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Gender Roles in Response to Water Scarcity for Coffee Production: A Case Study of an Ethnic Group in the Central Highlands of Vietnam

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Abstract: In the central highlands, a key coffee growing area of Vietnam, water for coffee production is becoming increasingly scarce. Although, central and local governments have implemented several mitigation strategies, only 19% of areas under coffee cultivation in the Central Highlands have access to state-constructed irrigation schemes. As a result, coffee producers have had to develop alternative strategies to cope with water scarcity. Based on quantitative and qualitative data collected from an ethic minority group of Ede in the Central Highlands, this research has indicated that farmers develop coping strategies for water scarcity based on their local skills, knowledge and gender division of labor. Although, differentiation of gender roles has been discussed in the literature for agricultural production, few studies have specifically focused on gender roles in construction and implemention of coping strategies in response to water scarcity. It was found that men played more significant roles in responding to water scarcity. However, women's roles have significantly changed in coffee production in general and in cpoing with water scarcity in particular. To supplement the coping strategies of farmers to water scarcity, it is recommended that central and local governments provide more technical and financial support to male and female farmers.

Key words: Water scarcity, coffee farmers, gender roles, coping strategies, Central Highlands, Vietnam

INTRODUCTION

Water scarcity is a relative concept (Winpenny, 1997). As postulated by Anonymous (2006a, b) addressing water scarcity requires an integrated and multi dimensional approach to managing water resources with the aim of enhancing economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Thus, the stake holder's involved in the mitigation process are the central government, local authority, nongovernmental organisations and the residents (Mukuhlani and Nyamupingidza, 2014).

Water scarcity is not unique in any country only but is existent in most African and Asian countries (Mukuhlani and Nyamupingidza, 2014). In Vietnam, the Central Highlands is the most productive coffee growing region with the total area reaching 616,000 ha. However, only 19% of the productive area for coffee has access to state-developed irrigation schemes. Farmers on the remaining 81% of land rely on diverse local strategies using either groundwater or surface water from local streams. In recent years, water scarcity has increasingly affected the productivity of smallholder farmers in this region.

In response to water scarcity, central and local governments have implemented mitigation strategies not only for coffee production but also the agricultural sector as a whole. Many approaches have not been effective and as a result farmers have either individually or collectively developed alternative their coping strategies. Several studies relating to coping strategies that respond to water shortages for both domestic use and agricultural production can be found in the literature including: an action framework for the agricultural sector (FAO, 2012) and examples of local communities preparing strategies in response to dry-season water stress to supplement inadequate government approaches (Klock and Sjah, 2011; Pereira, 2005; Mukuhlani and Nyamupingidza, 2014). However, the existing research on coping strategies in response water shortages for specific crops such as coffee is limited.

The scholarly literature on gender and climate change in general and gender and water scarcity in particular is growing with many papers putting forth arguments that share similarities with WED ideas that were popular in the 1980 and 1990's. This trend of thinking emphasized on women as chief victim-and-caretaker of climate change. By arguing, so, women have been placed at the centre of climate change: "poor women are generally on the receiving end of the effectss of increaing environmetal degradation and depletiong of natural resources because their envolvement in and reliance on, livelihoods activities

which depend directly on the natural environment" (Denton, 2002). Similarly, these literatures indicated that water scarcity results in greater negative impacts on rural women and girls than on men. Women and girls were found to be burdened more through the collection of fresh water attributed to gendered domestic roles. However, decision-making in regards to access to water resources is also a determining factor as land ownership is often linked to water access. Women's control of water resources for drinking and irrigation is limited because of the societal values that define men as the guardians of property and heads of households making decisions for women regarding water resources in the public sphere. Level of control over water resources is further dependent on other factors such as ethnicity and socio-economic status. Notwithstanding this, control over natural resources is limited for majority of women worldwide. The limited participation of women in decision making, valuable knowledge is lost and this has the potential to result in the failure of government policies and programs (Anonymous, 2007; IFAD, 2012; NCI, 2015).

One limit to these arguments, however is that women are examined as a homogeneous and undifferentiated social category. Moreover, women's roles were considered separately from men's roles. Several scholars advocated women's capacities as well as adaptive knowledge in response to climate change and water scarcity (Enarson and Fordham, 2001; Ariyabandu, 2003, 2004; Acharya, 2009). For Resurreccion (2011), "the danger with such 'women only' assertions when translated into policy is that they neutralise and reinforce inequitable gender division of labour, thus, inadvertently increasing women's workloads in programmes aimed at empowering them. In short, they add 'environment' and 'climate adaptation/mitigation' to women's already long list of caring roles".

While 'women' as the sole subject still persists in the growing gender and climate change literature, Demetriades and Esplen (2008) encourage context-specific research drawing on local realities and adaptation strategies and they plead for an understanding of the complex relational nature of gendered power. It could be said that culture defined gender roles in response to climate change, they may be more flexible than at first appears and subject to negotiationn and change that go beyond fixed definitions of 'women' and 'men'. Based on this strand of argument, my research examines gender roles from a relational perspective "involving interaction of women and men, structured through norms and institutions, reconfigured through individual agency" (Elmhirst and Resurreccion, 2012).

In this study, we aim to determine how gender plays role in coping with water scarcity related to coffee production and how gender issues appear in policies which intervene in water scarcity through short-term and long-term projects.

MATERIALS AND METHODS

Two main approaches that have been applied in doing this research including community-based rural development and gender analyses. Farmer coping strategies for responding to water scarcity are diverse and related to management and practices. In this study, the term farmer "coping strategies" is taken to mean the ways in which farmers "contend with" or "adjust to" an increasingly scarce water supply situation for coffee production. A coping strategy in this research is seen from two aspects including: individual problem-solving such as technical solutions, alternative cropping, water allocations and farm budgeting and collective action, especially water-sharing groups within the community.

The use of everyday practice approach for doing research and analysis is the most appropriate for capturing both structural aspects and people's life stories and experiences (Cecilia, 2001). For water issues, several researchers have applied theories of everyday practice in doing research on water access, water control and water coping strategies. For Scott (2009), everyday informal practices "are central to understanding the workings of the contemporary urban hydraulic system" especially as they confront and compromise the authority of engineers or technocrats to control the water system. In Peloso and Morinville (2014)'s study, theories of everyday practice are drawn upon to examine the actions that people take to improve their water security by utilising and resisting different features of the water network. In this research, the theory of everyday practices is applied in order to investigate the responsive capacity of the farmer or to answer how farmers manipulate their knowledge and resources to cope with water shortages to sustain coffee production.

In agriculture, particularly for coffee production, men and women play different roles because they possess different types of knowledge and skills relating to cultivation process including water management. However, gender roles in coping with water shortages in coffee production in this research are considered from a view of "relational" perspective. This means that women and men do not act separately but they interact with each other through norms and institutions. In the context of water shortages, male and female coffee growers can work together in order to develop relevant coping strategies. In addition, specific strategies can be also implemented differently by men and women.

In consultation with the local government, three villages (Sut H'Luot, Sut M'DRang and Sut M'Dung) representing ethnic group of Ede in Cu Sue Commune, Cu M'gar District were selected to investigate the strategies that farmers used to cope with water scarcity for coffee production. Both primary and secondary data were utilized in doing this research. The primary data was collected through directly interviewing 50 coffee farmers in the district. Farmers were selected on the basis of acquiring data from a range of scales of coffee production and levels of diversification in terms of livelihood strategies. Questionnaires were developed as a guideline for semi-structured interviews including basic information about the householders at each farm, the strategies farmers have applied in order to cope with water shortages and the gendered roles in developing and applying these strategies. In order to capture gender roles in coping with water scarcity, interviewees were selected to have an equal representation of sex. Three focus group discussions were also held with the participation of local government staff and famers to identify the most appropriate strategies in coping with water shortages in the region. Participant observation was also used to gather information in each community.

Data collected was proceeded and analyzed by descriptive statistics were used to characterize the water shortage situation in each region including the loss of coffee productivity and the formulation and implementation of coping strategies for responding to water shortages for coffee production. Secondly, comparative analyses were used to understand how different coping strategies have been selected by different farm household groups and locations to cope with water scarcity.

RESULTS AND DISCUSSION

Context; A brief history of coffee production in Cu M'gar: Similar to other locations, Cu Sue Commune in Cu M'gar district has undergone tremendous economic and social change, since, Vietnam's reunification in 1975. Previously, the main economic activities of the community where the Ede minority group are predominant were subsistence production of rice using swiddens, supplemented by hunting, fishing and gathering. Ede people also cultivated secondary crops in gardens and raised animals. Mutual assistance and reciprocity was widespread (Trung, 2003). After 1975, Vietnam's communist government launched a major resettlement campaign in New Economic Zones (NEZs) to better utilize labor, diversify the economy, accelerate collectivization and ensure the security of peripheral regions.

By 1985, there were 25 NEZs in Dak Lak Province (Fortunel, 2000). All members of the Ede minority in Cu Sue lived on rice shifting cultivation until the establishment of the State-run Ea Pok Coffee Company in 1985. Along with other Ede people, Ede farmers in the three villages where the research was conducted were required to use fixed cultivation practices. All Ede farmers were settled along the Ea Chan stream were allocated between 1000-2000 m^2 of residential land and one hectare of state land with which to grow coffee. With fertile soil and an ideal local climate, Ede farmers of Cu Sue Commune achieved yields of up to 5 tons of dried coffee seed per hectare and buoyant coffee prices throughout the 1990's provided high cash incomes.

The rise of the Vietnamese coffee economy nearly doubled that of the Vietnamese Gross Domestic Product in Dak Lak Province, particularly in Cu Sue Commune within a decade. However, the rapid agricultural transformation of the province has raised a number of environmental concerns. Total land used for agricultural production in Dak Lak doubled in the 1990's with an average increase of 46,000 ha/year. The rapid expansion of cultivated areas led to substantial forest destruction. Between 1980-2000, Dak Lak Province lost forest at an average rate of 20,000 ha/year. Forest destruction in Cu Sue as well as in other locations can now be seen as a cause by which surface water can no longer be stored in the forests and groundwater reserves deepen. This causes water shortages for agricultural production in the region. Another reason for this is that farmers have increasingly expanded the area of land under coffee and rice cultivation, two crops consume which consume large amounts of water.

Derived from traditional perceptions, the gender identity of Ede people depends on cultural behaviour ascribed to each gender in particular to the gender division of labour. In the past, Ede women played a significant role in traditional society. They were the head of their families, lineages and landowners. They were highly respected in comparison with men who had a lower position. In the family, daughters were always preferable to sons because the daughters were the "insiders" who were expected to transmit ancestral property as well as live with their parents even after marriage.

Since 1975, Ede society has been undergoing fundamental changes due to the socioeconomic development policies of the Vietnamese Government in the Central Highlands. Nuclear families are replacing traditional extended families and Ede men are having a greater role in economic activities in order to support their nuclear families. This has put the men and their wives on a greater parity. Meanwhile, Ede women have been

playing a larger role in economic activities and their power is decreasing in relation to men in the family as they are spending more time away from their households. The power structures and the gendered division of labour in Ede families and society in general and in regards to coffee production in particular have been undergoing major changes.

Water scarcity and its influences on coffee production: Water sources for coffee production include natural surface water, ground water and water from irrigation schemes. Surface water is mostly sourced from small streams. Although, there are many small streams in the district with density of 0.6-0.7 km/km^2 they are unevenly allocated. It was witnessed that there were very few streams linked to the extremely small water reserve which flow through Cu Sue Commune. All thirty of the Ede respondents supposed that they could not use stream water for coffee production, especially in last 2 years.

Usually, the rainy season starts in March but in 2016, the first rain in Cu Sue of the season occurred in late June. The difference between rainfall in the rainy and dry seasons is so large that rainfall in the rainy season (from March to October) accounts for 87% of the total rainfall (93.5% in 2015). There is also a big conflict between water demand for coffee production (watering season from January to April) and water availability in the region generally. These differences between the demand and availability of water would be manageable based on the development of an effective irrigation scheme, however, very little research has been invested enough in this area. The three Ede villages where the research has been conducted are located far away from the reservoirs and there is no canal to transport the water. Moreover, there is no existing solution planned a water store to be implemented in the region.

As the irrigation scheme cannot provide enough water for coffee production, almost all farmers in the region have irrigated their coffee plantations using groundwater reserves from individual wells. Survey data shows that each coffee plantation has from one to two wells depending on its size. The average depth of the wells is 26.8 m and one well can service an area of approximately 6,400 m^2. Since, 2015, many households have deepened their wells with some households even digging extra wells to seek water for saving their coffee plantations. A reduction in forested area, climate change and the high density of household wells has caused severe ground water degradation (Head of Department of Agriculture and Rural Development, Personal Communication). The groundwater level in the research site has decreased by between 5 and 7 m in comparison over the period between 2010-2014.

Coffee growers in Cu Sue Commune reported that they have been suffering from water shortages, since, 2015. However, the water scarcity has become more serious since the beginning of 2016. In 2015, it could be witnessed that majority of the paddy fields in the three Ede villages still had enough water for cultivation, however, in 2016 all of them have remained empty. Only some rice plots in the Kinh villages could be sown. All respondents referred to a peak water scarcity occurring in April and May, 2016 when villagers could not obtain water from usual sources for domestic use. In Sut M'Dung Village, dozens of families needed to buy freshwater contained in plastic tanks for domestic uses, costing approximately 15,000 VND ($US 1 equals to VND 22,659 (http://www.exchange-rates.org/Rate/USD/VND/4-7-2017) per day and restricted to drinking and cooking purposes.

In a practice common to other farmers in the region, all survey households irrigate their coffee plantation by pouring water directly to the base of the tree. A standard amount of water of 600 L per tree, per irrigation event is consumed by this method. If there is sufficient water, coffee is irrigated between 4 and 5 times per year as outlined in Table 1.

According to local coffee growers, the first irrigation event is the most important because it strongly impacts upon coffee productivity. In 2015 and 2016, the villagers experiences water shortages and could not maintain the watering schedule for coffee. The number of times the coffee trees were irrigated changed dramatically. The survey data showed that farmers irrigated their crops 6.6 times per year on average. Furthermore, the duration of an irrigation event increased from 3.5 days per time before 2015 to 21 days per time in 2016. For example, a fmale respondent who has a plantation with 340 coffee trees stated that she irrigated only 10 trees per day because her well has been lacking in water for over a year (female coffee farmer, personal communication). Like many households in the village, she could not determine the time spent on irrigating or the duration of an irrigation event as she was observed to need to prioritize the daily irrigation of some trees while letting over coffee trees die.

Table 1: Watering schedule for coffee

Purpose of watering/duration	Irrigation events
Flower blooming	
Mid January-Early February	1-2
Seed fostering	
March	1
April	1
Before harvesting	
September	1
Total	4-5

Survey data, 2016

Under the situation of water scarcity, household's coffee productivity reduced from 2.6 tons/ha in 2010 to 1.4 tons/ha in 2015. One villager reported that she only harvested 200 kg of coffee per hectare in 2015 (female farmer, Sut H'Lout Village, personal communication). On further discussions in April and June of 2016, she predicted that her family may harvest any coffee seed in that year. Strongly impacted by water scarcity, all coffee producers in Cu Sue had to develop strategies to cope with this situation.

"A female farmer and her family have lived in Sut H'Luot Village, since, 1985 when the fixed cultivation policy was implemented. She and her husband have to work to feed three children. Both of them are literate. They have been given two plantations with total 10,000 m^2 and a rice field with 300 m^2 by their parents. Before 2014 they could harvest coffee on all areas. But since 2014, water has become scarce, so, one of their plantations of 5,000 m^2 could not be irrigated. Coffee trees in the non-irrigated plantation have all died while the other plantation has experienced water shortages since early 2016. In 2015, 300 kg of coffee bean, 200 kg of paddy and 50 kg of maize were harvested. The female farmer and her husband have been working as hired-farm labors 5 days a month. The per capita of the family was about 400,000 VND per annum, equivalent to poverty line announced by Ministry of Labour, Invalids and Social Affairs."

Gender roles in response to water scarcity for coffee production: This research focuses on the coping strategies of farm households rather than on public approaches. On the basis of the ways in which farmers practice coffee production as well as the coping strategies farmers selected to save their livelihoods in response to water scarcity for coffee production, three major types of coping strategies were be identified including: short-term; medium-term and long-term approaches.

Shorterm-strategies: Short-term strategies are applied in order to save the coffee plantation from water scarcity are digging more wells, deepening wells, sharing water among households, purchasing water and adapting the schedule of watering. Among the 16 households who decided to dig more wells, ten could not find any water and this coping strategy had to be discontinued after digging ten or even 20 m in depth. Many household chose the coping strategy of deepening their existent wells. However, the financial investment associated with the well deepening was expensive and only 36% of the survey households could afford this.

Four households were able to share water with their siblings and neighbors, however, all of these respondents were Kinh people who lived closed to a water source. Five other households had adopted the coping strategy of buying water from their neighbors at price of 30,000 VND/h of pumping.

The most popular short-term strategy was found to be changing the watering schedule. Majority of respondents reported this approach. Prior to water scarcity issues, one farmer could irrigate one thousand coffee trees per day but since 2015, each well was found to be depleted of water after irrigating only twenty or thirty coffee trees. Thus, farmers needed to divide their plantation and irrigate rotationally.

Male laborers played an important role in deciding and practicing the short-term strategies in response to water scarcity. Digging and deepening wells was mostly done by men with support of machines. If family members were not available for this strategy, households would hire other male labors in the community. Women contributed to this strategy as assisstants through food provision for hired workers and family members. In local people's perception, digging and deepening wells are extremely hard works which belong to men because they own physical power. Dissimilar to digging and deepening wells, female laborers more actively participated in coffee irrigating when watering time was lengthened.

Medium-term strategies: Medium-term strategies are the ways in which farmers apply practice intercropping, particularly growing pepper and avocados in the coffee plantations and to reduce the number of coffee trees in order to grow other crops such as maize and cassava. In the case of water scarcity, almost all households had decided to intercrop with pepper in their coffee plantation. As the price of pepper has been high for 4 years, farmers in Cu Sue have intercropped with pepper since, 2012 at different scales. Avocado has been also grown since 2014. According to respondents, avocado is easily sold at reasonable price but seedlings are expensive, so, few households can afford to invest in this strategy. Some households whose coffee plantation cannot access to water decided to replace coffee trees with annual crops such as maize and cassava. These households planned to return to coffee production when water situation improves.

Unlike short-term strategies, women have played an important role in the development as well as implementation of medium-term strategies. Although, the decision of which crops should be replaced as well as intercropped has been made by an agreement between male and female family members, gender differences in conducting other farming activities has been recognized, even though, gender differences among the Ede as well as

Kinh people in conducting agricultural tasks are not easily observed at the research site. informants have a tendency to reply that "men and women do everything equally when asked about gender differences in agricultural work, however re-phrased or follow-up questions reveal some gender differences in responsibilities and tasks for the livelihood of Ede people, although, the strongest tendency in Ede households is to share responsibilities closely between husband and wife.

The results in Table 2 indicate that, gender differences have been found across generations in Ede families. Young Ede women were mainly responsible for domestic works particularly taking care of children while young men who moved to live with their wive's families have to respond to productive works. However, when medium-term strategies are applied both young and elder Ede women need to work longer hours in the field as they have to take care and harvest not only coffee but also pepper, avocado and other crops.

Long-term strategies: Long-term strategies include seeking jobs outside the village to work as industrial workers as vendors in urban areas and using the money to hire farm laborers, integrating the coffee crops with livestock raising and practicing water saving techniques for coffee production.

Under the conditions of water scarcity, local livelihood strategies become more diverse. There is an appearance of new livelihood strategies such as working as street vendors and industrial workers and developing animal husbandry livelihoods, particularly with goats as shown in Table 3.

Only two households in the study areas applied water efficiency as a coping strategy. Both of them were Kinh people who migrated from the red river delta in the early 1990's. Their strategy is based on an irrigation system supported by a project funded by Asian Development Bank.

Government's intervention in water scarcity (gender neutral policies): In the context of water shortages in Central Highland provinces, the central government has taken substantial short-term action in supporting farmers as well as in improvement of current irrigation scheme. For example, Dak Lak Province has been given 49 billion VND and 500 tons of rice in emergency resources. The central government has also invested money in the improvement and development of the existing irrigation scheme. The provincial people's committee of Dak Lak has also promoted and implemented several strategies in order to assist farmers to cope with water scarcity such as: warning local people of water shortages, advising local people to save water both in production and consumption, repairing existent irrigation scheme including reservoirs, damps, wells and canals, providing water based on prioritizing domestic uses to use by

Table 2: Gender roles in response to water scarcity in coffee production

Activities	Elder women	Elder men	Young women	Young men
Coffee production				
Growing	Frequent	Sometimes	Sometimes	Sometimes
Pruning	Frequent	Sometimes	Sometimes	Sometimes
Fertilizing	Frequent		Sometimes	
Watering		Sometimes		Frequent
Harvesting	Frequent		Sometimes	
Drying	Frequent	Frequent	Frequent	
Selling	Frequent		Sometimes	Frequent
Coping with water shortage				
Well digging		Assistant	Main	Main
Well deepening		Assistant	Main	Main
Water purchasing	Assistant	Main	Main	
Water transporting		Assistant	Main	Main

In-depth interview, 2016

Table 3: Long-term coping strategies with water scarcity

Individual strategies	Number (n = 50)	Percentage	Income per year (Thousand VND)
Seeking jobs outside the village			
Industrial workers (3 men and 2 women)	5	10.0	24.000
Farm-hired labors (15 men and 3 women)	18	36.0	7.200
Vendors in urban area (5 women)	5	10.0	21.000
Livestock development			
Goat	5	10.0	6.000
Pig	10	20.0	12.000
Chicken	15	30.0	4.000
Practicing saving water techniques (drip irrigation)	2	12.5	-

Survey data, 2016

animals, perennial and then annual crops, advising farmers to apply water saving techniques in agricultural production, particularly in coffee watering, suggesting that farmers to select crops which consume less water; re-arrangement crop cycles based on water availability and reforestation, especially in upper catchment areas. Furthermore, in order to manage water sources more effectively, the provincial people's Committee of Dak Lak has also issued decision to require those who wish to construct wells for either domestic use or crop irrigation in drought areas to apply for approval from the Department of Natural Resources and Environment (DoNRE) (Table 4).

As mentioned previously, coping strategies in response to water scarcity can be viewed at national, provincial, community or household scale. In the case of Cu Sue Commune, not only the central government but also the provincial, district and commune levels have intervened to help farmers to cope with the drought. However, government intervention has been limited to giving recommendations which are not adequate enough to cope with serious water scarcity. For example, both central and local governments have suggested that coffee producers should implement drip irrigation systems in order to save water and ensure productivity at 4 tons/ha. However, in our in-depth interviews with 50 farmers it was found that only two among them could take advantage of this technology for several reasons. First, this technique requires a high financial investment. Farmers need to invest about one hundred million VND for an Israel-designed drip-irrigation system and about 40 million VND for a Vietnamese-designed one that can cover 2 ha of coffee plantation (Nhin, 2014; TMVC., 2013) whereas the average size of a coffee plantation is only 0.6 ha. Thus, the scale of the coffee plantation is the second reason the application of drip-irrigation is limited. Third, if farmers apply drip irrigation, the fertigation is required through drip irrigation tubes. If fertilizers purchased are not of high quality then they will not dissolve and cause maintenance issues with the pipes. Fourth, sabotage and theft of irrigation equipment in the village is another reason that constrain investment in drip irrigation as a water saving methodology.

Similar to the provincial government, district and commune leaders have also given advice to farmers regarding adapting their production to water scarce conditions. For example, District Department of Agriculture and Rural Development recommend that farmers substitute water intensive crops to others that, consume less water. DARD also produces irrigation schedules for each commune where the irrigation scheme is available. Nevertheless, respondents from Cu Sue suggested that they have not received any advice from local authorities.

As a consequence, farmers have developed alternative strategies in order to cope with water scarcity based on their experiences and knowledge. The

Table 4: Assessing the coping strategies in the context of water scarcity

Possible options	Who benefits from this option?	Who can effort to make this option?	What supports are necessary?	Un-intended consequences
Seeking water sources (well deepening or digging, water purchasing and sharing)	Coffee growers (both women and men)	Households have enough financial resource Male labors are mainly responsible for seeking water sources	Financial support from government or development programmes	Water resource degradation Financial burdence Female family members and children are more negatively impacted
Changing watering schedule	Coffee growers (both women and men)	Households have enough family labor or those who can hire outside labors	Training from agricultural extension officers	Farmers, particularly women have suffered from workload as they have to devote more time to watering than ever
Intercropping patterns	Coffee growers (both women and men) Community	Households have enough both financial and human resources	Training from agricultural extension officers	Over-production of pepper and avocado may happen, so farmers may face with no market for sell Women have to work harder as they must take care of several crops at the same time
Water saving technique (dripping system)	Coffee growers (both women and men) Community	Households have enough financial resource Fertilizers and pesticides are high quality enough	Financial and technical support from government or other development programmes	Sabotage and theft of irrigation application equipments in the village irrigation Women may be lagged behind if they cannot operate watering system
Livelihood diversification	Coffee growers Community (women, men, girls and boys)	Labors have professional, language and integrated skills	Local initiative	Local people, especially, women might face with social risks from outside
Government programmes	Coffee growers Community (women, men, girls and boys)	Implementing relevant government programmes	Financial and technical supports from government programmes	Irrelevant implementation of government programmes Gender neutral in irrigation policies

CGIAR (2016) has found that the coping strategies applied in response to water scarcity in Cu Sue differs among households and some households are better able to cope with drought than others. For example, in terms of short-term strategies, high and medium income households tended to dig or deepen their wells while poor and pro-poor households did not. About 12 out of 50 households surveyed could neither afford to dig a new well or deepen existing wells because of financial limitation. Similarly, a common practice among farmers in Cu Sue Commune is to integrating other trees (e.g., pepper, avocado, fruits and acacia) into the coffee plantation. This cultivation practice has been considered as medium-term coping strategy in response to water shortages. There are no standard guidelines produced in Vietnam for such practices, so intercropping designs have varied from household to household (CGIAR, 2016). Moreover, intercropping practices also differ due to varied financial, human and social capacity. Where, income for those who engaged with pepper production could compensate those households for lost coffee income, others without the required resources could not access this harvest. For example, a female farmer planted 200 pepper vines in her coffee plantation in 2013 but 160 vines had died in 2016 because of the drought and the other 40 vines had no production. For some villagers, avocado crops both can bring higher income and consumes less water in comparison with coffee and pepper, however, few people can apply this coping strategy at scale due to the high investment cost in the seedlings.

The difficulties with irrigated paddy rice and coffee production in the area were considered as a push factor for local farmers to migrate to work in urban areas and look for alternative livelihoods and other sources of sustenance. Mohieldeen (1999), referring to the coping strategies of migrants leaving Lower Wadi Al Hayma due to water scarcity problems to factories in big cities in Yemen and noted that 85% of respondents in that research had first tried to work as casual hired laborers surrounding their villages.

Seeking jobs outside community is also diverse among households in the Central Highlands. Kinh people were found to be more active in coping with water shortage situation, especially in regards to seeking outside jobs outside the village. Kinh families have paid much more attention to the education of their children than Ede and Dzao. As a result their adult daughters and sons are able to find jobs as industrial workers in Ho Chi Minh City, Binh Duong and Dong Nai provinces. Furthermore, those who do not want to migrate to other provinces have the capacity to generate income from other activities such as vending in Buon Me Thuot City which is 15 km away from Cu Sue Commune or working as industrial workers in the Tan An industrial zone which is located approximately 8 km from the commune. On the contrary, almost all Ede people in Cu Sue are dependent on coffee farming or working as casual hired farm labors surrounding the village. A key cause of this is that they are not qualified for industrial jobs.

Together with seeking off-farm jobs, developing animal husbandry has been considered as a coping strategy in response to severe drought. About 5 out of 50 survey households have recognized that goats can be fed not only by grass but also by Acacia leaves. Acacia has been grown in coffee plantations to stand as trestles of pepper trees and to provide feed for goats. Moreover, acacia also provides good conditions for coffee trees, providing the shady forest conditions that they they prefer and fixing nitrogen (fertilizer) for their growth.

A respondent believed that raising goats could be a suitable livelihood strategy for both Kinh and Ede people in the context of water scarcity because of feed availability and high demand for goat meat. However, as this economic activity is still new villagers still worry about the feed source and technical requirements.

In 2008, the International Trade Centre (ITC) conducted a survey on the role of women in the coffee sector. In highly mechanized systems, like Brazil women were found to played a very small role in field and harvest work whereas for more manual systems, like in most of Africa, women complete up to 90% of the field and harvest work. This finding is consistent with the case of Cu Sue Commune where almost all work is completed manually. Table 2 shows that both women and men participate in all phases of coffee production. However, gender differences have been identified in production and income generation roles. Information from both in-depth interviews and participant observations in Cu Sue indicated that the physical works of land preparation and irrigation was carried out by young men, mostly the sons-in-law in the matriarchal community. In Ede households, the elderly women and sons-in-law have play more important roles in coffee production, particularly in primary processing and selling of the final products. Young women are responsible for annual crop production and domestic works. At the old-age, these gender roles dramatically change. Elderly women work harder whereas elderly men tend to spend more time on relaxing. This explains why young men and elderly women involve in all stages of coffee production process (Table 2).

Mukuhlani and Nyamupingidza (2014) indicated that water scarcity in Zimbabwe more negatively affected women and girls because they had increased burdens in

water fetching and health care and they are impacted by water-borne diseases and the risk of sexual harassment at water points. As a result, women do not have time to invest in education and economic activities and they continued to lag behind in terms of development (Birch *et al*., 2012). Dissimilarly, in Cu Sue both women and men have been negatively affected by water shortage. When water scarcity occurred both men and women became water fetchers for domestic uses. Sometimes, men had to devote more time to carry water because they had to go far away to buy drinking water by motorcycles that could not be driven by many women.

In the case of coffee production, water scarcity has increased the productive roles of women, particularly in intercropping patterns and goat raising. This finding was supported by Valdivia and Mupenzi Mutimura who stated that small stock (chickens, goats and rabbits) was mostly done by women in Rwanda, Kenya, Indonesia, Bolivia and Peru. This research has also found that, men have been more negatively impacted by water scarcity. All works relating to physical hard labour in respond to water shortages for coffee production such as well digging, well deepening, water purchasing and water transporting were carried out by men, especially, young men.

Apart from water fetching for domestic uses and practicing coping strategies to respond to water shortages for coffee production, gender differentiations have also been noted in looking for alternative livelihoods. During the water shortages, many coffee producers left farming and went to work in the urban areas and industrial zones. As showed in previously, most of the migrants were youths. It was found that, Kinh people migrated farther than Ede people and men went to work outside much more than women. Culture, language and education are factors that cause these gender as well as ethnic differences. The finding of my research in Ede community is supported by Nightingale (2009)'s conceptualization of gender which shifted "from a set of fixed binary roles assigned to women and men to viewing resource management and indeed, climate adaptation as processes where gender and social inequalities are contested, changed and reinforced. It is through these processes that the social meaanings of the various social categories of difference-man, womwn, ethnic gourp member, etc., are played out and that power is actually produced and performed" (Nightingale, 2009).

CONCLUSION

Water scarcity for coffee production in Cu Sue Commune, Dak Lak Province has become increasingly severe due to a range of factors including a reduction of rainfall, lowering of the groundwater table, poorly planned irrigation schemes, high density industrial crop plantations and deforestation. Water scarcity has resulted in a decline in coffee productivity and then in producers income. Some households who have been strongly dependent on coffee production have fallen into poverty. All men and women as well as boys and girls have been negatively impacted by water scarcity both in production an in consumption.

In response to water scarce situation, farmers have constructed their own strategies to cope with water scarcity for coffee production and their livelihoods. It has been observed that the coping strategies include short, medium and long-term approaches. Although, short-term coping strategies differed from household to household they were mainly associated with digging more wells, deepening wells, purchasing water, sharing water and changes to irrigation schedule. Male farmers have mainly responded to the short-term approaches. The most popular medium-term coping strategy was intercropped cultivation, integrating of coffee plantations with pepper, avocadoes and acacia. In order to practice the intercroping cultivation both young and elder Ede women have become double burden as they have to devote more time on taking care of not only coffee but also pepper, avocado and other crops. For the long-term coping strategies such as livelihood diversification and application of water efficient irrigation methods, women seemed more active than men.

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