System dynamics modelling for defining livelihood strategies for women smallholder farmers in lowland and upland regions of northern Vietnam: a comparative analysis

ABSTRACT

This study aims to compare the main determinants of the quality of lives and livelihood options for women smallholder farmers between the lowland and upland regions of northern Vietnam. A systems approach and relevant systems tools were used to develop rich pictures (systems models) that depict the current situations and interrelationships amongst different factors within the systems. The comparative analysis showed similar and distinctive characteristics of the farming systems and women farmers in the two regions. Patterns of relationships and interplays amongst different variables reflect the complexity and multidimensional nature of the lives of the women, who are part of and influenced by the interwoven social, economic, cultural and environmental systems. The study provided insights and practical guidance for making “strategic decisions” towards sustainable agricultural systems and livelihoods of the target group in the respective regions. The systems approach, framework and process steps employed in this study are of a generic nature and can therefore be applied to solve complex problems in various other contexts around the world. Theoretical and practical contributions of using systems approaches in agricultural research and development are discussed.

Keywords: Agricultural systems; Livelihoods; Systemic interventions; System dynamics modelling; Women smallholder farmers.

I. INTRODUCTION

Vietnam has a poor and an agriculture-based economy in South East Asia. The country consists of more than 10 million small farms (Hazell & Rahman, 2014). Agricultural

production provides the major livelihood for the rural poor (Ha *et al.*, 2015b). Small-scale rice-based production and land fragmentation are typical characteristics of the farming systems in Vietnam (Van Hung *et al.*, 2007).

In the northern part, there are two distinctive regions. The Red River Delta (RRD) represents a flatland paddy-based production area, being ranked as the second largest rice production region in the country, where most of the major ethnic group (Kinh or the Vietnamese) resides (Chi & Fujimoto, 2012; Le, 2014). The Northern mountainous region (NMR) is the poorest region of the country with complex terrain forms and diversified cultures of more than 30 ethnic minorities (Vien, 2003). Local people are facing various challenges, particularly poverty, poor agricultural yields, land degradation (Yen *et al.*, 2013) and distant markets (Castella *et al.*, 2005). The NMR is divided into three zones, namely, high, low and mid-elevation mountain zones. Local people adapt their agricultural systems based on the specific environmental conditions and their traditional habits. Typical agricultural systems according to the zones include “rock-pocket agriculture”, “composite swiddening” and “agroforestry” systems, respectively (Vien, 2003). Both the RRD and NMR share a common feature, namely a significant level of gender inequity, particularly women smallholder farmers in rural areas (Ha *et al.*, 2015b; Trinh *et al.*, 2015).

Development efforts in improving living standards of rural poor households and promoting gender equity have recently been given a high priority by the central and local governments (IFAD, 2013; Kelly, 2011). This is because gender inequity has been evident in many regions of the country, including the two aforementioned regions (FAO, 2010; Kabeer, 2003). Women are the major labourers in both domestic and production tasks. Their work burdens, together with the old customs against women, were reported to hinder their educational and job opportunities, participation in social activities, and access to productive resources. In contrast, men have more opportunities moving to work in non-agricultural sectors (Ha *et al.*,

2015a; Thinh, 2009). Previous studies showed that the development of livelihood strategies and raising income for women farmers could improve their social status, decision making power and improved quality of life, particularly in northern Vietnam (IFAD, 2011; Lapar *et al.*, 2006).

Given that women farmers are part of rural households and farming communities, addressing issues faced by them requires a holistic and multidisciplinary approach. According to Spedding (1988, pp.8-9), it is misleading to only focus on agriculture itself when studying an agricultural system. Due to its multi-disciplinary nature, agriculture involves mixtures of disciplines such as social sciences, economics, biology, etc. Furthermore, Villarreal (2000) has proven a strong influence of local culture on agricultural production. This author also highlighted the complexity of the situation in which gender-related issues were studied under a gender system. The gender system is part of and influenced by bigger systems in which relationships between socio-cultural, economic, political and historic factors are all interwoven.

Many development efforts have been proven inappropriate due to the complex issues in agriculture and rural development in the northern region. For example, a lack of understanding of local conditions, culture and capability has been reported as main causes that led to various failures in technology transfer and livelihood development programs (Vien, 2003; Vien *et al.*, 2006). Culas (2012) criticizes many drawbacks and failures in agricultural development projects in Vietnam, which are mainly due to the lack of a “multidisciplinary approach” from design to implementation. Few studies focus on “socio-agricultural dynamics and changes”. Linear thinking in technology transfer that leads to unintended consequences on resource-poor women smallholder farmers has also been reported by Paris and Chi (2005). Therefore, various issues in agriculture such as the vicious cycle of poverty, negative debts, unsustainable livelihoods and gender inequity are still

unresolved problems that affect many disadvantaged groups, particularly the women smallholder farmers in many regions (Bosch *et al.*, 2015).

Taking the above into account it is clear that a more holistic and multidisciplinary approach is required for better understanding of the context and subsequently the nature of interventions that are required. Systems thinking approaches, modelling tools and decision support systems have been used in agricultural systems research and development around the world (e.g. Bawden, 1991; Eastwood *et al.*, 2012; Florin *et al.*, 2013; Lamprinopoulou *et al.*, 2014; Macadam & Packham, 1989; Mainland, 1994; Paracchini *et al.*, 2015). However, so far no study has been conducted using systems dynamics modelling to analyse and compare the complexity of women farmers' determinants of life and the interactions amongst different subsystems beyond the production systems in the two regions of Vietnam. This study will contribute to addressing the current knowledge gap through an in-depth analysis of the women's situations and provide both policy and practical recommendations to improve their livelihoods and quality of life.

Due to the distinctive differences in terms of natural, social and cultural characteristics between the lowland and upland regions, farming systems and specific challenges of women farmers in the two regions reveal their own nuances (Ha *et al.*, 2015b; Trinh, 2014). This study therefore aims to compare general characteristics and the main determinants of the quality of life of women farmers and provide insights for defining appropriate livelihood options for each region using a systems approach.

II. APPROACH AND METHODS

2.1. Overall approach and study locations

The study employed a systems approach with relevant systems tools (described below) in two regions, lowland and upland (Figure 1) of northern Vietnam. Haiphong is a typical lowland province in the Red River Delta. The province has a total natural land area of 1,519 km²,

including two islands, with an average elevation of 0.7-1.7m above the sea level. Flatland constitutes 85% of its total land area. Haiphong is situated in the typical sub-tropical region of northern Vietnam with an annual average temperature of 23 to 26°C (depending on seasons). A population of more than two million was reported in 2016 (Gregorich, 2016). Four rural districts of Haiphong, namely, Kien Thuy, An Lao, Vinh Bao and Tien Lang, were selected that represent the typical lowland area where there is a relatively large proportion of smallholder farmers, the key target group of this study.

Figure 1 – Map of the research locations. Red star represents the research location in the lowland (Haiphong, the Red River Delta); Yellow stars represent the research locations in the upland (Northern Mountainous Region) (Source: Adapted from Clement & Amezaga, 2013).

Phu Tho and Lao Cai provinces represent the northern upland and/or northern mountainous region (NMR). Phu Tho is a typical midland province located in the sub-tropical monsoon region with an average temperature of 23°C and annual humidity of 85% (FAO, 2012). The province has a population of 1,351 people, being one of the poorest provinces in the Vietnam (GSO, 2013). The province's total natural land area is 3,533.3 km² (GSO, 2013). However,

only 54.8% is considered arable for production (FAO, 2012). Meanwhile, Lao Cai represents an upland province with the total land area of 6,383 km² (GSO, 2013) and an average annual temperature of 23°C (DARDLC, 2012; FAO, 2011). The province is a mosaic of 33 different ethnic minority groups (LCPPC, 2011), contributing to roughly 65% of the total population (656,900 people) (Culas, 2011; GSO, 2013). This province is one of the top-five poorest provinces of Vietnam (Phi, 2012).

In Phu Tho province, Tan Son district was chosen. Bac Ha and Sa Pa districts were selected in Lao Cai province. These three districts are amongst the poorest districts of Vietnam (CEMA, 2010; UN, 2013). Women farmers in these districts are the most vulnerable group (Trinh, 2014).

Due to the above mentioned reasons, women smallholder farmers in both regions were chosen as the target group for this comparative study.

2.2. Process steps carried out in the lowland

The case study in rural Haiphong was conducted following the first five steps of the Evolutionary Learning Laboratory (ELLab) (Bosch *et al.*, 2013). The process started from identifying issues and gathering mental models of relevant stakeholders via both baseline surveys and stakeholder workshops to develop a shared understanding of the current situation of the women farmers (Step 1). Representatives of the appropriate stakeholders were selected for capacity building and learning-by-doing activities throughout the ELLab cycle (Step 2). Vensim[®] (Ventana[®], 2011) and Netica[™] software (Norsys, 2013) were used to support the development of systems models of the current situations, defining levers for systemic interventions and developing an overall management plan (Steps 3-5) (Figure 2).

Figure 2 - Evolutionary Learning Laboratory for Managing Complex Issues under conditions of interwoven relationships between economic, social, environmental and cultural factors (Source: modified from Bosch *et al.*, 2013).

In response to the requirements of the funding body (Gates-Foundation, 2013), which focused on labour saving innovations and strategies for women smallholder farmers, the selection criteria of participants in the ELLab processes were discussed and agreed between the research team and the local partner, the Department of Agriculture and Rural Development. Those include (1) being smallholder farmers in the research area; (2) geographic representation of participants/informants; (3) balanced representation of ethnicity (if any); and (4) balanced representation of rich, fair, and poor participants within the smallholder women farmers in the area.

Both qualitative and quantitative data collection methods were employed through a baseline survey with 33 smallholder farmers prior to a number of stakeholder workshops and separate mini-workshops or forum discussions with women farmers in the four rural districts. The baseline survey provided background information on the profile of households, current production status, market outlets, gender-related issues, and labour use. The plenary

workshops were organised with the participation of 75 representatives from the local government departments and organizations, input/service providers, women farmers, and agribusinesses in both Haiphong and a neighbouring province, Hai Duong. Representatives of agribusinesses were later engaged in the ELLab process due to the initial findings that highlighted the need for improving income via market actor linkages.

The mini-workshops were conducted in each district with the participation of 36 - 40 women smallholder farmers for more in-depth understanding of their real challenges, expected solutions and how they are ranking what they regard as priorities.

2.3. Process steps carried out in the northern mountainous region

The case study in the NMR is a follow-up research activity from a baseline study on impacts of vegetable farming on livelihoods of women farmers in two selected provinces, Phu Tho and Lao Cai (Trinh, 2014). However, by using a systems approach, the follow-up analysis provided a broader picture and interrelationships of all factors determining the livelihoods of the rural women rather than a mere focus on production of a single crop.

In addition to the main variables defined from analyses of the baseline study (Trinh, 2014), relevant secondary data were collected from reports and other published sources of different international and domestic organizations, such as the Australian Centre for International Agricultural Research (ACIAR), Vietnam Women's Union, Vietnam Academy of Agricultural Sciences, Provincial Departments of Agriculture and Rural Development, and previous studies in the two provinces to support findings. Vensim[®] software (Ventana[®], 2011) was used to develop a causal loop diagram (CLD) that depicts the current situation, highlighting patterns of relationships and potential levers for systemic interventions to improve their lives.

2.4. Description of concepts and their implications

The *patterns of relationships* denote how different variables are interlinked and the nature of feedback loops that are formed, either reinforcing or balancing loops (Bosch *et al.*, 2013). The *reinforcing feedback (R) loop* represents positive feedback, showing “growing or declining actions”. In contrast, the *balancing feedback (B) loop* indicates negative or counteracting feedback, which “seeks stability or return to control, or aims for a specific target” (Maani & Canava, 2007: 33). For example, Ha (2008) reported the traditional habit of many Vietnamese farmers that applies untreated farmyard manure into their ponds. The conventional practice causes a number of environmental and health concerns in rural areas. Figure 3 illustrates two types of feedback loops. Applying untreated manure causes pond water pollution in the long run. In turn, the latter induces a higher number of dead fish due to the polluted water. The more fish dies, the worse the pollution of water becomes. This feedback creates a reinforcing (R) loop. The polluted condition of pond water and the increased number of dead fish influence farmers’ awareness. Therefore, application of untreated manure is reduced (balancing loops, B1 and B2, Figure 3), seeking alternative methods that are more environmentally sound.

Figure 3 – Example of reinforcing (R) and balancing (B) feedback loops through the traditional practice of Vietnamese farmers applying untreated farmyard manure into their ponds. *Legend: Arrows*

197 ($\Rightarrow$) indicate the causal links; Arrows with a double vertical bar ($\dashv\!\!\!\rightarrow$) represent a time delay; S –
198 same direction; O – opposite direction.

199 The patterns of relationships help to explain causal relationships and interactions between
200 different variables within a subsystem. They also show interplays amongst factors in the
201 subsystems. Analyses of these patterns enabled participants to understand the nature of
202 interconnectedness between different factors and the outcomes/consequences of an
203 intervention.

204 The *leverage points* are defined as “points of power” or “places within a complex system (a
205 corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing
206 can produce big changes in everything” (Meadows, 1999: 1).

207 Identifying the leverage points within a system helped to develop a systemic action plan for
208 coordination of proposed systemic interventions that produce high impacts towards achieving
209 the defined goal. It seeks to improve the whole system performance rather than the traditional
210 approach of linear thinking, leading to “quick fix” solutions and various unintended
211 consequences and even counterproductive outcomes (Bosch *et al.*, 2013; Ha *et al.*, 2015c;
212 Maani, 2013; Sterman, 2001; Vester, 2007).

213 **III. RESULTS AND DISCUSSION**

214 **3.1. System dynamics model of the current situation of women farmers in the lowland**

215 Figure 4 shows a systems model developed from the synthesis of all mental models of the
216 women farmers and related stakeholders concerning different issues affecting the lives of the
217 women in rural Haiphong. Analyses of relationships patterns revealed the interwoven
218 relationships and interplays amongst the variables.

Figure 4 - CLD modelling for improving the quality of life of women small farmers in rural Haiphong. Legend: S - same direction; O - opposite direction; R - reinforcing (feedback loop); B – Balancing (feedback loop) (Source: adapted from Ha et al., 2015c).

Low income, high work pressure and poor health were, in order of importance, determined as the three major challenges that the smallholder women farmers are facing. Therefore, raising income, reducing workload and improving health were set as the three main objectives to achieve the goal of improving the quality of life of the women.

The systems model enabled participants to better understand the current situation, interrelationships amongst the variables and the need for engagement of all relevant stakeholders. The identified patterns of relationships helped the participants to determine potential important factors (red variables, Figure 4) that can change the system's performance.

The results clearly show that factors determining the quality of life of the women farmers are way beyond their production systems. Their production-related labour hardship, the focus of the funding body, is just part of the big picture of interrelated factors that altogether influence their lives (Figure 4). The women's uttermost need is to raise their income through improved market access, which can address many other issues. Their increased income was stated to strengthen their financial capacity for investment in production and access to productive resources. It will help to improve production efficiency and thus reduce cost and increase savings (R3, Figure 4). The raised income implies a higher status within their family, resulting in better family support and work sharing. As a result, their work hours are lessened, creating more opportunities for them to earn additional income via secondary jobs (R2, Figure 4). The reduced workload enables them to participate in social activities and organisations that will improve their knowledge, skills and subsequently status. This could lead to improved gender equity, gradually removing old customs against women and thereby better family support and work sharing (R1, Figure 4). The results are consistent with finding of Lapar *et al.* (2006) and IFAD (2011, 2013) in other provinces in northern Vietnam. In addition, the improved production efficiency reduces their work pressure and therefore improved health, which in turn further enhance production efficiency (R5, Figure 4).

The developed model helped all the stakeholders to understand their role and areas of possible support that need their involvement. Further steps in defining systemic interventions, testing future scenarios for developing an integrated management plan towards the end goal are presented in Ha *et al.* (2015c), which is beyond the scope of this article.

3.2. System dynamics model of the current situation of women farmers in the northern mountainous region

Due to the specific challenges in the upland, local people, particularly women farmers, have to face a range of difficulties. There are many hindrances to livelihood improvement. Those include distant markets, inappropriate cropping structure, production risks, limited literacy level, language barriers, gender inequity, small landholdings, subsistence production habits, and food insecurity (Trinh, 2014; Trinh *et al.*, 2015). These issues were multidimensional and intertwined with one another. Together they influence the lives of the women in particular, rural households and farming communities in the NMR in broad terms.

Food security, income, equity, and health and leisure were determined as the key determinants of the livelihoods of the women farmers in the NMR (Figure 5).

Figure 5 – CLD modelling on improving the quality of life of women small farmers in the NMR.

Notes: S – same direction; O – opposite direction; R – reinforcing (loop). Red coloured variables are potential leverage points for systemic interventions (Source: adapted from Trinh *et al.*, 2015).

The systems model developed following the analysis of the baseline survey has provided a ‘big picture’ of the current situation, highlighting patterns, relationships and potential

important factors (red variables, Figure 5) that could leverage performance of the whole system. Interventions focusing on these factors would be expected to yield high impacts on improving the quality of life for the women and farming households in the highland (Figure 5).

Due to harsh biophysical conditions in accordance with the traditional subsistence production habit of local residents in this region, food insecurity was stated as the most challenging issue, in which a large proportion of households have to face several months of food shortage (Trinh, 2014). Addressing this issue through mainly enhancing production efficiency and reduced production risks can be considered critical before addressing their need to raise income and others.

Productivity and yield of agricultural products are important for food security. Improving production efficiency would be the key to address the current issue of poor yield. This requires policy support in terms of access to productive resources, production technology and extension services (including capacity building) to help change their subsistence production habits and cropping structure to be more commercial and profitable, and thereby have more secure and increased income (Figure 5). The results are consistent with findings of Minot *et al.* (2006) and Nguyen (2012) in the NMR. The increased income would enable the smallholder farmers to access production technology that would directly lead to improved production efficiency (R2, Figure 5). Their access to improved technology also helps to reduce their production risks, resulting in more secure and increased agricultural yield. This would be a motivation for them to adopt production technology (R1, Figure 5).

Their improved production efficiency and income would result in improved health and leisure time for the women. Bosch *et al.* (2015) found that increased income enables women

smallholder farmers to have better access to healthcare services, while improved production efficiency lead to more free time. In this case study, their enhanced health and leisure would enable the women to participate in other income activities to raise their family income (R5, Figure 5). Their raised income would also improve their social status, promoting gender equity, which results in better access to productive resources and thus income (R4, Figure 5). Their raised social status and more equity would lead to reduced housework burdens and thus more time for social and education activities, which would further promote gender equity (R6, Figure 5). The outcomes are consistent with findings of Bosch *et al.* (2015) and IFAD (2013).

3.3. Comparative analyses of general characteristics of farming systems and factors influencing the quality of life of women farmers in lowland and upland regions

3.3.1. Similar characteristics

First, the rural women and farming households in both regions have to face a number of similar challenges which are *multidimensional, interconnected* and related to *multiple stakeholders* such as market actors, service providers, extension networks and local governments. The systems models (Figures 4 & 5) clearly show that the farmers live and work within a complex web of interdependent subsystems (environmental, political, social, economic and cultural), which are beyond their farming/production systems. For example, Figure 4 shows that labour hardship of the women in Haiphong is influenced by (1) old customs against women (*cultural factor*) leading to their production and domestic work burdens; and (2) conventional labour intensive production practices (*production system*). To reduce work pressure the stakeholders stated the need for government support (*political factor*) with regards to production infrastructure, access to production implements, regulating

input prices, and strengthening the extension network for effective capacity building. In addition, institutional support for local production service groups and cooperatives were found equally important to facilitate work sharing and production efficiency. Forming formal cooperatives via land consolidation on voluntary basis amongst individual farmers was stated as one of the requirements for the success of smallholder agribusiness and thus their income (*economic factor*). The recent baseline survey (Ha *et al.*, 2015b) indicated that conventional unsafe production using toxic chemicals is amongst the contributing factors to polluted environment (*environmental aspect*) and poor health, which influence their production efficiency. Raised income was also reported to have multiple benefits in access to healthcare services and productive resources, improving their status within the family and community (*social factor*), and thus improved family support and work sharing (Figure 4). Similar nature of interactions between the variables within a subsystem and their interplays with variables of other subsystems is also evident in the upland as indicated in Figure 5.

Second, ***land fragmentation, small-scale production systems and conventional practices*** have also been reported to hinder market access and thereby poor and uncertain income for the farmers in both regions (Ha *et al.*, 2015b; Trinh *et al.*, 2015). For example, the production land areas in rural Haiphong and Phu Tho are 0.31ha and 0.58ha per household, respectively (Ha *et al.*, 2015b; Yen *et al.*, 2013). Results are also consistent with findings of various studies in developing countries regarding the barriers to market access of smallholder farmers (e.g. Barrett *et al.*, 2012; Fischer & Qaim, 2012; Hazell, 2005) and findings of Minot and Hill (2007) in the uplands and peri-urban areas of Vietnam.

Third, being smallholder farmers in a poor country, their production is highly dependent on ***supporting policies and orientation (political factor) of the central and local governments***.

This is similar to the characteristics of smallholder farmers in other developing countries such

as those in Sub-Saharan Africa (Bosch *et al.*, 2015). For example, funding and support from the governments for production infrastructure (roads, power grid and irrigation canals), regulation of prices of inputs (e.g. fertilisers, pesticides), capacity building via the extension network, and promotion of market linkages were found essential in the lowland (Figure 4). Similar aspects of support are also evident in the NMR (Figure 5). Some slight differences regarding the political factors between the two regions, as well as the requirements that farmers have to address are presented in Subsection 3.3.2.

Finally, the systems dynamic models in the two regions denote several similarities. In both regions, factors such as ***changing production practices and organisation, and enhancing market actor linkages*** to improve income for the women in particular, rural households and farming communities in broad terms were found to be important. Extensive use of chemical pesticides in both regions (Ha *et al.*, 2015b; Pham & Smith, 2013; Trinh, 2014) could be seen as an implication of unsustainable production systems. It is also a contributing factor to poor quality produce and health of the producers. Additionally, the need for engaging the women in ***social activities and capacity building*** to improve their status and thus gender equity are also asserted in both regions (Figures 4 & 5). According to Nghiem (2010), enhancing education levels would improve farmers' livelihood options. However, the authors argue that education would be a long-term objective while the basic needs are being addressed (for example, food security, health and income). A study by Safa (2005) in Yemen showed that education level does not have significant influence on income of smallholder farmers in the highlands, but it has significant impact in the lowlands. Furthermore, a large number of studies has proven that informal capacity building and social engagement for marginalised women could improve their livelihoods and promote gender equity via improved knowledge,

social status, decision making power, reduced domestic violence and improved work sharing by men (Bosch *et al.*, 2015; IFAD, 2011, 2013; Lapar *et al.*, 2006; Minot *et al.*, 2006).

3.3.2. Differences between the two regions

Due to the evident differences in regional settings (natural and human aspects), factors influencing the livelihoods of women smallholder farmers in the two locations also have distinctively different characteristics.

Table 1: Differences in general characteristics of farming systems and main factors influencing the lives of women smallholder farmers in lowland and upland regions

Indicators	Lowland region	Upland region
Biophysical conditions	Flatlands and ease of water access for irrigation that are favourable for land consolidation and mechanisation in agriculture to reduce labour input, production costs, improve efficiency and economy of scale to meet requirements of businesses (Ha <i>et al.</i> , 2015b, 2015d). Market access is relatively easier than that in the NMR.	Hilly and mountainous topography and rain-fed areas, and high production risks due to harsh environmental conditions and pest damages (Trinh, 2014; Trinh <i>et al.</i> , 2015; Yen <i>et al.</i> , 2013). Distant markets and limited access to information (Linh <i>et al.</i> , 2015; Trinh <i>et al.</i> , 2015).
Farming systems characteristics	Typical cropping systems in the lowland Red River Delta are irrigated rice-rice, rice-cash crop, and rice-maize systems (Le, 2014). In rural Haiphong rice-farming is the dominant production system (Chi & Fujimoto, 2012; FAO, 2002). The system has 1 to 3 rice harvests per year, depending on water availability. Other subsidiary crops such as vegetables, maize, root crops, soybean, sugarcane and fruit are	Diverse agricultural systems associated with ecological zones and ethnic groups (Vien, 2003; Yen, 2013); High proportion of rain-fed production systems in hilly lands (Minot <i>et al.</i> , 2006; Trinh, 2014). Rice, maize, cassava, sweet potato are staple food crops in the NMR (Yen <i>et al.</i> , 2013). In which, rice contributes to 46% of total crop production value (Yen, 2013). Family farming and subsistence

Indicators	Lowland region	Upland region
	often integrated in the production system. Livestock and off-farm activities are significant sources of household income (Dixon et al., 2001). Livelihoods of the women smallholder farmers in this area are dependent on crops (55.0%) (mainly rice and cash crops), and livestock production (30.3%) (Ha <i>et al.</i> , 2015b).	production is the typical agricultural system which is mainly based on manual family and animal labour. Farm outputs are mainly consumed by the family, small proportion of the outputs is sold or exchanged at nearby markets (Vien, 2003).
Farmers' characteristics (<i>socioeconomic aspect</i>)	The majority of women farmers and rural households in the lowland belong to the major ethnic group (Kinh or the Vietnamese) (Vien, 2003). Commercial production is evident in this region (Ha <i>et al.</i> , 2015b).	Mainly ethnic minorities (approximately 30 groups) living in the region associated with high level of illiteracy, language barriers and subsistence production practice and thus poor yield (Trinh, 2014; Trinh <i>et al.</i> , 2015; Yen <i>et al.</i> , 2013).
Main determinants of the lives of women farmers (<i>socioeconomic</i>)	Three key determinants: Income, workload and health, in order of importance (Figure 4).	Four key determinants: Food security, income, gender equity, and health & leisure (Figure 5).
Food security (<i>socioeconomic</i>)	Food insecurity is not an issue of the women farmers in rural households in the lowland. This is probably due to the favourable conditions of flatlands and the ease of access to irrigation water for increasing the number of crops per year.	High proportion of households (32-70%) facing food shortage for 1-6 months in the selected communes of Phu Tho & Lao Cai. This is mainly due to high production risks, conventional subsistence production practices, inappropriate land use management and poor access to productive resources (Trinh, 2014; Trinh <i>et al.</i> , 2015). These cause uncertain and poor yield (Figure 5).
Poverty level (<i>socioeconomic</i>)	15.6% and 25.0% of the interviewed respondents belong to 'rural poor' and 'marginal poor' groups with an average income of less than USD1.0/person/day (Ha <i>et al.</i> , 2015b).	Poverty rate in NMR is 43.9%, which is higher than the average rate (33.0%) of the northern provinces. However, the rate of ethnic minority community reached 67.4% (Nguyen, 2012).
Market situation (<i>economic aspect</i>)	Availability of potential local enterprises with high willingness for contract farming; Huge potentials for agricultural produce in	Distant markets and asymmetric information due to the remoteness of the farming communities. Lack of market

Indicators	Lowland region	Upland region
	both domestic and export markets. Therefore, market actor linkages via contract farming are feasible (Ha <i>et al.</i> , 2015a, 2015d). A number of specialised cooperatives have been developed in Haiphong.	focus due to the subsistence production habits (Trinh, 2014). These would hinder commercial development of agricultural products.
Degree of gender inequity (<i>cultural aspect</i>)	There is still a significant level of engender inequity in terms of production and housework tasks. However, decision making power in production is not significant different ($P < 0.05$) (Ha <i>et al.</i> , 2015b).	High level of gender inequity with a strong conception that women belong to kitchens and are not allowed to go to school. They also become main caretakers of their families (Trinh, 2014).
Supporting policies of the central and local governments	Recent favourable policies through development programs for both crop and livestock development. Land consolidation for the ease of contract farming with agribusinesses is currently in progress. However, some issues need to be addressed, including corruption and non-transparency during implementation of the support programs (Ha <i>et al.</i> , 2015b). The extension network in this area can be evaluated stronger than that in the NMR. Yet, communication and coordination between the extension network with other local partners (farmers' associations and local authorities) should be improved (Ha <i>et al.</i> , 2015b).	Inappropriate land use management has been reported as one of the major hindrances to livelihood development of the women smallholder farmers in the region (Trinh, 2014). This has been explained by the "top-down government policies" that ignore the actual conditions (biophysical and human factors) at the localities. Therefore, poverty is still an unsolved problem in this region (Yen <i>et al.</i> , 2013). Extension services through training and technology transfer programs are available in the remote farming communities (Yen, 2013). However, this technology transfer efforts are questionable in terms of the relevance and quality of the education material. This also lead to low adoption rates of technology (Linh <i>et al.</i> , 2015).

373 As discussed, having a number of similarities regarding their multidimensional challenges as
374 being smallholder farmers under the same political system, the women farmers in the two
375 regions have rather distinctive nuances due to both human factors and regional settings.

These lead to the significant differences in terms of their prioritized needs and what they regard as the main determinants of their quality of life.

The women in NMR have to face more challenging issues due to a number of reasons. Those include unfavourable biophysical conditions, further away from markets, lack of information, conventional subsistence production habits, language barriers, high level of gender-bias conception against women as well as inappropriate supporting policies. Therefore, the multiple issues could only be addressed by a more holistic approach and coordinated actions rather than the traditional “piecemeal” approach. A complete process towards defining systemic interventions and developing an overall integrated management plan as presented in (Ha *et al.*, 2015c) could be applied in the NMR as well to help address the multidimensional problems that the women farmers are facing.

IV. CONCLUSION

This study provided in-depth insights to the current situations of women farmers in the two regions. Though having some similarities, the regional differences in terms of geographical, natural and human factors reveal a more vulnerable situation of the women farmers in the NMR. This study has also highlighted potential levers for systemic interventions to address their respective challenges.

The interrelationships amongst different factors in the two systems models suggest a need for engaging relevant stakeholders in the problem structuring and decision making processes. This will ensure the provision of more practical and rational policy recommendations for coordinated actions to improve the lives of the women farmers in the two regions.

It became clear that solving specific challenges of the women smallholder farmers in both regions requires a holistic view to analyse the situation in more depth for adequate interventions. This is because they are part of and influenced by bigger systems (rural households and farming communities) and their complexity where various factors (biophysical, social, economic, political and cultural) are intertwined. It is important that this must be taken into consideration for appropriate approaches and interventions in each specific locality.

This study provides both theoretical and practical contributions in agricultural systems research and development. It introduces a new approach and systems tools in dealing with complex problems of agricultural systems in the studied contexts. Given the generic nature of the approach and process steps, the systems approach and tools can be applied to solve complex problems in other contexts around the world. This study has proven that the traditional top-down and/or supply-driven approach is clearly inappropriate, which does not address the real needs of local people and thus not lead to sustainable outcomes. The traditional approach tends to solve immediate problems such as labour hardship, while it ignores the fact that the lives of the women farmers are influenced by various factors beyond their production systems. The study addresses the drawbacks of a so called “silo thinking” in many development efforts in Vietnam as pointed out by a number of authors (e.g. Bosch *et al.*, 2013; Culas, 2012; Paris & Chi, 2005). The systems approach also helps to visualise areas of interventions within the systems that need to engage relevant stakeholders for coordinated actions towards sustainable outcomes.

Further research is recommended that will focus on market actor linkages for improved market access and development of systemic management plans for improving the quality of life of the women smallholder farmers in NMR.

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