectively (Le et al., 2013).

Ethanol distribution and blending

The ethanol produced as a biofuel is sold and transported to oil refineries by a fuel truck. At the refinery blending stations, the blending process uses pumping machines to deliver gasoline and ethanol into one tank (Le et al., 2013). The blending ratio is 5 % ethanol to 95 % gasoline to obtain the fuel designated E5, which is then transported by different transport facilities to gas stations in Dak Lak province to be sold to the final consumers. At the national level, about 9.40 million tonnes of fresh cassava root was produced in Vietnam in 2011, up from only 1.99 million tonnes in 2000. This was achieved through both the expansion of the area under cassava cultivation (from 237,600 to 555,700 ha) as well as from increasing the yield of cassava (from 8.36 t/ha in 2000 to 16.91 t/ha in 2011).

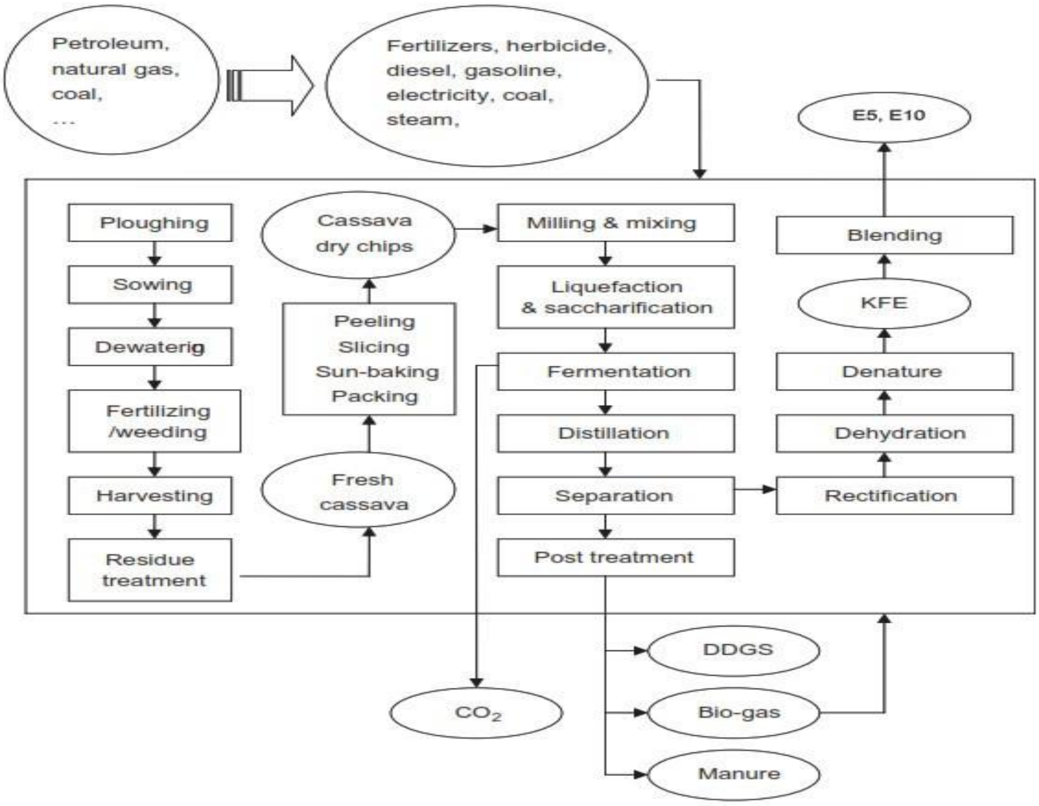


Figure 3.16. The cassava-based ethanol production process (Yu & Tao, 2009)

When all the new ethanol factories planned by PetroVietnam come into operation, each factory will consume about 240,000 tonnes of cassava chips per year. In 2012 ethanol production accounted for around 16 % of the total cassava produced and that had increased to 35 % by 2015. With the introduction of gasohol E10 to the market, it is expected that by 2025 about 48 % of national cassava production will be used for ethanol production (French Development Agency [AFD], 2012). Therefore, farmers will have more choice about where to sell their output and their income should, therefore, be improved. Table 3.14 shows that the yields of cassava calculated per household and per ha are approximately 21 and 18.6 tonnes, respectively, in Krong Bong district. The equivalent figures in Ea Kar are over 26.5 and around 21.6 tonnes, respectively, and for Ea H’leo, 24.6 tonnes and approximately 20 tonnes, respectively. Therefore, the potential for cassava-based ethanol production based on the yields of cassava per household and per ha are approximately 3,132 and 3,522 litres respectively in Krong Bong, around 3,640 litres and 4,506 litres, respectively in Ea Kar and around 3,365 litres and 4,141litres, respectively, in Ea H’leo.

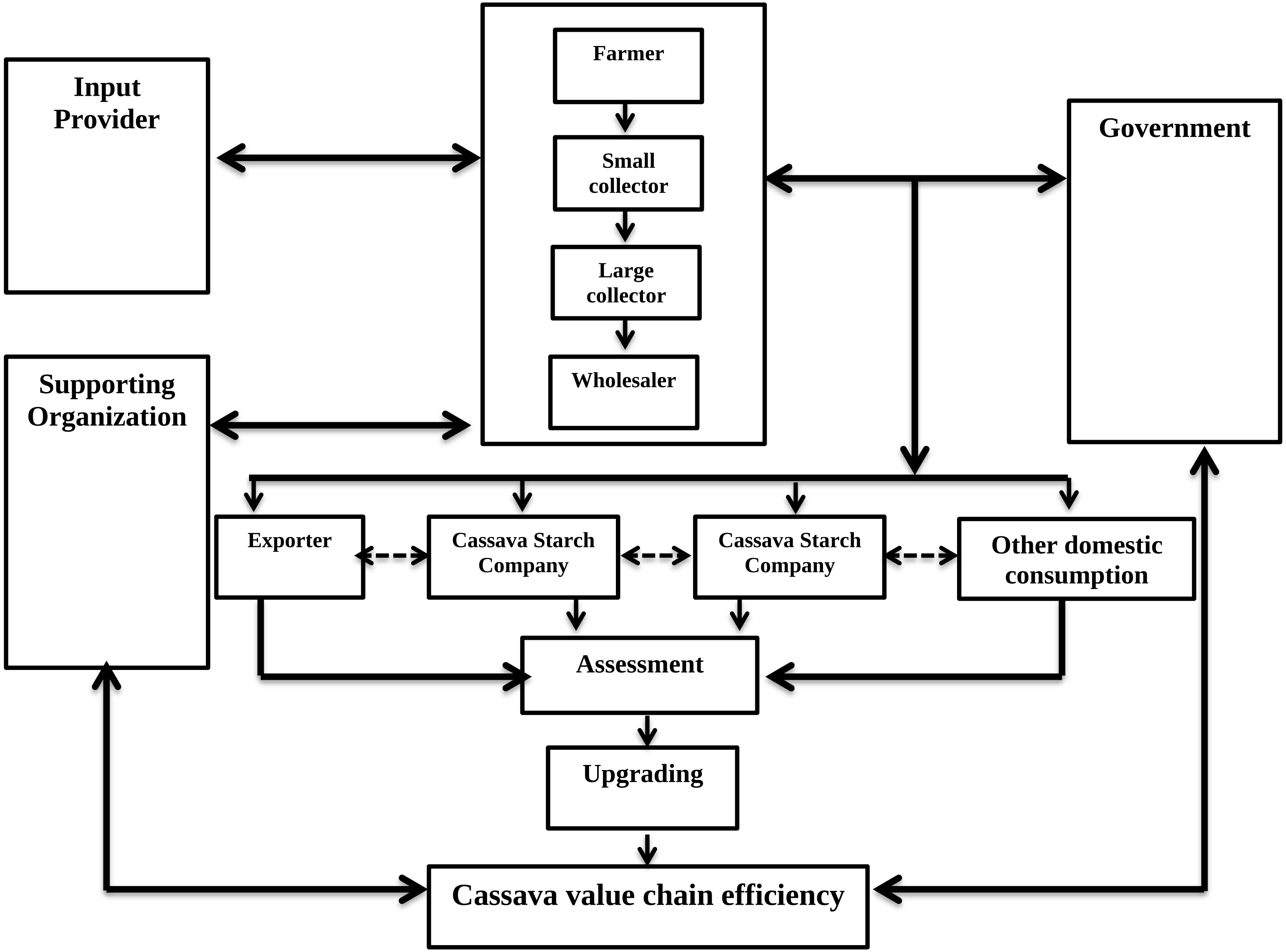
Table 3.14. The potential of ethanol production based on cassava at the study site

Districts	**Yield of cassava**		**Potential cassava-based ethanol production at a conversion rate of 5.94 kg per litre**	
	tonnes/household	**tonnes/ha**	**litres/ha**	**litres/household**
Krong Bong	20.92	18.60	3,131.72	3,522.20
Ea Kar	26.76	21.63	3,640.65	4,505.84
Ea H'leo	24.60	19.99	3,365.43	4,141.03

In light of the foregoing, the study shows that based on the total cassava production in 2017 (703,300 metric tons) the potential production of ethanol from cassava is theoretically estimated at 11.84 million litres at a conversion rate of 5.94 kg fresh cassava per litre of ethanol (Dai Viet Company in-depth interview). According to Mr Dao Trong Tuan, who is the Chairman of the board of directors Dai Viet ethanol factory in Dak Lak (personal communication), the production cost of one cubic metre of ethanol was VND15,920,000 or US$681 (exchange rate: US$1 = VND23,390: HSBC, 2018). However, according to Mr Dao Trong Tuan, in some cases, notably that of Brazilian ethanol, the price is currently US$600 per tonne at Ho Chi Minh City port in Vietnam, which means that the total cost of producing ethanol in Brazil and transporting it to Vietnam is lower compared than the cost of producing it in the Dai Viet factory. This is due to local small-scale farming, a lack of advanced cultivation technology, and price support in the short-term derived from the state (Hoa et al., 2019).

However, the world’s stocks of fossil fuels are being swiftly depleted and global warming and climate change caused by the emission of greenhouse gases threaten rising ocean levels, and these factors support the production of bioethanol from cassava. Bio-fuel can be categorized as a first or second-generation renewable energy source (Ozoegwu et al., 2017). Those products are produced from starch or sugar-based substrates such as grains, sugar beet or are made from lignocellulosic materials such as cassava (Naik, Goud, Rout, & Dalai, 2010; Ozoegwu et al., 2017). Other forms of renewable energy include hydropower, wind, solar and geothermal power, along with power generated from biomass, all of which are environmentally friendly. Currently, development based on renewable energy sources is widespread throughout the world and concern for the environment has led to international forums and agreements focusing on renewable energy and the mitigation of global climate change, such as the Earth summit of 1992, the Kyoto protocol of 1997, the Copenhagen accord of 2009 and the recent Paris agreement of 2015, negotiated at the United Nations Climate Change Conference, COP21 (Ozoegwu et al., 2017).

Figure 3.17: Framework to cassava value chain analysis



CHAPTER 4 DISCUSSION AND CONCLUSION

4.1 Discussion

4.1.1 Discussion about the advancing sustainable livelihood of smallholder through linkages among actors within cassava value chain

Our results concurred with the finding of Naziri and Bennett (2014) in both African and Southeast Asia that Cassava is mostly cultivated as a mono-crop by household farmers in small plots but was somewhat at variance with, the findings of Njukwe et al., 2014 that in Cameroon, cassava is cultivated by over 90% of the farming population, mostly as an intercrop in small plots of between 0.4 to 12 hectares. Further, the study reported herein revealed that the education status of the respondents was different from those studied by Njukwe et al. who found that 21% of the farmers had only primary education while the present study found that the majority of the participants (76.67%) had received at least secondary school education which may represent an advantage when cultivating cassava. Further, some previous studies found that not only were cassava tubers consumed but the leaves of the cassava planted were also used as a foodstuff constituting a part in the daily food intake of some African people (Andersson et al., 2016).

However, in our study, the cassava leaves were left in the field after harvesting. Son et al. (2016) found that the percentage of cassava converted to dried chip in Quang Binh province was 50% of the fresh cassava harvested. However, this rate depended on various factors such as the variety grown as well as the period that the cassava was kept post-harvest. This finding is in accord with the findings of our research. Additionally, our findings suggest that in order to improve the value chain the first priority is to ensure that the products meet the needs of the market, which was also suggested by (Thanh, Tan, & Thu, 2017)) as a means of enhancing the value chain for exported agricultural products. These researchers also suggested that particular solutions need to be adopted to overcome individual problems to ensure that exported agricultural products meet the needs of the export market in order to create a sustainable value chain. The present study also reveals that low productivity and competitiveness in the cassava value chain may be due to various factors such as poor infrastructure, lack of farmer skills and limited capital resources, as well as a lack of synchronized mechanisms amongst competent authorities (Fonji et al., 2017).

Our results agreed with those of Fonji et al., (2017) relating to cassava cultivation in the central region of Cameroon. Moreover, the results of the present study were in agreement with those reported by Leo (2015) with regard to the effect of growing cassava on the income of small-scale farmers in Abia State, Nigeria which suggested that in order to increases the income level of farmers, they should apply advanced technologies and enhance the capacity of buildings (Leo, 2015). Further, as some previous studies have noted, in order to be successful, all partnerships should be formalized by appropriate contracts which clearly state the roles and responsibilities of the actors across the value chain (Njukwe et al., 2014). Our findings also determined that improving the cassava value chain can be achieved by cooperation among the stakeholders. Other scholars have emphasized farmers' participation in profitable stages of the cassava value chain by strengthening coordination, growing new cassava varieties and applying novel processing technologies (Sewando, 2012).

Most previous studies have observed that the most common means by which farmers transport cassava involves the farmer carrying the cassava from the field to their home, and Njukwe et al., (2014) found that transportation from the growing area in Cameroon was dominated by head or back-loads, and that 32.5% of the cassava grown was consumed in fresh form due to inadequate infrastructure. This agrees with research by Tshiunza et al.

(1997) in six major African cassava producing countries where transportation from field to home was accomplished by various means but most (70%) was by head-load or back-load and that women accounted for over 80% of that form of transport. In our study, it was found that currently, more than 90% of the cassava is sold as cassava root and that most of the farmers bring their products home as well as supply it to their market using the local vehicle known as xe cay.

In addition, our study also found that almost all (97%) of the cassava tubers are consumed as raw material for starch and ethanol production, either based on direct sales or sales facilitated through collectors or traders, with only 3% processed for other purposes. This is important and quite different from some previous studies, for instance that of Nweke (1994) who found that an average of 40% of the cassava in South and Centre, West and North West and East regions in Cameroon as provided for sale in the market while Tshiunza et al. (1997) discovered that 85% of the farm production in six major African cassava producing countries was consumed in households while 10% was sold directly in markets with only 5% being used for processing purposes (Njukwe et al., 2014).

4.1.2 Gender issue in cassava value chain analyses

In this part of the paper, the factors influencing women's decisions to participate in cassava growing are first discussed (Table 3.8). Then, the level of participation of women and men in the production stage is commented on (Table 3.9). Next, the main factors affecting the quantity of cassava supplied (Table 3.10) are assessed and subsequently, the level of cassava farmers' participation in the cassava market (Table 3.11) is discussed. Finally, this section focuses on evaluating the role of gender within the cassava value chain at the production stage (Table 3.12). This study not only investigates the issue of gender roles but also deals with socio-economic and individual household factors which have an effect on both farmers' participation and the level of their participation in the cassava value chain. The findings support those of previous studies (Apata, 2013b; Butterworth, Abdulsalam-saghir, & Martin, 2008; Coles & Mitchell, 2010; Blessing Masamha et al., 2018a) which concluded that there are different economic values and benefits to be gained from the participation of males and females, based, for instance on access to assets and education level, in terms of sources of household income through farming activities. The results reported herein agree with the findings of (Blessing Masamha et al., 2018a) in relation to the cassava food value chain, which found that market participation was dominated by men while women were prominent in the processing stage of the cassava value chain at the household level. The results of the study are consistent with the findings of Coles and Mitchell (2010) that gender inequality is a significant obstacle to female participation in the production stages of cassava. However, this is a fair situation since many of these stages require physical strength, and whilst women can share the burden to a degree, men are likely to be predominant in the cassava value chain.

4.1.2.1. The factors influencing the decision of women to participate in cassava cultivation (see table 3.8)

The findings in this study are in line with those of (Blessing Masamha et al., 2018b) in that the variable based on the land area squared (LAN_Sq) was negatively and significantly associated with women's decision to participate in cassava cultivation ($p < 0.05$). This negative effect was consistent with the outcome of previous research relating to the size of the farm such as (Heltberg, 1998) study of the distortion of rural markets. The positive impact of household land area is also consistent with the results of (Saenz & Thompson, 2017) who investigated the role of gender and policy in farm households. Similarly, the number of people under 18 years old squared variable had a negative and significant effect ($p < 0.1$) on women's decisions to engage in cassava cultivation which was also positively and significantly ($p < 0.05$) affected by the number of their dependents consistent with the findings of (Blessing Masamha et al., 2018b). However, the results of this study were in contrast to those of Masamha et al. (2018b) in relation to the EDU variable both in its natural form as well as its transformed squared form. In the present study, these variables both had both negative and positive and significant effects ($p < 0.05$) while in the study of Masamha et al (2018) the coefficients were both negative although not significant. In particular, it was revealed in this study that the 1/LOA_Sqrt variable influenced women’s decisions to engage in cassava farming. The wider study also discovered that rural credit is very difficult to access through the formal credit market in rural areas. Only a small number of previous studies have identified and estimated the effect of the availability of credit on the cassava value chain. Our result shows that access to credit through, for instance, loan programs and other forms of assistance encourage female leadership roles in households and this supports the findings of (Arega et al., 2007; Saenz & Thompson, 2017). However, it was found that the ownership of local transport (LO.TRA) had a negative and insignificant effect on women’s participation in this study. This finding is similar to those of (Jagwe, Ouma, & Machethe, 2010; Blessing Masamha et al., 2018a) relating to the cultivation of bananas in Africa and the analysis of the cassava value chain with respect to gender in Tanzania, respectively. The result of our study reflects a difference from initial expectations. This can be explained by the fact that most fresh cassava is bought at the farm gate by middlemen. Therefore, farmers may not need to transport their product to the market. Hence, this variable had a negative effect although this was not significant.

In addition, in reviewing the role of gender in the value chain, most previous scholars have considered employment, working situations, salary and age as well as the marital status of women (Flores & Bastiaensen, 2017). The selling price of cassava had a positive effect on female’s decisions to participate in cassava cultivation but the effect was not significant. This finding is similar to that reported by (Arega et al., 2007) who assessed the effects of transactions and cost mitigation on maize producers. There are numerous infrastructural and physical challenges inhibiting the participation of female farmers in cassava cultivation as reported by (Singh-Peterson & Iranacolaivalu, 2018). Furthermore, this finding is in line with that of (Tran et al., 2018) who found that the education level, number of dependents and access to credit of rice farmers influenced women's participation decisions.

4.1.2.2. The level of participation by women in the production stage of the cassava value chain (see table 3.9)

In regard to the level of participation in the production stage of the cassava value chain by women and men, the finding of the present study is quite different from that of (Blessing Masamha et al., 2018b) with the R^2 coefficients for women and men being quite similar at 0.55 and 0.67 respectively, while Masamha et al. found that the R^2 value for females was approximately double that for males (0.447 and 0.26, respectively). This means that the total variation explained by the model for men is less than that for women. Based on previous research, excluding variables such as marital status, region and age may have affected the significance of the results from the OLS model. However, variables added to the regression model for females, such as Ln_CAS.ARE, SEL.PRI and Sqrt_EXP.CUL had both negative and positive effects which were significant ($p < 0.05$). Further, in the model for males, the finding relating to the age of the household head concurs with that of (Ayamga, Sarpong, & Asuming-Brempong, 2006; Blessing Masamha et al., 2018b) and was also statistically significant. This finding is also in line with that of Masamha et al., that access to information technology negatively affected the participation of women in cassava production. However, this finding seems to contrast with the findings of Siziba and Bulte (2012) in relation to the cereal market (Siziba & Bulte, 2012). In addition, the burden of caring for children and elderly relatives in the household also represents a barrier impeding women from participation in cassava cultivation (Singh-Peterson & Iranacolaivalu, 2018).

4.1.2.3. Factors influencing the farmer's decision to participate in the market (see Table 3.10)

The study found that women play an important role in making decisions relating to participation in the cassava value chain and this finding is different from that of some previous studies. For instance, it contrasts with that of (Sebatta et al., 2014) relating to the potato market in Uganda that in most cases men make the final decision on whether to supply products or not, as well as where and in what quantity. The study's finding also contrasts with that of (Hill & Vigneri, 2011) relating to female farmers selling coffee in Uganda but is in agreement with that of Doss (2001) who found that female farmers dominate subsistence crop cultivation. This result is not surprising since in Vietnam the role of women in rural areas has been enhanced based on women's empowerment and their access to markets and this has enhanced their power to make decisions within households (Morrison, Raju, & Sinha, 2007). Further, this finding is similar to that of (Siziba & Bulte, 2012) that education level, gender and household size may influence farmers' decisions relating to market participation although the effect was not significant. Moreover, they found that the age of the head of the household had a negative and significant effect which contrasts with the result of the present study. However, the findings of this study are consistent with those of (Jagwe et al., 2010) that selling price and the gender of the household head all have an effect on decision making, although this was not statistically significant. The result of this study is also contrary to that of Jagwe et al. in relation to the experience of the farmer which was found to have a positive and significant effect in the present study but were not found to be significant factors by (Jagwe et al., 2010). However, this study's finding is consistent with that of (Tran et al., 2018) in relation to the production of rice in Vietnam, with both studies finding positive and significant effects from the cultivated land area variable as well as the women's age variable on the men's decisions to participate in cultivation.

4.1.2.4. The level of market participation by farmers in the cassava value chain (see Table 3.11)

In terms of the level of market participation, the gender of the farmer being male had a negative and significant ($p < 0.05$) effect on the quantity of cassava sold in the market. This finding contrasts with the result reported by (Sebatta et al., 2014). Moreover, based on the farmers' group discussion, the farmers tend to think that cassava is the women's crop. This supports the positive impact of women's participation in cassava farming (Morrison et al., 2007) and decisions as to when, where and what quantity of cassava to sell. (Krong Bong, Farmers' group discussion, 2018). Men, on the other hand, have more opportunity to engage in other non-farm activities in order to earn money either as casual labour or by working for private companies, and this finding supports those of (Barrett, 2008; Reardon, Timmer, Barrett, & Berdegué, 2003; Sebatta et al., 2014). In this study, the women's role was equivalent to that of men and they were often responsible for contact with middlemen when selling their produce either at the farm gate or at markets although this depended on individual households. Similar results were reported in relation to farmers' participation in the banana market by (Jagwe et al., 2010) where the number of children under 18 years old had a positive and significant effect on the level of market participation. Moreover, both studies found that the farmers' experience had no statistically significant effect on market participation. In contrast, however, Jagwe et al. found that the transportation variable had a positive and significant effect which contrasted with the findings in this study.

4.1.2.5. The roles of men and women in the cassava cultivation process (see table 3.12)

In terms of the role of gender in the cultivation stage of the cassava value chain, the study's findings were similar to those of Radel et al

(2012) in respect of the cultivation of chilli in Calakmul, Mexico in that male household heads controlled agricultural processes such as weeding, harvesting as well as being responsible for the entire production process including when, where and what to grow, with women participating in work activities in the role of helper. The result of this study also supported that of (C. Radel, 2011) in that women had little participation in spraying pesticides and preparing the land using tractors. A plausible explanation for this is women's physical characteristics, their low educational levels and also a lack of technical skills, which may result in women making less use of farm machinery (Fischer et al., 2018). Additionally, this finding is consistent with that of (Blessing Masamha et al., 2018a) who investigated intra-household gender dynamics in the cassava value chain and found that in most cases men and women were jointly responsible for harvesting although the task was predominantly performed by men. What emerged from this study was that women's participation in the processes of planting, weeding and harvesting was different from their role in Africa countries where they were involved not only planting, weeding and harvesting but also fertilizing crops and spraying pesticide in cassava cultivation (Coulibaly et al., 2014c; Blessing Masamha et al., 2018a).

4.1.3 Discussion about the potential of cassava-based bioethanol

Cassava is mainly grown in Vietnam for its industrial value and Dak Lak province is no exception. Cassava is thus the cash crop that creates an income for a larger number of poor households in remote areas in Dak Lak than any other crop (Hoa et al., 2019a; Howeler et al., 2018). In particular, this region has two ethanol plants namely Ethanol Dak Lak Joint Stock Co. Ltd, in Dak Lak province and Dai Viet Co. Ltd. in neighbouring Dak Nong province (Nga, 2019) with installed production capacities of 66 and 68 million litres of ethanol per year, respectively (Hieu, 2016b). The area under cassava cultivation rose from 32,000 ha to 36,300 ha in the period 2011 to

2017, with the average yield of cassava fluctuating from over 18 tonnes to almost 20.5 tonnes per ha. The total production during that period varied from 610,000 tonnes to a peak of 703,300 tonnes (fig. 3.12). Dak Lak province is, therefore, a region where cassava is a more important crop compared to other areas in Vietnam.

This finding agreed with that of Naziri et al (2014) relating to small-plot cultivation of cassava by households in Southeast Asia and Africa with the average cassava yield reported in that study ranging from approximately 18 to 22 metric tonnes of cassava tuber per ha, as against the average of all the study sites in the present study which was nearly 20 tonnes per ha. The results of this study are also quite consistent with the findings of previous research related to the average yield of cassava of around 18 tonnes per ha (Hieu, 2016b) and approximately 19 tonnes per ha (FAO, 2017). However, the yield found in this study was twice that found in Cambodia by (SNV, 2015) of about 9 metric tonnes per ha. Cassava produced in Dak Lak can currently be used for many purposes because of its high starch content, which makes it an appropriate raw material not only for bioethanol production, but also for various other industries, for example, the pulp, textile and food and beverage industries. (Anyanwu et al., 2015). The findings of the present study revealed that the conversion ratio of ethanol from dried chips is 2.7 kg per litre which concurs with the findings of previous studies (Le et al., 2013; Leng et al., 2008; T. L. T. Nguyen et al., 2007)

4.2 Conclusion

4.2.1 Cassava value chain and smallholders’ sustainable livelihood

This research used structured and semi-structured interviews with numerous cassava value chain actors, focus group discussions with farmers (Andersson et al., 2016), and in-depth interviews with key informants to construct a comprehensive overview of the cassava value chain which was also supplemented by direct participant observations in Krong Bong, Ea Kar and Ea H'leo districts in Dak Lak province. Our findings revealed that activities in the cassava value chain are dominated by males and that it is the farmers who create the highest value added while the role of intermediaries is the most profitable. It was also found that the household farmers from among the ethnic minority groups suffered most physical losses at the stage of selling their products because they tend to keep the fresh cassava for some days after harvesting it and then sell it to a collector or trader. Additionally, most of the farmers lack sufficient capital for investment in technologies etc. to improve cassava productivity and they, therefore, obtain less profit than other groups who trade in or process cassava. In the light of the foregoing result, improving the profitability of household farmers is a major challenge that will require critical and specialized budgetary and political support at national and global levels (Sattar, Wang, Tahir, & Caldwell, 2017). In particular, the household farmers in the Dak Lak cassava production areas have limited resources although the household farmers' incomes are improving because of the currently increasing cassava price. The study found that intermediaries play an important role in the relationship between the cultivation and consumption step and they not only provide input material but also supply informal credit that can help farmers conduct good cassava cultivation. However, these intermediaries purchase cassava at low prices from household farmers depending on the contracts they sign with them. Depending on their financial capacity, cassava is collected either as fresh cassava or as dried chips. In either case, however, most of the profits from the cassava value chain accrue to the intermediaries.

With regard to the processors, the factories who were the end users of 97% of the cassava currently grown specialize in the production of starch and ethanol. It would be beneficial for them to diversify into other cassava products to meet different market demands in the future. Our findings suggest that these actors currently receive less profit than before because of increasing input-material costs. It is undeniable that the demand from factories makes the cassava market more competitive and it is also leading to the price of the fresh cassava produced by Vietnamese farmers becoming dependent on the Chinese market, which is a very volatile and risky market. Therefore, processing factories play a vital role in the cassava value chain and their demand has led to the enhancement of the value of cassava root, which in turn has mitigated hazards inherent in the traditional market by diversifying the uses to which cassava is put to include products such as starch, flour and ethanol. On the other hand, this study revealed that although there are various distribution channels, there are, in fact, two major channels which dominate the cassava value chain. Therefore, addressing the emerging opportunities and challenges in the cassava market requires cross-sectoral participation from the full range of stakeholders in the value chain notably the government through the Ministry of Agriculture and rural development which can supply credit in the form of soft loans for fertilizer or pesticide. This would probably represent a cheaper form of capital financing than is currently available through intermediaries. Once interdisciplinary cooperation is committed from all sides, this will improve the operation of the cassava value chain in this region.

Finally, this finding has just focused on value added and financial cost as gross and net profit of stakeholders in the cassava value chain. It has not yet referred to the role of gender in the household such as females' decision to participate and level of participation cassava production as well as market participants. In addition, this study has not clearly analyzed the role of government policy in reducing the risk of cassava market (such as price subsidy, rural credit policy). Thus, it is highly recommended for further researches regarding inequality gender and, or improving females' role in the cassava value chain as well as policy reform in order to give a boost to the cassava value chain for both farmer and the rest of stakeholders.

4.2.2 Gender perspective in cassava value chain analyses

In conclusion, cassava cultivation entails labour-intensive activities including land clearing, and tillage, planting, weeding, harvesting and processing for consumption. In common with previous research, this study's findings shed light on the key issue of female participation in the cassava value chain and finds that their role is not as extensive as that of men. This finding is, however, limited to rural females in a remote area and contrasts with the emerging role of females in economic activities. This study not only sheds light on the issue of gender but also explores the effect of how factors related to socio-economic and individual household characteristics affect both participation and the level of participation in the cassava value chain of smallholder farmers, especially the role of female throughout cassava production and supply to the market. The gender equality issue is dealing well with smallholder farmer in the cassava value chain. Thus, it is highly recommended for a further study relating to sustainable livelihood for smallholder farmer through advancing the cassava value chain both farmer and the rest of stakeholders as well as giving plausible policy from the local authority.

4.2.3 Bioethanol

Estimating the potential for cassava-based bioethanol in Dak Lak province. The annual production capacity of ethanol from the total cassava output of the region could theoretically reach almost 12 million litres of ethanol at current levels of cassava cultivation, with ethanol production based on the average cassava output per household of between 3,500 to 4,500 litres per household/year depending on the area in which the household is located. However, the yield of cassava has been gradually increasing over the years and there is undoubtedly a huge potential for the exploitation and production of bioethanol (Mkandawire, 2016) derived from cassava in Dak Lak. However, consumer behaviour and their willingness to pay a higher price for fuels such as E5 and E10 containing bioethanol, which has only become available in the last decade, will undoubtedly play a vital role in their production and consumption

It is recommended that local authorities in Vietnam should implement comprehensive policies relating to the production of raw materials for the biofuel industry and the development of the areas in which they are cultivated. The production of ethanol from cassava requires cross-sector participation from the government and other stakeholders involved in the cassava-based ethanol industry. The commitment and cooperation of stakeholders in each area will enable the development of a locally-based ethanol industry. This, however, can only be achieved if production technologies are developed which enable current yields to be surpassed (Mkandawire, 2016). Cassava-based ethanol production is not only a means of dealing with future shortages of fossil fuels but it also creates added value for cassava root by diversifying the range of products derived from this crop. Therefore, the bioethanol market should be developed by supporting the consumption of biofuel-supplemented motor fuels such as E5, E10 across the nation. Moreover, the environmental cost of the use of different forms of energy should be accurately assessed and built into their pricing, in order that the issue of environmental protection can be more efficiently dealt with. Furthermore, it is important to protect domestic biofuel production by implementing reasonable taxation policies including the imposition of duties on imported ethanol subsidized by foreign government policies. The potential for producing ethanol from cassava clearly exists in Dak Lak Province and is technically feasible, as has been shown elsewhere. However, its commercial success will depend on the price that its consumers are prepared to pay

(Mkandawire, 2016). Therefore, in order for, this potential to be realized the technical, market and consumption aspects must be carefully considered and measures implemented to ensure favourable conditions for bioethanol production from cassava.

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APPENDIX

Appendix A: Journal papers

I. List of papers published as Author

1. Advancing smallholders' sustainable livelihood through linkages among stakeholders in the cassava (Manihot Esculenta Crantz) value chain: The case of Dak Lak Province, Vietnam. Applied Ecology and Environmental Research. https://doi.org/10.15666/aeer/1702_51935217 © 2019 ALÖKI Kft, Budapest, Hungary (ISI, Q4, IF = 0.72).


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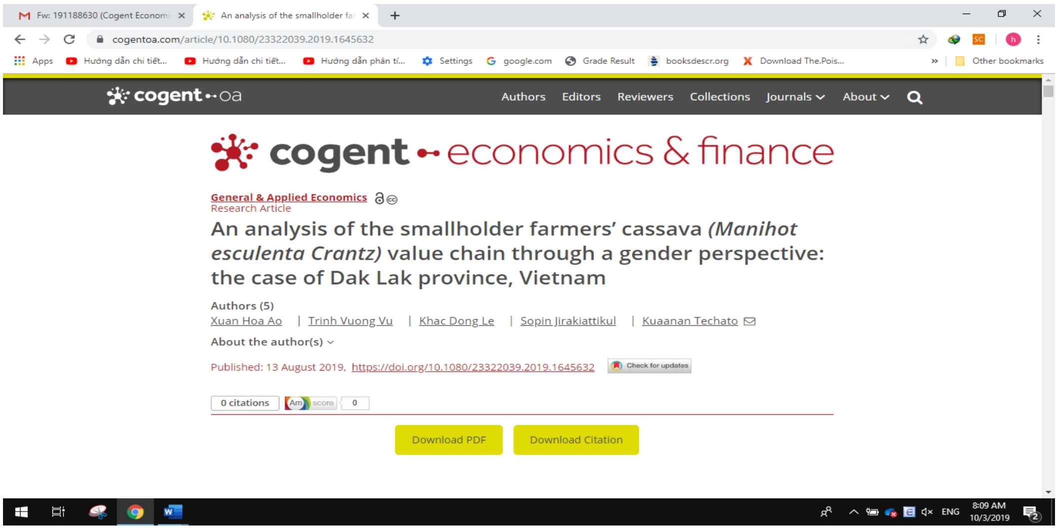
2. An analysis of the smallholder farmers' (Manihot esculenta Crantz) value chain through a gender perspective. The case of Dak Lak province, Vietnam. Cogent Economics & Finance. https://doi.org/10.1080/23322039.2019.1645632 (ISI, ESCI)



II. List of papers published as Co-author

1. Dong. L. K, Sutinee. S, Hoa. A. X, Dong. N. P, Ali. S, Manop. P, Kuaanan. T. A quick comparison of patrol efforts for supportive protection: a case study of two stations in Vietnam. Applied Ecology and Environmental Research 16(2):1767-1781. ISSN 1589 1623 (Print). ISSN 1785 0037 (Online). DOI: http://dx.doi.org/10.15666/aeer/1602_17671781 © 2018 ALÖKI Kft, Budapest, Hungary (ISI, Q4, IF = 0.681).

2. Le Khac Dong, Sutinee Sinutok, Georg Koeble, Ao Xuan Hoa, Shahid Ali, Thomas Okfen, Kuaanan Techato. Application tool of Global Positioning System as the first stage of patrol skills for protected areas. Songklanakarin Journal of Science and Technology (SJCT) (Scopus, CiteScore = 0.5, SJR = 0.240, SNIP = 0.432). Accepted paper: 14/03/2018.

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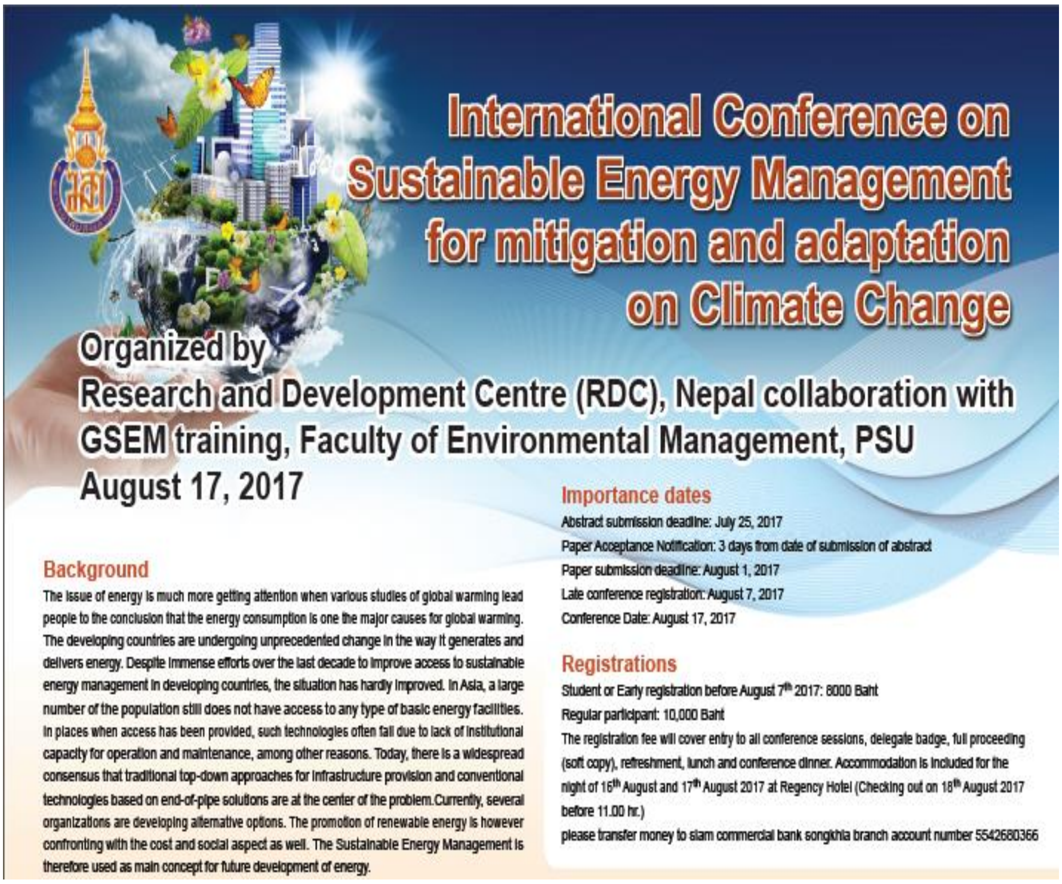
4. Dong Le Khac, Sutinee Sinutok, Hoa Ao Xuan, Manop Promchane, Kuaanan Techato. Potential of approached ecotourism consideration as part of patrol efforts responsibility in Pu Hu nature reserve. EnvironmentAsia 11(3) (2018) 203-212. DOI 10.14456/ea.2018.48. ISSN 1906-1714; online ISSN: 2586-8861. EnvironmentAsia (Thai Society of Higher Education Institute on Environment (TSHE), SJR = 0.17).

III. List of conference papers as Author

1. Ao Xuan Hoa, K. Techator, W. Jutidamrongphan, L. K. Dong. "Community-based buffer zone management policy in Vietnam". International Conference on Sustainable Energy Management for Climate Change Adaption and Mitigation on August 17th 2017 at Siam Oriental Hotel Hat Yai, Songkla, Thailand.


International Conference on Sustainable Energy Management for mitigation and adaptation on Climate Change
Organized by
Research and Development Centre (RDC), Nepal collaboration with GSEM training, Faculty of Environmental Management, PSU
August 17, 2017
Background
The issue of energy is much more getting attention when various studies of global warming lead people to the conclusion that the energy consumption is one the major causes for global warming. The developing countries are undergoing unprecedented change in the way it generates and delivers energy. Despite immense efforts over the last decade to improve access to sustainable energy management in developing countries, the situation has hardly improved. In Asia, a large number of the population still does not have access to any type of basic energy facilities. In places when access has been provided, such technologies often fail due to lack of institutional capacity for operation and maintenance, among other reasons. Today, there is a widespread consensus that traditional top-down approaches for infrastructure provision and conventional technologies based on end-of-pipe solutions are at the center of the problem.Currently, several organizations are developing alternative options. The promotion of renewable energy is however confronting with the cost and social aspect as well. The Sustainable Energy Management is therefore used as main concept for future development of energy.
Importance dates
Abstract submission deadline: July 25, 2017
Paper Acceptance Notification: 3 days from date of submission of abstract
Paper submission deadline: August 1, 2017
Late conference registration: August 7, 2017
Conference Date: August 17, 2017
Registrations
Student or Early registration before August 7th 2017: 8000 Baht
Regular participant: 10,000 Baht
The registration fee will cover entry to all conference sessions, delegate badge, full proceeding (soft copy), refreshment, lunch and conference dinner. Accommodation is included for the night of 16th August and 17th August 2017 at Regency Hotel (Checking out on 18th August 2017 before 11.00 hr.)
please transfer money to siam commercial bank songkhla branch account number 5542680366


CERTIFICATE
RDC Nepal
Faculty of Environmental Management, PSU and Research and Development Centre, Nepal present the certificate to
Ao Xuan Hoa, K. Techato, W. Jutidamrongphan, L.K. Dong
as
Presenter/Presenters
For the paper entitled
Community-Based Buffer Zone Management Policy In Vietnam
International Conference on Sustainable Energy Management for Climate Change Adaptation and Mitigation
on August 17th, 2017 at Siam Oriental Hotel Hat Yai, Songkhla, Thailand
Assoc. Prof. Dr. Banchong Witthayawirasak
Dean, Faculty of Environmental Management
Asst. Prof. Dr. Kuaanan Techato
GSEM2017 Training Director
Dr. Saroj Gyawali
Chair of the International Conference

Paper ID: 011

COMMUNITY-BASED BUFFER ZONE MANAGEMENT POLICY IN VIETNAM

[1,2]AoXuanHoa;[1]K.Techato; [1]W.Jutidamrongphan[a] and[1]L K Dong

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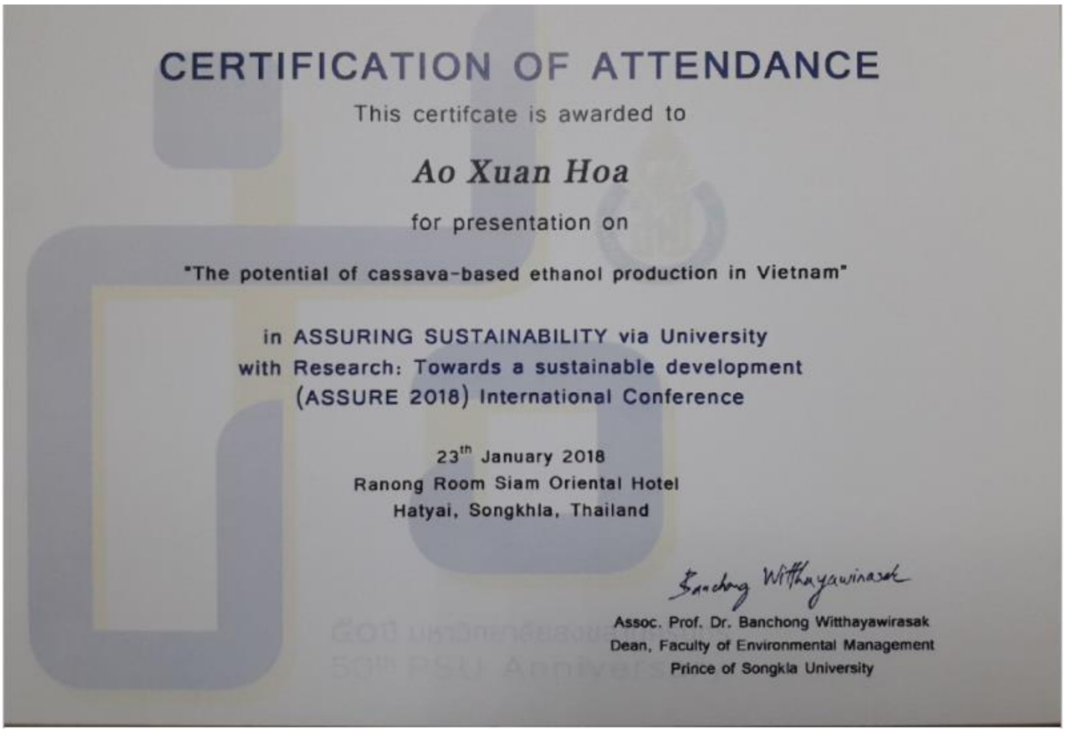
ABSTRACT

Currently, the Vietnamese government has been facing many challenges to protect buffer zones in national wide. State policies have accepted local communities and personality as legal recipients of forest and land-use rights in buffer zone. The local people not only participate in forest protect and management but also receive various benefits in these activities. Using communities-based buffer zone management perspective, this aim of paper is examined the efficiency of the implementation cutting-egg policies of Government. Data is analyzed by fourteen buffer zones in seven different geographic regions where have nation park, was conducted leader of national park in-depth interview, and forest official who have responsibility associated with protect and patrol forest as well as indigenous people. In addition, household surveys were conducted and sampling was based on the type of settlement and land size and basing on the distance from the park boundary. The result represented that the success of policies in buffer zone management are depending on various factors and partners. Furthermore, also is given among local community, local authorities and government collaboration within community-based management is necessary. The Vietnamese government have been given to improved livelihood of local people by buffer zone-based protect and management policies. The forest cover area is increase gradually and the rapid rate of rise in many species within biodiversity conservation plan in national level. Conversely, there are no appropriate mechanisms to effectively evaluation between the recent investment by government and socio-economics efficiency which are gained by local community.

Keywords: Community-based, buffer zone, sustainable livelihood, biodiversity, local people.

2. Ao Xuan Hoa. "The potential of cassava-based ethanol production in Vietnam". In assuring sustainability via university with research: Towards a sustainable development (ASSURE 2018) International conference on 23rd January 2018 Ranong Room Siam Oriental Hotel Hat Yai, Songkla, Thailand.


CERTIFICATION OF ATTENDANCE

This certifcate is awarded to

Ao Xuan Hoa

for presentation on

"The potential of cassava-based ethanol production in Vietnam"

in ASSURING SUSTAINABILITY via University
with Research: Towards a sustainable development
(ASSURE 2018) International Conference

23th January 2018
Ranong Room Siam Oriental Hotel
Hatyai, Songkhla, Thailand

Assoc. Prof. Dr. Banchong Witthayawirasak
Dean, Faculty of Environmental Management
Prince of Songkla University

Paper ID:
Topic: The potential of cassava-based ethanol production in Vietnam
Authors: [1] Ao Xuan Hoa, [1]Kuaanan Techato, and [2]Sopin Jirakiaattikul*.
Affiliation: 1 Faculty of Environmental Management, Prince of Songkla University, Songkhla province, Thailand, uhugua@hotmail.com; 2 Department of Economics, Prince of Songkla University, Songkhla province, Thailand, jirasopin@gmail.com

Abstract

Global biofuel demand has increased significantly over the decade in the past, as countries have implemented fuel-blending mandates and goals as emissions strategies to decrease greenhouse gas mitigation in the transport sector. The period from 2005 to 2015, the Biofuel that was increased in quantity of production about 80 billion litres. That was from less than 50 billion litres to over 130 billion litres, accounted for approximately 4 percent of global road transport fuel. Furthermore, demand is expected to continue increasing as more countries process the use of biofuels for transportation.

The term "Biofuel" covers a wide range of fuels, produced from living organisms or from metabolic by-products (organic or food waste products). In order to be considered as a biofuel, the fuel must contain over 80 percent of renewable materials. Ethanol (ethyl alcohol: C_2H_5OH) is a colourless liquid with a range of commercial applications, including use as a petrol equivalent in transport fuels by blending with unleaded petrol to make E10, which is a retail fuel option. E10 does not require special fuelling equipment and can be used in any conventional gasoline vehicle. Ethanol contains approximately 34% less energy per unit volume but has a higher octane rating than unleaded petrol; therefore engines can be operated more efficient by raising their compression ratios. The system

boundary of the Cassava Fuel Ethanol (CFE) is set up to identify the exchange of the system with the environment in terms of energy inputs and outputs. There are three main segments involved in the CFE system are cassava cultivation, ethanol conversion, and transportation.

Keywords: Biofuel, Cassava, Cassava Fuel Ethanol, Ethanol, E5.

References

Appendix paper

ADVANCING SMALLHOLDERS' SUSTAINABLE LIVELIHOOD THROUGH LINKAGES AMONG STAKEHOLDERS IN THE CASSAVA (*MANIHOT ESCULENTA* CRANTZ) VALUE CHAIN: THE CASE OF DAK LAK PROVINCE, VIETNAM

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Abstract. Cassava (*Manihot esculenta* Crantz) is a versatile crop that plays a vital role in sustaining smallholders' livelihoods, and in increasing farmers' income. This research assessed the cassava value chain in Dak Lak province, Vietnam. It demonstrated the need for enhanced efficiency in the production of cassava thus enhancing the cassava value chain. Value chain analysis was conducted through a questionnaire-based survey of 300 household farmers, in-depth interviews with key informants, and focus group discussions in seven communes in three districts. The aim was to explore how to improve and develop the value chain, increase stakeholders' incomes and particularly, to ensure sustainable household livelihoods. The findings relating to the sharing of value added among the stakeholders showed that farmers create the highest value added but that intermediaries derive the most profit. In addition, relationships exist amongst different stakeholder ranging from input providers to the final users which are overwhelmingly starch and ethanol factories. There is a local linkage between input suppliers and farmers, both spot-market and persistent relationships which exist between farmers and intermediaries. Furthermore, the distribution of both gross and net profits overwhelmingly favors the traders and processors. However, intermediaries play an important role and the farmers would not secure full benefits without their support.
Keywords: *gross profit, household, intermediaries, stakeholder's relationship, value added*

Introduction

Cassava (*Manihot esculenta* Crantz) is a perennial drought-resistant crop cultivated mainly in dry areas, which contributes significantly to the nutrition and livelihood of many farmers (Sewando, 2012). This crop is a versatile plant that is used in the production of a large number of products ranging from traditional food products to livestock feeds as well as having uses in the industrial sector as a raw material for ethanol and starch and its numerous derivatives (Pingmuanglek et al., 2017). The Vietnamese cassava value chain is characterized by numerous intermediaries due to inadequate commercial infrastructure as well as a fragmented pattern of land use for cassava production (Thao et al., 2013). As a result, cassava has a lower value compared to other crops in the same region. Dak Lak province is in the middle of the Central Highlands where four other provinces, Gia Lai,

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Kon Tum, Lam Dong, and Dak Nong are also located (Dak Lak, 2018). In Dak Lak, cassava is grown as a cash crop by rural households and the income earned from cassava plays a vital and increasing role in farmers' livelihoods (Son et al., 2016). The area cassava plantations in Dak Lak province has grown from 30,732 ha in 2014 to 36,300 ha in 2017 (GSO, 2018a), and the yield of cassava during that period fluctuated only slightly from 18.3 to 18.8 tonnes per hectare (GSO, 2018b). Cassava farmers also face various challenges stemming from a lack of access to modern inputs and improved varieties, as well as the problems relating to the local infrastructure and a lack of access to credit (Njukwe et al., 2014). Hence, improvements in the productivity of cassava, the processes used, their products, in the means of distribution in the value chain would lead to an improvement in output (Masamha et al., 2017). This would in turn contribute to an increase in household income which would lead to increased spending in areas such as education and health services as well as other aspects of daily life (Rutherford et al., 2016). Nevertheless, unpredictable cassava prices in developing countries have tended to increase the vulnerability of farming household incomes (Ouma and Jagwe, 2010). In addition, the farmers have limited to connection with the market as well as a lack of comprehensive information. Consequently, building relationships among stakeholders in the cassava value chain and increasing cassava productivity is necessary in this region. The aim of the study is to improve and develop the cassava value chain, increase stakeholders' income and particularly, to find out the appropriate strategies to ensure sustainable household livelihoods.

Review of literature

Cassava is a crucial source of food in Africa because it can be planted in unfertile soil and is also able to resist severe weather (McNulty and Oparinde, 2015; Meridian Institute, 2012), and it is, for instance, a vital staple crop in Liberia (Coulibaly et al., 2014a). Africa is one of the leading cassavas producing regions contributing over 56% of the total global supply (FAO, 2018). It has been proposed that labour, transportation systems and novel technologies, as well as the coordination of agents, are all factors by which the efficiency of the cassava value chain could be improved (Trienekens, 2011). The cassava market is primarily based on the cassava tuber and products made from it. However, cassava leaves also offer an additional source of nutrition although there have been few studies to date of their benefits or of how they are consumed and whether there is a wider market for them (Andersson et al., 2016). The utilization of locally available resources such as cassava, not only creates value-added products but also brings benefits to the local society, with benefits accruing to all stakeholders within the cassava value chain in the region (Mcnulty and Adewale, 2015). Olukunle (2013) found that income and employment for farmers in Nigeria could be created from the cassava value chain as well as other actors in the value chain with over one million jobs being created in rural areas of Nigeria and an increase of approximately US$450 per year in the income of 1.8 million participating farm families. However, although a strong long- standing market has been established in the cassava sector it was found that the farmers gained a smaller percentage of the total profits, compared to traders who received the largest part of the profit. Naziri et al. (2014) studied the cassava value chain and the diversity of post-harvest losses arising in four countries on two continents, Thailand and Vietnam in Southeast Asia, Nigeria and Ghana in sub-Saharan African. They found that post-harvest losses at different stages of the cassava value chain were due to cassava cultivation, processing and consumption methods and the relationships and linkages

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among the value-chain stakeholders. However, they suggested that there was no "one- size-fits-all" solution for dealing with post-harvest losses but those solutions depended on the specific characteristics of different value chains. They estimated that in Ghana, economic losses due to partial spoilage of cassava root were be between 16 and 28% caused by the long distance between the production site and the place of final consumption. Similarly, in Nigeria, economic losses suffered by cassava root due to breakage and deterioration during harvesting and distribution were estimated to be between 10 and 30%. Daniels et al. (2011) were able to provide a complete picture of the value chain in Nigeria including farmers, processors, traders, input suppliers and other stakeholders. In Cambodia, the yield of cassava is from 8 to 10 tonnes per ha with the average area under cassava being 0.2 to 1 ha/household. A study of the cassava value chain was conducted by the IBC (Inclusive Business for promoting sustainable Cassava smallholders) project in Tboung Khmum province and the study particularly examined government policy (SNV Cambodia, 2015) as well as examining gender-related aspects of the value chain. The linkages among stakeholders were analyzed with the aim of improving knowledge as well as proposing appropriate measures for further strengthening the cassava value chain. In recent years, the productivity and yield of cassava in Vietnam has increased and it now ranks third in terms of agricultural production after rice and corn. The area planted to cassava has reached 560,000 ha, with an average yield of 17.63 tonnes/ha and a production of 9.87 million tonnes annually (Hieu, 2016). This is because the area in which cassava is grown has been widened and hybrid varieties have been applied with farmers now cultivating 70% hybrid varieties including KM94 and 30% local varieties (Phuc, 2015). The average yield of cassava in 2016 was approximately 19 tonnes/ha (FAO, 2018), which was more than double that in 2000 (8.4 tonnes/ha). Nguyen et al. (2005) presented a complete picture of the cassava value chain and also the relationship among the stakeholders in the chain. The study also examined the role of the government as well as their operations and the sharing of benefits between stakeholders in the value chain, finding that as (Olukunle, 2013) noted in Nigeria, the farmer received unfairly small share of the benefits while intermediaries obtained most of the profit in the cassava value chain. According to (Naziri et al., 2014) study of postharvest losses there were differences between the northern and southern parts of Vietnam. In the north, production was mostly by small-scale farmers while in the south, it was characterized by both larger scale production and processing units normally consisting of from 20 to 30 hectares. That study found that post-harvest losses mainly occurred on large sized and small-sized plots because the local people lack of knowledge as well as in harvested. The kind of losses experienced were breakage and deterioration of roots as were found in other areas studied. Vietnam is a tropical country and it is unsurprising that cassava has become one of its most vital crops (GSO, 2018c). In Dak Lak the area planted with cassava increased from 32,000 ha to over 36,300 ha between 2011 and 2017, with the average cassava yield fluctuating around 19 tonnes/ha and the total production reaching a peak of 703,300 (*Fig. 1*) tonnes in 2017. The province is, therefore, a region where cassava is one of the most prominent crops. The study reported discusses the major aspects of the cassava value chain in Dak Lak province. Firstly, it systematically identifies and maps the stakeholders participating in the distribution channel and marketing of cassava and details the profit and cost structures. Secondly, it identifies the sharing of benefits between the various actors and analyzes the gross and net profits within the chain. It also examines how and by whom benefits could be gained from enhancing the relationships among the actors and organizations involved. Thirdly, it examines ways in which the cassava value chain could be upgraded by improvements in cassava productivity (Naziri et al., 2014). Finally, it highlights the role of relationships

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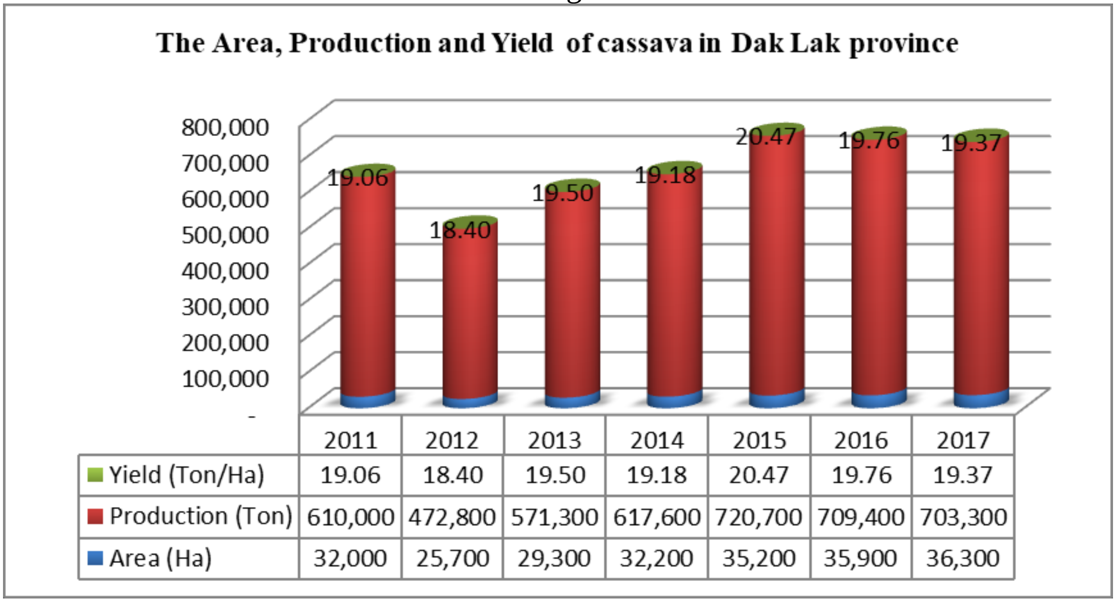
and coordination mechanisms in improving farming-related policies in order to enhance the cassava value chain and to increase the earnings of farmers.



	2011	2012	2013	2014	2015	2016	2017
Yield (Ton/Ha)	19.06	18.40	19.50	19.18	20.47	19.76	19.37
Production (Ton)	610,000	472,800	571,300	617,600	720,700	709,400	703,300
Area (Ha)	32,000	25,700	29,300	32,200	35,200	35,900	36,300

Figure 1. *The area, production and yield of cassava in Dak Lak 2011-2017*

Materials and methods

Study area

Dak Lak province is located in the Central Highlands between longitude 107°28'57" and 108°59'37" east, and between latitude 12°9'45" and 13°25'06" north (*Fig. 2*). It occupies an area of 13,125.37 km^2 (Dak Lak, 2018). Currently, the population is over 1.8 million people with a provincial population density of over 137 people per square kilometre. There are 47 ethnic groups living in the province, the largest; of which, the Kinh account for about 70% of the people, with other ethnic minority communities including Ede, Thai, Tay, M'nong, and Nung people representing the remaining approximately 30%. The climate of the province is separated into two sub-regions with the North West being quite hot and dry in the dry season, while the climate in the south east is cool and pleasant. The Krong Bong district is located in the south east and the centre of the district is 55 km from Buon Ma Thuot city in the north west of the province (Krong Bong, 2018). Krong Bong has an area of 1,257.49 km^2 and a population of 90,126 people. It is affected by the tropical monsoon, and it's climate, which has two distinct seasons, rainy and hot, is not only impacted by the generally high altitude but is also influenced by the Cu Yang Sin mountain, which rises to over 2,400 m. Ea Kar district was established on 13th September 1986 under decision No.108/1986/QĐ-HĐBT of the Vietnamese government. It is 52 km from Buon Ma Thuot city, along the No. 26 National Highway. It is located to the north of Dak Lak province and has a land area of 1,037.47 km^2 and the population density is over 138 inhabitants per square kilometre. Cassava is one of the staple crops produced to meet the material needs of local industry and it is the largest producer among agricultural crops in Dak Lak province (Ea Kar, 2017).

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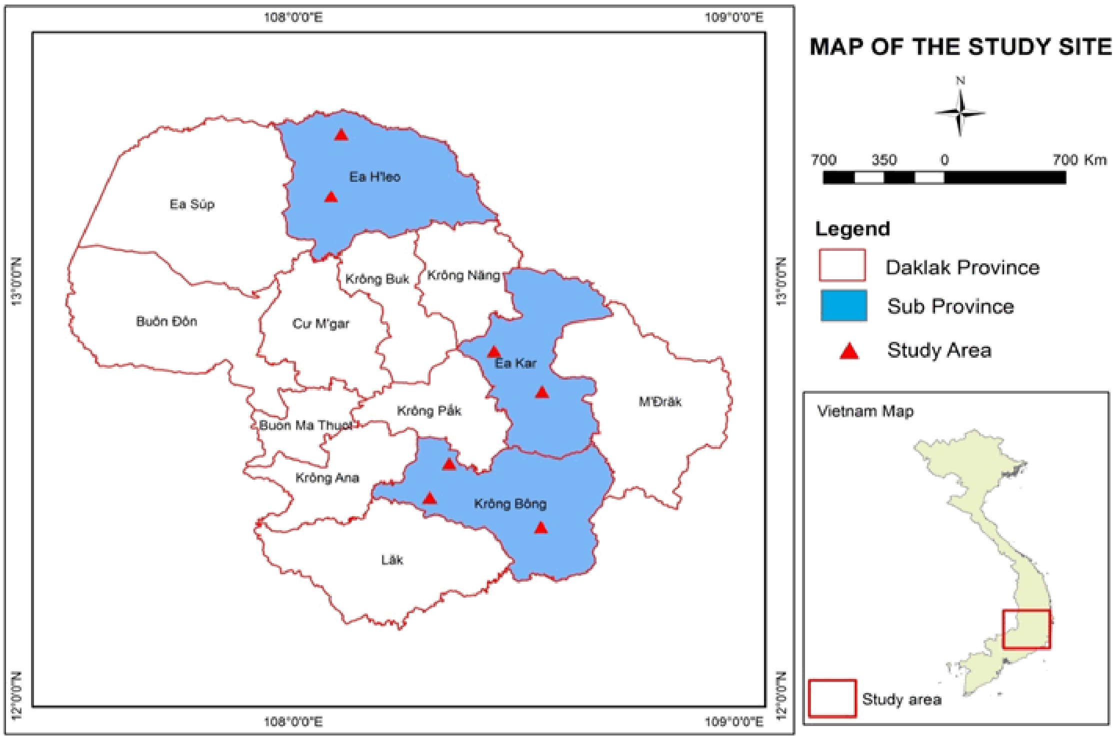

Figure 2. *The location of the study area*

Ea H'Leo district is the northern gateway of Dak Lak province. The district is approximately 80 km from Buon Ma Thuot city and was separated from Krong Buk district on 8th April 1980 under government decision No.110/QĐ-HĐBT. It has an area of 1,335.12 km^2 and a population of 125,123 people. Cassava is a prominent crop in the region (Ea H'leo, 2018). The study reported was conducted by surveys in three districts, Ea Kar, Krong Bong and Ea H'leo which are prominent areas of cassava production in Dak Lak. The major source of household income is from cassava, other cash crops and cattle husbandry. The average area planted to cassava by households is from 0.5 ha to 3.5 ha and the average yield is approximately 20 tonnes/ha. Most of the households growing cassava consist of northern ethnic minorities such as the Ede, Dao, Tay and Nung.

Data collection and analyses

Data collection

The study was conducted using a case study approach, which is one of several methods of conducting social science research (Yin et al., 2009). Data collection was conducted with the aid of structured questionnaires (Fonji et al., 2017). Data relating to household characteristics (Mukete et al., 2018) came from a household survey, interviews with key informants and focus-group discussions with heads of household and actors in the cassava value chain. The cross-sectional design enabled the researchers to address the study objectives and this method was adopted in order to save time during the data collection process (Kothari, 2004; Masamha et al., 2017). This method has been employed in a number of previous studies of the cassava value chain and related issues (Komen et al., 2010; Masamha et al., 2017; Son et al., 2016). The researchers selected seven communes from the three districts, Krong Bong, Ea Kar and Ea H'leo, using the multi-stage sampling method. In each commune, a questionnaire-based survey was conducted to collect relevant data from stakeholders in the cassava value chain based on visits to households. In this study, the interviews covered at least 70% of the households in each commune, where the farmers grow cassava. The questionnaire employed consisted of a mixture of open and closed ended questions. It was written in English then translated into Vietnamese before being used to interview the indigenous people (Echato and Echato, 2018). To complement the survey data, both primary and secondary data were collected from stakeholders who

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directly participate in the value chain, including from input providers, traders and processors (Masamha et al., 2018). Both in-depth interviews using a semi-structured questionnaire and direct observation in the field were also applied in this study (Coulibaly et al., 2014b). The in-depth interviews were conducted with key informants, including directors of local cassava starch factories (Son et al., 2016), input suppliers, cassava growers, collectors, traders, in Cu Kty, Hoa Son and Cu Pui (Krong Bong district), Ea Sar and Ea Pal (Ea Kar district), and Ea Tir and Ea H'leo (Ea H'leo district). These key informants were surveyed using a different questionnaire, which covered core processes (Naziri et al.,2014) traded quantities and prices of inputs as well as the selling price of cassava in the local market compared to other areas. Focus group discussions with cassava farmers were conducted during 2018 in the seven different communes included in the study. Field trips were used to gather primary as well as secondary data. The basic unit for this research was the *household farmer* which was defined as a group of people living together in the same house and taking part in the same daily activities (Mukete et al.,2018). The populations of the study were the cassava growing household farmers in Dak Lak province. Goal-directed sampling, a commonly used sampling approach was adopted, with the sample of participants being selected based on preselected criteria appropriate to a specific research question (Mack et al., 2005). The total sample size was 300 households across the seven communes, and 20 both collectors and traders, and key informants were interviewed as well as the owner of a cassava starch factory in the area.

Statistical analyses

Both qualitative and quantitative methods of analysis were applied in this study to understand the roles and actions of the major's actors (Apata, 2013). The analysis of the data from the questionnaire-based survey involved coding, data entry and analysis using the SPSS Version 20 statistical program (Masamha et al., 2017; Mukete et al., 2018) and Microsoft Excel. Frequencies and means for socio-economic and demographic data were described based on descriptive statistics (Masamha et al., 2017).The qualitative data from the in-depth interviews with stakeholders and focus group discussions were analyzed by specific content analysis in order to identify and examine the most important topics (Masamha et al., 2018). A value chain details the many activities that are required to take a product or service through the different phases of production and delivery to the final consumers, and its disposal after use (Kaplinsky and Morris, 2000). The analysis of the cassava value chain was based on the value-chain analysis method (VCA) (Naziri et al., 2014) and value-chain upgrade solutions were computed in this study using a quantitative method. The VCAs were designed using techniques to determine specific relationships and linkages at different stages among actors who participate in the cassava value chain. Analyzing supply stages, marketing and trading relationships between actors in chain analysis has become a key tool since it can enable an understanding of the whole chain (Meaton et al., 2015). This study identified major aspects of the cassava value chain in Dak Lak province. The production cost, intermediate input (II) value added (VA) and other economic parameters, including gross profit (GPr), net profit (NPr). These were evaluated based on specific actors' perspectives. Revenues were calculated according to the following equation:

$$\text{Revenues} = (Q \times P) + \text{income from by-products}$$

where Q = quantity sold and P = price paid by buyer (Purcell et al., 2008).

Components of total value generated by the value chain such as output value (Y) and product value were also calculated using the Q × P formula, based on analytical frameworks for value chain analysis proposed by international organizations such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, 2007).

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Value added (VA) was calculated to measure the new wealth created by a productive activity and thus the creation of wealth and the contribution of the production process to the growth of the economy. VA was calculated according to the following equation:

$$VA = Y - II$$

where Y = total sales (output) value and II = intermediate input such as fertilizer, pesticide and seedlings.

Profit elements were calculated as follows:

$$GPr = VA - (\text{wages and salaries} + \text{interest charges} + \text{taxes})$$

$$NPr = GPr - \text{depreciation}$$

GPr expresses the economic gain, or loss, to an actor once all current production costs have been met. NPr indicates the economic gain or loss taking into account the predictable costs of actual investment.

Results

Description of stakeholders in the cassava value chain

Input provider

The study found that there were both backward and forward linkages in the cassava value chain. Input providers were backward-linked from the farmer. Thus, input providers were important actors who supply agricultural products to meet farmer demands for items such as seedlings, fertilizer and pesticide as well as being a source of informal credit for agricultural activities. A good relationship between providers and farmers has the potential to improve the value chain by giving farmers access to informal credit without them needing to resort to the banking system or other sources of credit, and can help small-scale household farmers to pool their resources to deal with activities which cannot be done by individual farmers.

Farmer/producer

This is the first actor in the chain and they are mostly located in rural areas where an inequitable infrastructure has developed, with the farmer being at a disadvantage by needing to supply fresh cassava to the buyer (Njukwe et al., 2014). *Table 1* shows the socio-economic characteristics of household farmers across the study sites. The average age of the respondents is one of the major factors that affect the chain with 82.33% being over 35 years of age and 71.67% having received at least secondary formal education. Furthermore, it was notable that males represented almost 90% of the respondents suggesting that cassava production is overwhelmingly dominated by men. In addition, most of the farmers (92.32%) had more than 5 years' experience of cassava cultivation. The fresh cassava produced by farmers is mostly sold locally to large traders or factories as well as to other collectors at both the village market and the farm gate. However, this spot linkage only exists during the harvest period. The seedlings for the cassava varieties cultivated in the region are derived from multiple sources such as producers' own farms or those of neighbours, local seeding centres or from donations by international organizations conducting research about cassava cultivation. The land is generally prepared with a machete, hoe or dibble and the cassava plant cutting is inserted vertically, horizontally or at an angle (El Bassam et al., 2010). Some farmers who own larger areas prepare their land using tractors.

Table 1. *Socio-economic characteristics of respondent at the study sites*

Profile		COMMUNE							Total	%
		CUKTY	**CUPUI**	**EAHLEO**	**EAPAL**	**EASAR**	**EATIR**	**HOASON**		
Gender	Female	3	7	5	5	4	5	3	32	10.67
	Male	41	35	40	38	38	37	39	268	89.33
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**
Age of the respondent	< 25	0	0	0	0	1	0	1	2	0.67
	> 55	8	5	8	7	5	11	13	57	19
	25-35	3	14	7	9	12	1	5	51	17
	35-45	17	19	16	14	13	20	11	110	36.67
	45-55	16	4	14	13	11	10	12	80	26.66
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**
Level of formal education	0	1	6	5	2	3	3	2	22	7.33
	1	10	15	6	9	9	9	5	63	21
	2	26	18	27	28	23	24	29	175	58.33
	3	7	3	7	4	7	6	6	40	13.34
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**
Number of years of cultivation by farmer	< 5	1	10	9	5	5	6	2	38	12.67
	> 15	12	4	15	7	6	8	11	63	21.00
	10-15	18	14	14	21	18	19	18	122	40.67
	5-10	13	14	7	10	13	9	11	77	25.66
Total		**44**	**42**	**45**	**43**	**42**	**42**	**42**	**300**	**100**

Transportation of the harvested cassava from the field may be by truck, motorbike or bicycle, but is mostly accomplished by a tractor-pulled trailer known locally as a *xe cay* (*Fig. 3*). Cassava is widely grown as a mono-crop by small-scale farmers on fragmented land (0.1 to 4.5 hectares) for food purposes and for use in the industrial sector. Nevertheless, larger scale inter-cropping models are also practiced by a small number of household farmers who sell their produce to processing factories. Cassava production is labour intensive (Masamha et al., 2017) so it is one of the best options to improve a farmer's livelihood in a rural area where there is an excess of labour available.

Collectors and traders

Collectors can be grouped based on the quantity of cassava which they buy, namely local, small and large and they include local people as well as those who come from a different region. They play a vital role in the linkage between the cultivation and consumption of fresh and dried-chip cassava. Depending on the buying capacity of the collector, the cassava is collected by different means. Local collectors usually gather directly from both small-scale cassava farmers and from indigents who collect the cassava residue from the harvested fields in or near the village. Larger collectors are able to buy fresh cassava from previous actors in the value chain as well as providing information to those other actors. Most of the product is then sold to starch or ethanol factories with a small volume being delivered to the Tay Ninh province cassava factory.

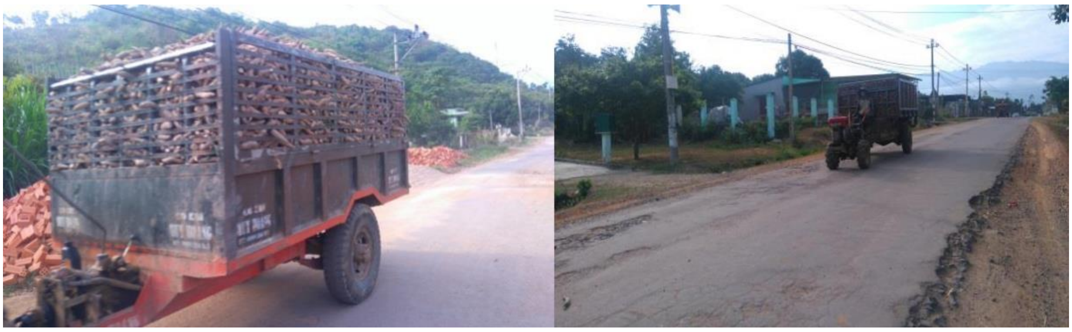

Figure 3. *Transportation in the cassava value chain. (Photo by author)*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

Processors

Most of the cassava produced in Dak Lak is bought by starch or ethanol factories in each district. There are seven starch factories in Dak Lak province with capacities ranging from 150 to 250 tonnes of cassava starch per day, all of which are owned by the Dak Lak Starch Cassava Company. In addition, cassava is used as a raw material by Dai Viet, which was established in 2010, and is one of the biggest ethanol factories in Vietnam with an installed capacity of 54,000 tonnes of ethanol per year. The factories buy cassava in the form of dried chip or fresh root from small collectors as well as from traders and farmers who have large cultivation areas. Thus, most of the cassava tubers are transported to factories by collectors or traders (Son et al., 2016). In addition to its industrial use, fresh cassava is also processed into cassava chips by small-scale chip producers for use both in household animal husbandry and by animal feed companies. There is also a small amount of cassava root used for human consumption including in the form of local traditional cakes known as *Banh Trang* or *Bot Loc*.

Cassava value chain distribution channel in Dak Lak province

Currently, there are a number of distribution channels for cassava derived from cultivation by farmers to the final customer. However, there are only two major channels and these have an effect on the income of the households surveyed in this study. Firstly, the cassava is supplied to starch companies in order to produce starch (Son et al., 2016) for the export market (85%) with the rest (15%) for the domestic market. The second channel is to the ethanol factory which uses cassava as its feedstock to produce ethanol for a diverse range of domestic consumers (*Fig. 4*).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

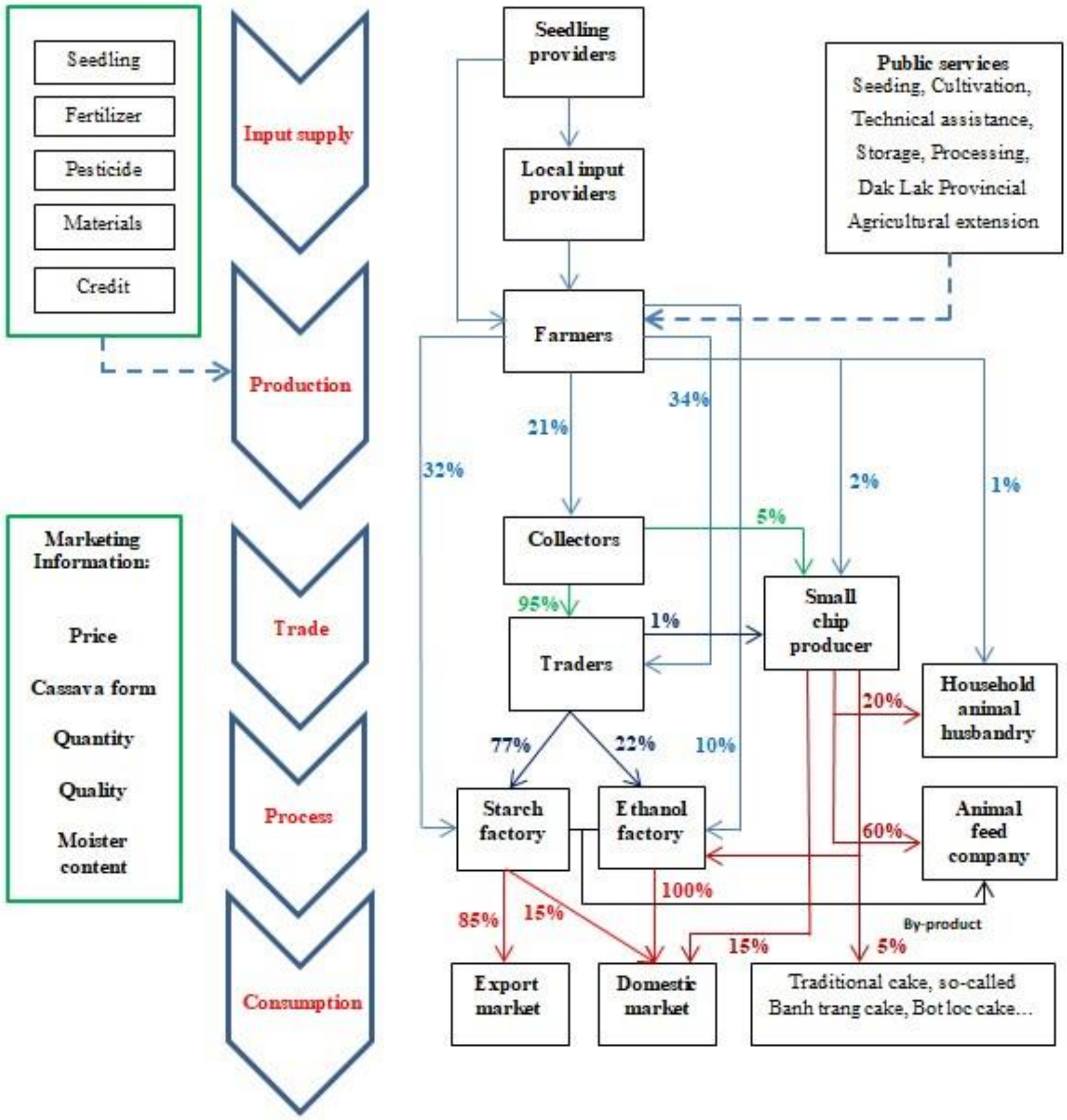

Figure 4. *Dak Lak cassava value chain map*

Based on our findings, it was estimated that 97% of the total cassava production is sold in fresh-root or dry chip form for industrial use with the rest being used to meet household requirements. In the first distribution channel, the fresh cassava tubers are either sold by the farmer to intermediaries (collectors, 21% and traders, 34%) and then sold to a starch factory, or are supplied directly by the farmer to the factory (32% - all percentages based on total production) to produce starch. In the second distribution channel, the farmers sell either directly to the ethanol factory (10% of total production) or through traders (22%) (*Fig. 4*). In addition, small chip producers and household animal husbandry account for 2% and 1% of total production respectively.

Financial analysis of stakeholders in the cassava value chain

Cassava growers

The yield of cassava production in the study site fluctuated in a range of 20 to 25 fresh root tonnes/ha. However, in exceptional cases, the yield was as low as 5.5 tonnes per hectare. This is because some households make an inadequate investment in growing cassava. Moreover, the low fertility of the land and the use of poor-quality varieties also contribute to low productivity. The average yield was approximately 20 tonnes of cassava tubers per hectare. The conversion rate was 50%, and the farmer can thus obtain around 10

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tonnes of dried chip cassava from the fresh quantity harvested. The producers had various options to sell their products to buyers. Depending on individual farmer's targets and market price information, the cassava growers sold 21%, 34%, 32% and 10% of their produce respectively to collectors, traders, starch factories and the ethanol factory. In terms of the price obtained for cassava, there is great variability depending on the price of exported starch (Son et al., 2016). In this study, the total farmer's income was VND47.895 million or US$2,048 per hectare (US$1 = VND23,390). The price of cassava was approximately VND2 million per tonne and the average yield was around 23.64 tonnes ha^{-1}. In the value chain analysis of cassava, the cost of intermediate inputs represented 8.52% of the total income of the producers, of which the highest percentage (over 50%) related to seedlings (VND4.081 million) (*Table 2*).

Table 2. *Major indicator analysis of fresh cassava value chain per hectare*

Item	Value (VND1,000)	Value USD	Proportion %
Output	**47,895**	**2,048**	**100.00**
Intermediate input	**4,081**	**174**	**8.52**
Seedlings	2,257	96	4.71
Fertilizer	1,000	43	2.09
Pesticide	239	10	0.50
Transporting	556	24	1.16
Fuel	29	1	0.06
Value added	**43,814**	**1,873**	**91.48**
Land preparation	3,338	143	6.97
Planting labour	3,570	153	7.45
Fertilizer labour	214	9	0.45
Weeding labour	1,702	73	3.55
Pesticide labour	133	6	0.28
Harvesting labour	6,019	257	12.57
Transport labour	97	4	0.20
Interest	122	5	0.25
Gross profit (GPr = NPr)	**28,618**	**1,224**	**59.75**

Exchange rate: 1 US$ = 23,390 Vietnamese dong (VND) (HSBC, 2018)

The value added was calculated to be VND43.814 million (US$1,873) which accounted for 91.48% of the total production and this confirms that cassava is a favourable crop, which contributes to household farmer income with high economic efficiency, producing a GPr of VND28.618 million per hectare with low intermediate input costs. In the case of chip cassava, the value added and the NPr accounted for 92.33% of the total production and 55.64% per hectare, respectively (*Fig. 5*). Although the total cost incurred also involved incurring an additional VND4.320 million (US$67) per hectare for peeling and drying the fresh cassava. However, both the income and profit received by the producers was higher for chip cassava than for fresh cassava since chips attract a higher price than fresh cassava, selling for VND4,500 per kg compared to VND2,026 per kg respectively. Furthermore, processing cassava into dried chips at the farm level provides employment for the indigenous people and thus helps to deal with rural employment, which is a growing problem in the region, and also helps to diversify the farmers' income. Finally, the farmer is able to negotiate the selling price with other actors in the value chain because they can store their product in dried chip form for a longer period in order to wait for the optimal market price (Viet et al., 2013).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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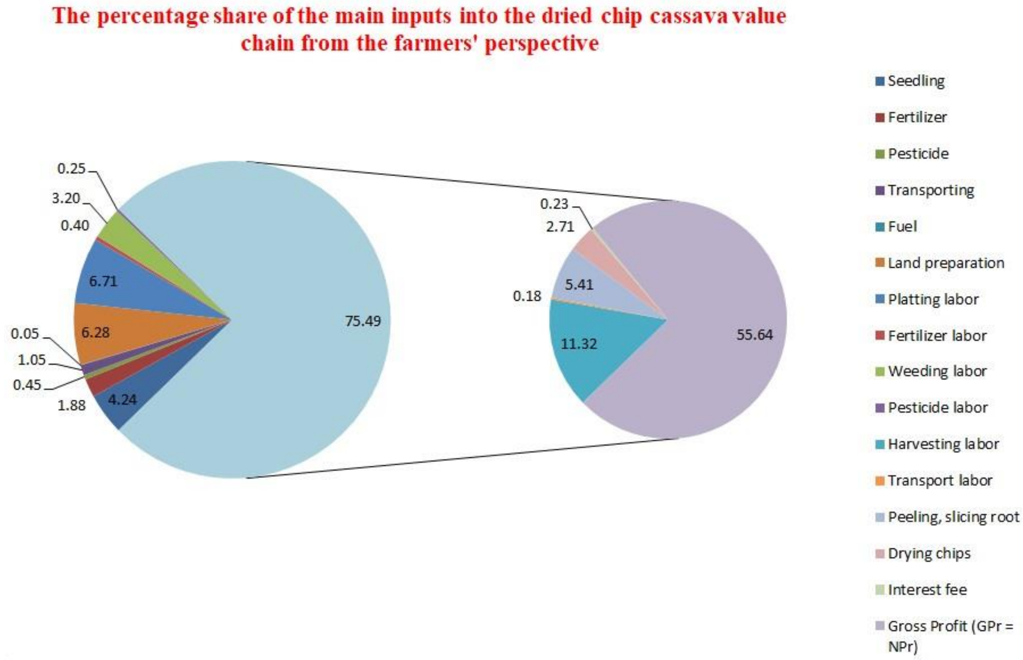

Figure 5. *The percentage share of the main inputs into the dried chip cassava value chain from the farmers' perspective*

The study found that based on different market price and productivity scenarios, the producer can always gain profit from their production. This is an advantageous situation and one that is attractive to household farmers who participate in the cassava value chain. In the worst-case scenario with both a low selling price and productivity, the farmers GPr was VND215 per kg, while the producer's GPr was VND1,729 per kg (*Fig. 6*) for the best scenario with a lucrative market and high productivity coinciding.

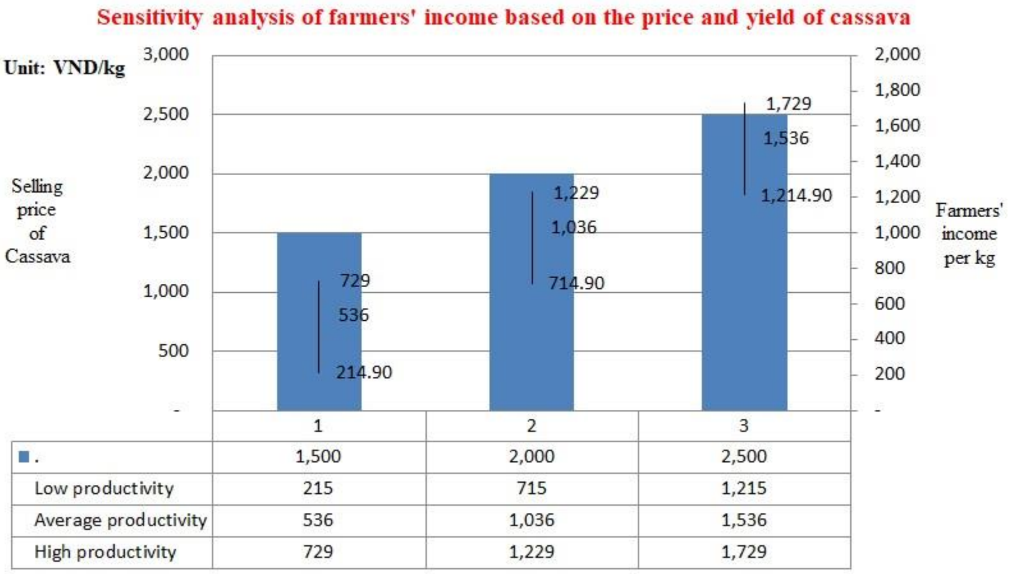

Figure 6. *The sensitivity analysis of farmers' income based on the price and yield of cassava*

The collector perspective

The analysis of the financial situation from the collectors perspective shown in, *Table 3* indicates that, the amount expended by collectors for fresh cassava was approximately VND2,338/kg of which, the cost of fresh cassava accounted for the highest proportion of approximately 85%, followed by transport costs accounting for 9.42%. At this stage, the value added was created less than farmer with 6.15% compared to mostly over 90% in dried chip cassavas. However, a large quantity of produce was purchased by the collectors and the GPr and NPr of VND62,650 and VND61,530 per ton respectively were both higher than those earned by the farmer. According to Viet et al. (2013), it is normal for an amount to be deducted from the price paid by collectors to cover impurities in the cassava supplied by the farmer. This ranges from 7 to 10% of the purchase price depending on the time after harvesting as well as the moisture content and this finding was supported by our study. The quality of cassava tubers deteriorates depending on the harvesting season, the length of cultivation and the time to storage. Moreover, the collector is usually faced with having to provide finance due to delays in payment by the starch factories and this will also affect the purchase price paid to the farmer. The business pattern is also similar for the sale of dried chips by farmers to traders, and starch and ethanol factories. The GPr and NPr are actually little different from the fresh root model at VND62,550 (US$2.67) and VND57,550 (US$2.46) per tonne, respectively. However, in the case of dried chips, the collectors have more opportunity to locate the best market for their produce. The quality of cassava tubers depends on the harvesting time and length of storage. Generally, the percentage of starch reduces proportionally based on the length of storage by as much as 10% after a matter of days. In addition, the processing factories often postpone payments to collectors for several weeks because the factories face short-term financial constraints. The collectors do not have any other options although their business activities are affected by this problem. One of the reasons is that the purchasing system in this area has not yet developed and the local market for cassava is excessively dependent on demand from the processing factories (*Fig. 7*).

Table 3. Major indicator analysis of fresh cassava value chain per ton from the collectors' Perspective

Item	Value (VND1,000)	Value USD	Proportion %
Output	**2,400.00**	**102.61**	**100.00**
Intermediate input	**2,252.00**	**96.28**	**93.83**
Cassava root	2,025.00	86.58	84.38
Transportation	226.00	9.66	9.42
Communication	1.00	0.04	0.04
Value added	**148.00**	**6.33**	**6.17**
Labour wages	47.50	2.03	1.98
Interest	12.85	0.55	0.54
Handling	25.00	1.07	1.04
Gross profit (GPr)	**62.65**	**2.68**	**2.61**
Depreciation	1.12	0.05	0.05
Net profit (NPr)	**61.53**	**2.63**	**2.56**

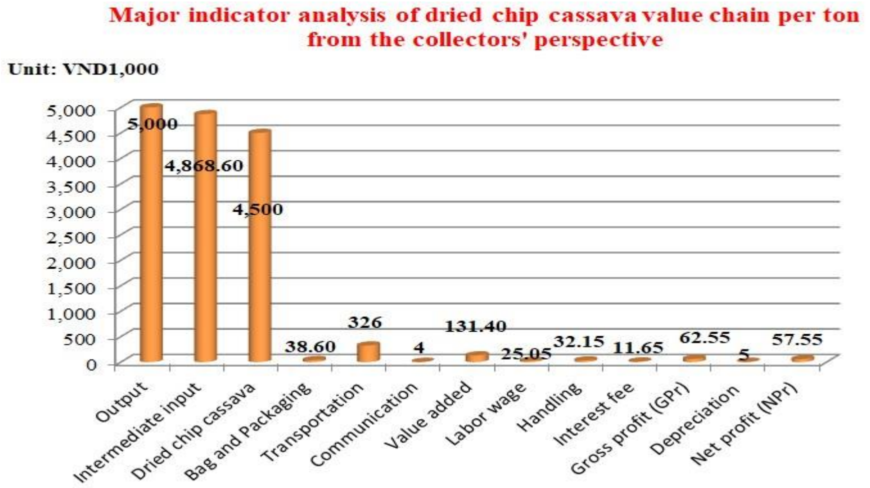

Figure 7. *The major indicators analysis of dried chip cassava per ton from the collectors' perspective*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

The trader perspective

The traders' business pattern is similar to that of collectors, with traders buying some fresh cassava as well as dried chip from producers in February and March but also obtaining most (95%) of their cassava from collectors in both root and chip forms (*Fig. 4*). The quantity purchased ranges between 20 and 25 tonnes per day with this figure reaching a peak of 40 to 50 tonnes per day during the harvesting season. It is notable that the purchase price paid by traders is very similar to that paid by collectors who buy cassava directly from farmers. Furthermore, traders usually negotiate with farmers in order to fix the price of cassava before it is harvested. However, changes in the market can affect this practice and, for instance, if the market price is greater than the price fixed before harvesting, then the purchase of the cassava will be concluded based on the market price. In contrast, if the market price is lower, the sale will be concluded based on the price fixed which represents a fair trading relationship between these actors in the cassava value chain. The average selling price of fresh and dried chip cassava were VND2.85 million (US$121.85) and VND5.5 million (US$235.14) per ton, respectively, and the gross profit gained was VND75,930 (US$3.25) (*Table 4*) per ton for cassava root and VND75,040 (US$3.21) per ton for dried chip cassava (*Fig. 8*). Nevertheless, traders play a vital role through their relationship with the farmer because they usually facilitate the supply of intermediate inputs, such as fertilizer, pesticide and herbicide, as well as financing the living costs of household farmers. The farmers can borrow money from the traders in order to deal with day-to-day demands which they have to face, including the cost of food, education and health care.

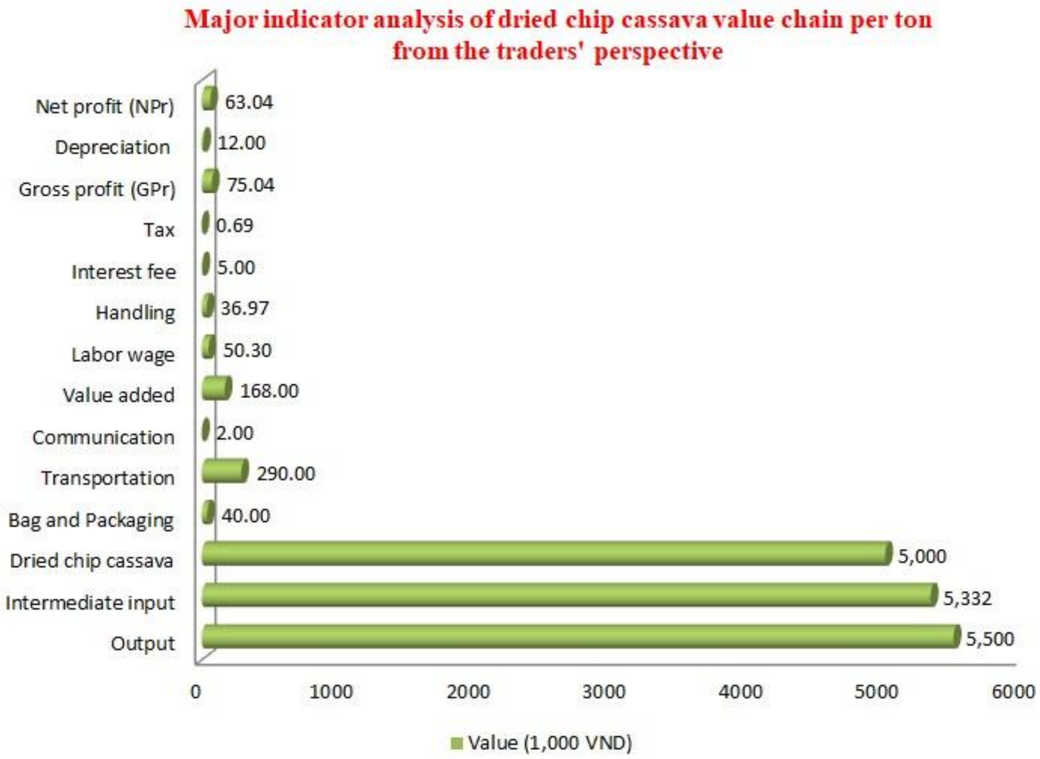

Figure 8. *The major indicators analysis of dried chip cassava per ton from the trader' perspective*

The starch factory perspective

The feedstock used by starch factories is mostly derived from traders (77%) as well as directly from producers (32% their production). The intermediate cost to produce 1 ton of cassava starch is approximately VND11.2 million (US$479.5) (*Fig. 9*). The conversion rate for fresh cassava is approximately 3.5 tonnes of cassava to produce 1 ton of cassava starch (Viet et al., 2013) and the factory is also left with a pulp residue for which there is a

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market after processing. Hence, the gross profit derived by the factory was found to be approximately VND1.14 million per ton (US$48.57) including the revenue from both cassava starch and pulp residue. However, there is great variability in the price of cassava starch depending on the export price of starch (Son et al., 2016)**.** Thus, the total cost and profit have been unstable over the years. This is a difficulty that most cassava starch factories are currently facing.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

***Table 4.** Major indicator analysis of fresh cassava value chain per ton from the traders' perspective*

Item	Value (VND1,000)	Value USD	Proportion %
Output	**2,850.00**	**121.85**	**100.00**
Intermediate input	**2,676.50**	**114.43**	**93.91**
Cassava root	2,400.00	102.61	84.21
Transportation	275.00	11.76	9.65
Communication	1.50	0.06	0.05
Value added	**173.50**	**7.42**	**6.09**
Labour wages	69.00	2.95	2.42
Interest	0.65	0.03	0.02
Tax	0.42	0.02	0.01
Handling	27.50	1.18	0.96
Gross profit (GPr)	**75.93**	**3.25**	**2.66**
Depreciation	10.00	0.43	0.35
Net profit (NPr)	**65.93**	**2.82**	**2.31**

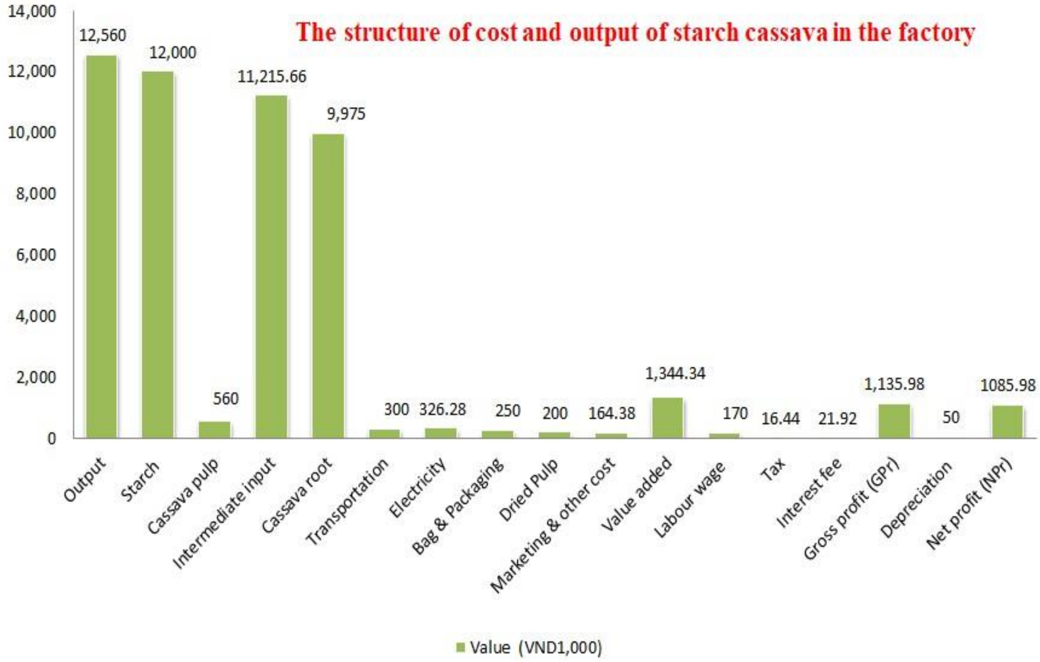

***Figure 9.** The structure of cost and output of starch cassava per ton from starch factory perspective*

The ethanol factory perspective

The production capacity of the ethanol factory in this area is approximately 54,000 tonnes per year or around 4,500 tonnes per month based on market demand. The ethanol produced is used for numerous purposes in industries including food, cosmetics, and pharmaceuticals as well as others. There is a large quantity of cassava available to the factory and there is the potential to export its product to the Chinese market as well as to other overseas markets. However, currently, the total production of the ethanol factory is used domestically since its current processing costs are not competitive with that of similar products from other countries, particularly with those in Brazil which dominates world ethanol processing. *Table 5* shows that the production cost in the Dak Lak ethanol factory is around VND15.74 million (approximately US$673) per ton while the price of ethanol processed in Brazil is currently US$600 per ton at Ho Chi Minh City port in Vietnam. Therefore while the factory currently earns a GPr of nearly US$29 per ton based on current production costs, according to Mr. Dao Trong Tuan (personal communication), who is the Chairman of the board of directors of the Dak Lak ethanol factory, it will be very difficult

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DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

to be competitive with prices in the global market in the near future without government support.

***Table 5**. Financial analysis of the operation of the Dak Lak ethanol factory per ton*

Item	Value (VND1,000)	Value (USD)	Proportion %
Output	**16,565.26**	**708.22**	**100.00**
Ethanol	15,900.00	679.78	95.98
Cassava pulp	560.00	23.94	3.38
CO2	105.26	4.50	0.64
Intermediate input	**15,200.00**	**649.85**	**91.76**
Cassava root	12,540.00	536.13	75.70
Transportation	500.00	21.38	3.02
Electricity	480.00	20.52	2.90
Energy	1,200.00	51.30	7.24
Dried pulp	180.00	7.70	1.09
Marketing and other cost	300.00	12.83	1.81
Value added	**1,365.26**	**58.37**	**8.24**
Labour wages	420.00	17.96	2.54
Interest	277.78	11.88	1.68
Tax	22.22	0.95	0.13
Gross profit (GPr)	**667.48**	**28.54**	**4.03**
Depreciation	324.69	13.88	1.96
Net profit (NPr)	**342.79**	**14.66**	**2.07**

The ethanol products produced in the ethanol factory are therefore at a disadvantage compared to ethanol at the global market scale, largely because of the small scale farming by which the raw material is produced, a lack of advance cultivation technology, and the provision of short-term subsidies from the Vietnamese government. *Table 5* indicates how the value added is shared among the stakeholders comprising the farmers, the ethanol and starch factories, and the collectors and traders who obtain approximately 38%, 28%, 27%, 4% and 3% respectively. From these figures, it can be seen that the greatest value-added is created by the farmers which is fair based on their contribution to the value chain among the stakeholders. Shifting to cassava cultivation from other crops is considered as an appropriate strategy in poverty alleviation for household farmers in rural areas. In the cultivation phase, it is the farmers who as the producers commit almost all the resources required to produce fresh and dried chip cassava. In addition, the farmers are also the stakeholders who gain the highest percentage of the NPr (48%). However, the absolute value of both their GPr and NPr was the lowest among the stakeholders in the chain due to the volume of cassava that is provided by each farmer. In contrast, while the value added by collectors and traders accounted for less than 5% of the cassava value chain their absolute profit was higher than that of the farmers since they are undertaking cassava transactions representing from 30 to 40 tonnes per day while most household farmers harvest less than 30 tonnes per hectare per year (*Figs. 10* and *11*).

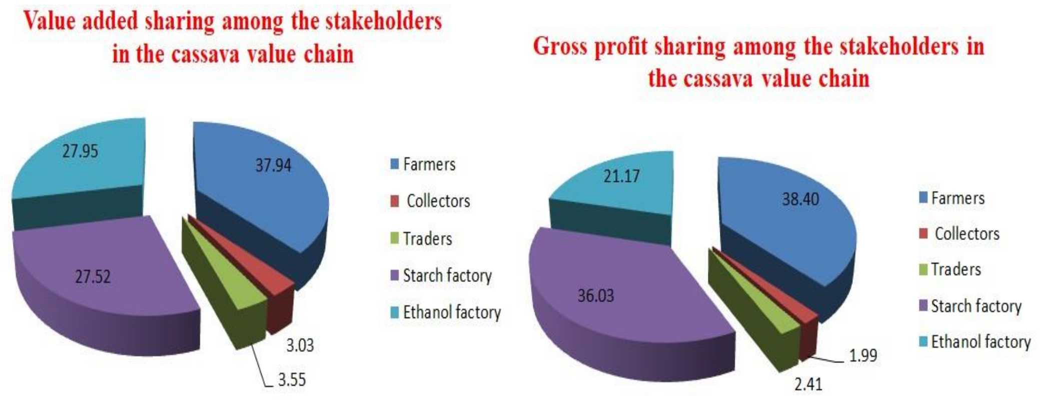

***Figure 10.** Value added and gross profit sharing among the stakeholder in cassava value chain*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

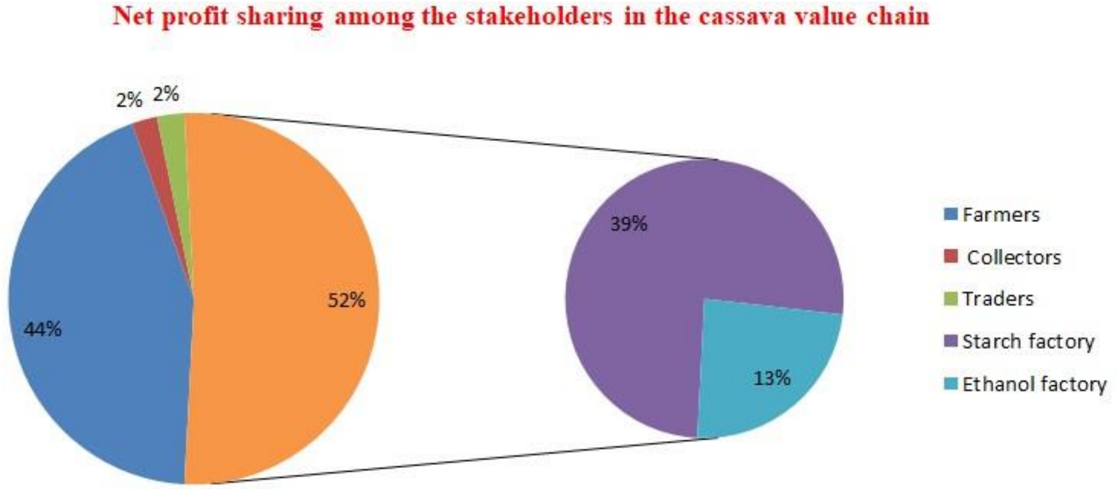

Figure 11. *The net profit sharing among stakeholder in cassava value chain*

With regard to the starch and ethanol processing factories, it is undeniable that they obtain the greatest absolute benefit from the cassava value chain since they are responsible for processing the largest volumes of cassava into products which they can sell. Moreover, they must meet the market demands of consumers and the value of the cassava will be increased through processing it as a raw material into starch, ethanol and other products. Hence, in order to increase the value of cassava, appropriate strategies involving linkages and collaboration among these actors is vital.

The relationships and linkages among cassava value chain stakeholders

Relationships exist amongst actors at different process stages in the cassava value chain by which input providers are connected with producers (farmers), farmers are connected with intermediaries and finally by which farmers and processors in the guise of both starch and ethanol factories are linked. Further, each of the actors has indirect relationships at each stage of the chain. The findings, of this study, identify a local relationship between input suppliers and farmers, which manifests its importance in the cassava planting season. However, this relationship does not solidify linkages since farmers generally prefer to change the location of their purchases every year. In addition, poor farmers cannot afford to buy input materials such as fertilizer and pesticide which might improve cassava productivity. Linkages between farmers and intermediaries are manifested as both spot-market and persistent relationships. On the one hand, the farmers can sell their products to any collector or trader who will pay the highest price. However, there is a potential risk in cassava value chain transactions that the selling price may be unstable over time. Buyers will always try to find any reason to reduce the purchasing price and sellers are under pressure to sell since the quality of cassava deteriorates rapidly and fresh cassava can only be preserved for two days after harvesting (El Bassam et al., 2010). This is a disadvantage for farmers who live far from the market particularly if the local infrastructure in their area is poor. On the other hand, the intermediaries can assist farmers not only by providing necessary input materials but also by extending informal credit to them. This, therefore, creates a persistent linkage; and generally, the buyer and seller meet, come to an agreement which is confirmed in a contract. In this relationship, therefore, there is a higher level of trust and some level of interdependence. Hence, the farmer and collector or trader are responsible for agreeing both the quantity of cassava and the price to be paid which is formalized by a contract agreed for each succeeding season. This linkage, therefore, tends to ensure a sufficient volume of cassava for forward actors in the value chain (i.e. end users). Moreover, the farmers will be assured of a sufficient volume of production from which

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DOI: http://dx.doi.org/10.15666/aeer/1702_51935217

they can support their occupation and that of their families. Thus, both actors gain benefit from persistent relationships.

Discussion

Our results concurred with the finding of Naziri and Bennett (2014) in both African and Southeast Asia that Cassava is mostly cultivated as a mono-crop by household farmers in small plots but was somewhat at variance with, the findings of Njukwe et al., 2014 that in Cameroon, cassava is cultivated by over 90% of the farming population, mostly as an intercrop in small plots of between 0.4 to 12 hectares. Further, the study reported herein revealed that the education status of the respondents was different from those studied by Njukwe et al. who found that 21% of the farmers had only primary education while the present study found that the majority of the participants (76.67%) had received at least secondary school education which may represent an advantage when cultivating cassava. Further, some previous studies found that not only were cassava tubers consumed but the leaves of the cassava planted were also used as a foodstuff constituting a part in the daily food intake of some African people (Andersson et al., 2016). However, in our study, the cassava leaves were left in the field after harvesting. Son et al. (2016) found that the percentage of cassava converted to dried chip in Quang Binh province was 50% of the fresh cassava harvested. However, this rate depended on various factors such as the variety grown as well as the period that the cassava was kept post-harvest. This finding is in accord with the findings of our research. Additionally, our findings suggest that in order to improve the value chain the first priority is to ensure that the products meet the needs of the market, which was also suggested by (Thanh et al., 2017) as a means of enhancing the value chain for exported agricultural products. These researchers also suggested that particular solutions need to be adopted to overcome individual problems to ensure that exported agricultural products meet the needs of the export market in order to create a sustainable value chain. The present study also reveals that low productivity and competitiveness in the cassava value chain may be due to various factors such as poor infrastructure, lack of farmer skills and limited capital resources, as well as a lack of synchronized mechanisms amongst competent authorities (Fonji et al., 2017). Our results agreed with those of Fonji et al. (2017) relating to cassava cultivation in the central region of Cameroon. Moreover, the results of the present study were in agreement with those reported by Leo (2015) with regard to the effect of growing cassava on the income of small-scale farmers in Abia State, Nigeria which suggested that in order to increases the income level of farmers, they should apply advanced technologies and enhance the capacity of buildings (Leo, 2015). Further, as some previous studies have noted, in order to be successful, all partnerships should be formalized by appropriate contracts which clearly state the roles and responsibilities of the actors across the value chain (Njukwe et al., 2014). Our findings also determined that improving the cassava value chain can be achieved by cooperation among the stakeholders. Other scholars have emphasized farmers' participation in profitable stages of the cassava value chain by strengthening coordination, growing new cassava varieties and applying novel processing technologies (Sewando, 2012). Most previous studies have observed that the most common means by which farmers transport cassava involves the farmer carrying the cassava from the field to their home, and Njukwe et al. (2014) found that transportation from the growing area in Cameroon was dominated by head or back- loads, and that 32.5% of the cassava grown was consumed in fresh form due to inadequate infrastructure. This agrees with research by Tshiunza et al. (1997) in six major African cassava producing countries where transportation from field to home was accomplished by various means but most (70%) was by head-load or back-load and that women accounted for over 80% of that form of transport. In our study, it was found that currently, more than 90% of the cassava is sold as cassava root and that most of the farmers bring their products home as well as supply it to their market using the local vehicle known as the xe cay (*Fig. 3*). In addition, our study also found that almost all (97%) of the cassava tubers are consumed as raw material for starch and ethanol production, either based on direct sales or sales facilitated through collectors or traders, with only 3% processed for other purposes. This is important and quite different from some previous studies, for instance that of Nweke (1994) who found that an average of 40% of the cassava in South and Centre, West and North West and East regions in Cameroon as provided for sale in the market while Tshiunza et al. (1997) discovered that 85% of the farm production in six major African cassava producing countries was consumed in households while 10% was sold directly in markets with only 5% being used for processing purposes (Njukwe et al., 2014).

Conclusion

This research used structured and semi-structured interviews with numerous cassava value chain actors, focus group discussions with farmers (Andersson et al., 2016), and in-depth interviews with key informants to construct a comprehensive overview of the cassava value chain which was also supplemented by direct participant observations in Krong Bong, Ea Kar and Ea H'leo districts in Dak Lak province. Our findings revealed that activities in the cassava value chain are dominated by males and that it is the farmers who create the highest value added while the role of intermediaries is the most profitable. It was also found that the household farmers from among the ethnic minority groups suffered most physical losses at the stage of selling their products because they tend to keep the fresh cassava for some days after harvesting it and then sell it to a collector or trader. Additionally, most of the farmers lack sufficient capital for investment in technologies etc. to improve cassava productivity and they, therefore, obtain less profit than other groups who trade in or process cassava. In the light of the foregoing result, improving the profitability of household farmers is a major challenge that will require critical and specialized budgetary and political support at national and global levels (Sattar et al., 2017). In particular, the household farmers in the Dak Lak cassava production areas have limited resources although the household farmers' incomes are improving because of the currently increasing cassava price. The study found that intermediaries play an important role in the relationship between the cultivation and consumption step and they not only provide input material but also supply informal credit that can help farmers conduct good cassava cultivation. However, these intermediaries purchase cassava at low prices from household farmers depending on the contracts they sign with them. Depending on their financial capacity, cassava is collected either as fresh cassava or as dried chips. In either case, however, most of the profits from the cassava value chain accrue to the intermediaries. With regard to the processors, the factories who were the end users of 97% of the cassava currently grown specialize in the production of starch and ethanol. It would be beneficial for them to diversify into other cassava products to meet different market demands in the future. Our findings suggest that these actors currently receive less profit than before because of increasing input-material costs. It is undeniable that the demand from factories makes the cassava market more competitive and it is also leading to the price of the fresh cassava produced by Vietnamese farmers becoming dependent on the Chinese market, which is a very volatile and risky market. Therefore, processing factories play a vital role in the cassava value chain and their demand has led to the enhancement of the value of cassava root, which in turn has mitigated hazards inherent in the traditional market by diversifying the uses to which cassava is put to include products such as starch, flour and ethanol. On the other hand, this study revealed that although there are various distribution channels, there are, in fact, two major channels which dominate the cassava value chain. Therefore, addressing the emerging opportunities and challenges in the cassava market requires cross-sectorial participation from the full range of stakeholders in the value chain notably the government through the Ministry of Agriculture and rural development which can supply credit in the form of soft loans for fertilizer or pesticide. This would probably represent a cheaper form of capital financing that is currently available through intermediaries. Once interdisciplinary cooperation is committed from all sides, this will improve the operation of the cassava value chain in this region.

Finally, this finding has just focused on value added and financial cost as gross and net profit of stakeholders in the cassava value chain. It has not yet referred to the role of gender in the household such as females' decision to participate and level of participation cassava production as well as market participants. In addition, this study has not clearly analysed the role of government policy in reducing the risk of cassava market (such as price subsidy, rural credit policy). Thus, it is highly recommended for further researches regarding inequality gender and, or improving females' role in the cassava value chain as well as policy reform in order to give a boost to cassava value chain for both farmer and the rest of stakeholders.

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APPENDIX

Figure A1. *Group discussion with farmers. (Photo by author)*

Figure A2. *Cassava field trip. (Photo by author)*

Figure A3. *In-depth interview with the director of the factory. (Photo by author)*

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APPENDICES

1. uestionnaire (For household)

HOUSEHOLD QUESTIONNAIRE

TITLE OF THESIS: VALUE CHAIN ANALYSIS AND THE POTENTIAL OF CASSAVA-BASED BIOETHANOL IN DAK LAK PROVINCE, VIETNAM

Interview date:

Commune:............................District: ....Province: Dak Lak

I. GENERAL INFORMATION ABOUT FAMILY

Name of Household Head:...

Name of interviewer: ....

1. Name:...Age: ....

2. Sex: ....Male:................. Female:

....Age

3. Education level: ....Relationship with the household head:......................

4. The number of members of the family: .... Male:……Female:...........

5. Phone number: ....

6. Type of house: Large-scale Average scale Small scale

II. PRODUCTIVE ACTIVITIES

1. Please inform which production activities following you are doing?

   Cultivation ☐
   Forestry ☐
   Aquaculture ☐
   Non- Agriculture ☐
   Other ☐

2. When did you start to cultivate Cassava?
3. Land using situation in 2017

Item	Surface (ha)	Crop season/year	Rent	Ownership	Other
1. Residential land					
2. Agricultural land					
2.1. Coffee					
2.2. Cassava					
2.3. Other crops cultivation					
2.4. Other purpose					

4. Crop production in 2017

Categories	Area (ha)	Output (tonnes)	Yield (tonnes/ha)	Sold output (tonnes)	Price VND	Amount VND
Coffee						
Cassava						
Cassava						
Other fruit trees						

5. Name of cassava varieties is currently cultivated: ....
6. The origin of cassava varieties:

   From household ☐
   From other farmers ☐

State seed company ☐
Subsidies ☐

7. Number of crops per year
1 ☐
2 ☐

8. The average yield of Cassava:
Main season: ☐
Out of season: ☐

9. Cost of input for cassava (calculated for hectare)

Item	Amount (1.000VND) Value			
	Family resource	Buy/Rent	Immediate payment	Late payment
Seedling				
Fertilizer				
Pesticide				
Labor				
Land using				
Interest rate				
Other cost				
Total				

10. Where does the farmer sell their cassava product?

Unit: VND/kg

Actors	Cassava quantity	Selling price	Selling place
Collectors/ commune Other districts			
Collector out of commune			
Wholesalers			
Retailers			
Consumers			
Other actors			
Total			

11. How do you know the buyer?
Recommendation of relatives ☐
Recommendation of commune ☐
Previous relationship with buyers ☐
Contracting with company ☐

11. Do you have contract farming? ☐
Yes ☐
No ☐

If yes, explain:..
When and why do you sign the contract? ....

12. Why do you choose this buyer?
High price ☐
Credit condition ☐
Contract farming ☐
Convenience ☐
Other ☐

13. Experience of farmer within cultivation Cassava

From themselves ☐
From paper or book ☐
From training ☐
From neighbour farmer ☐
Other ☐

14. Difficulty of farmer in the value chain
Capital ☐
Seedling ☐
Techniques ☐
Market ☐
Selling Price ☐

15. Advantages and Disadvantage in Cassava cultivation
Easy to cultivate ☐
Land appropriate cultivate ☐
High profit ☐
Climate and suitable weather ☐
Easy to consume ☐

16. History credit of household...
Have you ever borrowed for production investment?...
If no, why not?
Do you need to borrow credit?...
Yes: ☐
No: ☐
If yes, explain:...

Categories	**Source**	**Amount (VND)**	**Time for loans (year)**	**Interest rate (%/year)**	**Purpose**	**Source to paid**	**Payment deadline**
Cash							
Fertilizers							
Pesticide							
Food							
Other							
Equipment for production (machine Equipment for life: (Television, motorbike, Building House	1: Poverty reduction program of Government 2: Social policy Bank 3: Agri Bank 4: Association's farmer Women union Lender Relative Others					Selling products Selling land Borrow from another Bank Relatives Other	

2. Questionnaire (For Collector)

COLLECTOR QUESTIONNAIRE

TITLE OF THESIS: TITLE OF THESIS: VALUE CHAIN ANALYSIS AND THE POTENTIAL OF CASSAVA-BASED BIOETHANOL IN DAK LAK PROVINCE, VIETNAM

Interview date: ....

Commune:............................District: ....Province: Dak Lak

I. GENERAL INFORMATION ABOUT FAMILY

Name of Household Head:...

Name of interviewer: ....

1. Name:...Age: ....

2. Sex: .... Male: ....Female: ....Age..................

3. Education level: ....Relationship with the household head: ....

4. The number of members of the family: ....Male: ....Female: ....

5. Phone number: ....

6. Main job:...Other (if yes)

II. BUSINESS ACTIVITIES

1. How many times do you collect per crop or year? ....

2. How many tonnes of cassava did you buy per crop or year?................................

3. Price and quantity of Cassava

Date	**Time**	**Quantity**	**Purchasing price (VND/kg)**	**Amount (VND)**	**Buying place**

4. Total cost item of collectors (VND/kg)

Items	**Unit**	**Price VND**	**Quantity (Kg)**	**Amount (VND)**
Purchasing price				
Transportation				
Store				
Package				
Depreciation				
Rent labor				
Taxes and interest				
Other cost				
Total cost				

5. The average selling price of cassava?................................ VND/kg

6. Difference between purchasing price and selling price ....

7. How to find out the sellers/buyer?..

8. Do you have any support for farmer/wholesalers or trader?.................................

9. Have you ever received any support from wholesalers or trader/farmer?

Capital ☐

Techniques ☐

Inputs ☐

No ☐

10. Do you have any contracts farming with other actors in the value chain?

Yes, why?..

....

....

No, why?...

....

11. Do you have distinguished consumer when you buy or sell?
....
....
12. What are the requirements of the purchasers?
    - Good quality of cassava ☐
    - Enough quantity ☐
    - Always-available ☐
    - Appropriate price ☐
    - Other reason ☐

3. Questionnaire (For Wholesaler/Trader)

WHOLESALER/TRADER QUESTIONNAIRE

TITLE OF THESIS: TITLE OF THESIS: VALUE CHAIN ANALYSIS AND THE POTENTIAL OF CASSAVA-BASED BIOETHANOL IN DAK LAK PROVINCE, VIETNAM

Interview date: ....

Commune:............................District: ....Province: Dak Lak

I. GENERAL INFORMATION ABOUT FAMILY

Name of Household Head:..

Name of interviewer: ....

1. Name:..Age: ....

2. Sex: ....Male:........................ Female:....................... Age ....

3. Education level: ....Relationship with the household head:...............

4. The number of members of the family: ....Male: ....Female:..........

5. Phone number: ....

6. Main job:...Other (if yes)

II. BUSINESS ACTIVITIES

1. The total amount of Cassava that is bought per year?

Date	**Time**	**Quantity (kg)**	**Purchasing price (VND/kg)**	**Amount (VND)**	**Buying place**

2. Average revenue per crop/year? ....

3. Total cost item of wholesalers (VND/ton)

Item	Unit	Price VND	Quantity (Kg)	Amount (VND)
Purchasing price				
Transportation				
Store				
Package				
Depreciation				
Rent labor				
Taxes and interest				
Other cost				
Total cost				

4. Where do you buy Cassava?

Farmer ☐

Collector ☐

Other ☐

5. Do you have any contracts farming with other actors in the value chain?

Yes, why?...

....

No, why?...

....

6. Do you have distinguished consumer when you buy or sell?

Price ....

Quantity...

Form of payment...

7. What are the requirements of the purchasers?

- Good quality of cassava ☐
- Enough quantity ☐
- Always-available ☐
- Appropriate price ☐
- Other reason ☐

8. Whose is a consumer of cassava?

Customer	**Quantity (Kg)**	**Price VND**	**Amount VND**
Retailer/factory			
In province			
Other province			
Consumer			
Local consumer			
Consumer in BMT			
Consumer in district			
Supermarket			
Other			

9. How can you keep in touch with the supplier as well as consumers?
10. How can you assess the quality of cassava in collecting and consumption process?
11. Have you ever lacked some resource in your business?

4. Questionnaire (For Retailer)

FACTORY QUESTIONNAIRE

TITLE OF THESIS: TITLE OF THESIS: VALUE CHAIN ANALYSIS AND THE POTENTIAL OF CASSAVA-BASED BIOETHANOL IN DAK LAK PROVINCE, VIETNAM

Interview date:
Commune:............................District: ....Province: Dak Lak

I. GENERAL INFORMATION ABOUT FACTORY
Name of factory ....
Name of interviewer: ....
1. Name of respondent:....................Age:...
2. Sex: ....Male:....................Female:............Age.............
3. Education level: .... the position in factory.......................................
4. Phone number: ....

II. BUSINESS ACTIVITIES
1. The total amount of cassava that is bought per year

Date	Time	Quantity (kg)	Purchasing price (VND/kg)	Amount (VND)	Buying place

2. Average revenue per crop/year? ....

Output	Quantity (ton)	Price (VND)

3. Total cost items of factory (VND/ton)

Items	Unit	Price VND	Quantity (Kg)	Amount (VND)
Raw material				
Transportation				
Electricity				
Store				
Bag and Packaging				
Depreciation				
Rent labor				
Taxes and interest				
Other cost				
Total cost				

4. Where do you buy cassava?
- Farmer ☐
- Collector ☐
- Wholesalers/trader ☐
- Other ☐

5. Do you have any contracts farming with other actors in the value chain?
Yes, why?...
....
No, why?...
....
6. Do you have distinguished consumer when you buy or sell?

Price ....
Quantity...
Payment methods ....

7. What are the requirements of the purchasers?

Good quality of products ☐

Enough quantity ☐

Always-available ☐

Appropriate price ☐

Other reason ☐

8. Whose is a consumer of products?

Customer	Quantity (Kg)	Price VND	Amount VND
In province			
Other province			
Supermarket			
Other			

9. How can you keep in touch with the supplier as well as consumers?

10. How can you assess the quality of cassava in collecting and consumption process?

11. Have you ever lacked some resource in your business?

VITAE

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Educational Attainment

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List of Publication

*** Publications as Author**

I. List of papers published as Author

Advancing smallholders' sustainable livelihood through linkages among stakeholders in the cassava (Manihot Esculenta Crantz) value chain: The case of Dak Lak Province, Vietnam. Applied Ecology and Environmental Research. https://doi.org/10.15666/aeer/1702_51935217 © 2019 ALÖKI Kft, Budapest, Hungary (ISI, Q4, IF = 0.72).

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Cogent Economics & Finance. https://doi.org/10.1080/23322039.2019.1645632 (Scopus, Q3, SJR = 0.24)

II. List of papers published as Co-author

Dong. L. K, Sutinee. S, Hoa. A. X, Dong. N. P, Ali. S, Manop. P, Kuaanan. T. A quick comparison of patrol efforts for supportive protection: a case study of two stations in Vietnam. Applied Ecology and Environmental Research 16(2):1767-1781. ISSN 1589 1623 (Print). ISSN 1785 0037 (Online). DOI: http://dx.doi.org/10.15666/aeer/1602_17671781 © 2018 ALÖKI Kft, Budapest, Hungary (ISI, Q4, IF = 0.68).

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III. List of conference papers as Author

Ao Xuan Hoa, K. Techator, W. Jutidamrongphan, L. K. Dong. “Community-based buffer zone management policy in Vietnam”. International Conference on Sustainable Energy Management for Climate Change Adaption and Mitigation on August 17th 2017 at Siam Oriental Hotel Hat Yai, Songkla, Thailand.

Ao Xuan Hoa. “The potential of cassava-based ethanol production in Vietnam”. In assuring sustainability via university with research: Towards a sustainable development (ASSURE 2018) International conference on 23rd January 2018 Ranong Room Siam Oriental Hotel Hat Yai, Songkla, Thailand