Tạp chí

Kinh tế và Quản trị Kinh doanh

Journal of Economics and Business Administration

Chỉ số ISSN: 2525 – 2569 **Số 08, tháng 12 năm 2018**

MỤC LỤC

TÁC ĐỘNG CỦA BIẾN ĐỔI KHÍ HẬU ĐẾN NGÀNH SẢN XUẤT CHÈ TRƯỜNG HỢP TẠI TỈNH THÁI NGUYÊN, VIỆT NAM

Aaron Kingsbury[1], Dương Hoài An[2], Phạm Văn Tuấn[3]

Tóm tắt

Thái Nguyên là tỉnh có sản lượng chè lớn nhất ở khu vực miền Bắc Việt Nam. Biến đổi khí hậu đang có những ảnh hưởng trực tiếp đến những điều kiện sinh trưởng và phát triển của chè. Tuy nhiên, những nghiên cứu đánh giá tác động tiêu cực của biến đổi khí hậu đến năng suất và sản lượng chè trên địa bàn tỉnh Thái Nguyên để từ đó đưa ra các biện pháp giảm thiểu những tác động này chưa nhiều. Nghiên cứu này nhằm lấp lỗ hổng này. Cụ thể, thông qua các cuộc phỏng vấn sâu với các bên liên quan trong ngành sản xuất chè cho thấy rằng lượng, tần suất và mức độ nghiêm trọng ngày càng tăng của các cơn mưa, đợt hạn hán và nắng nóng cũng như những thay đổi bất thường về hình thái mùa vụ trong năm là những yếu tố ảnh hưởng chủ yếu đến ngành sản xuất chè trên địa bàn nghiên cứu. Ngoài ra, hiểu biết của người sản xuất chè về những tác động của biến đổi khí hậu nói chung và đến ngành chè nói riêng còn khá hạn chế. Họ thường đối phó với biến đổi khí hậu một cách khá thụ động. Nghiên cứu này cũng đề xuất một số giải pháp để phát triển bền vững ngành chè trên địa bàn tỉnh Thái Nguyên.

Từ khoá: *Sản xuất chè, ứng phó với biến đổi khí hậu, Thái Nguyên, Việt Nam*

THE IMPACT OF CLIMATE CHANGE ON TEA PRODUCTION THE CASE OF THAI NGUYEN PROVINCE, VIETNAM

Abstract

Thai Nguyen Province is at the centre of tea production in northern Vietnam. Changing climate continues to directly impact the ways and conditions under which tea is grown. Despite the importance of this crop to the Vietnamese economy, how these changes in climate affect production and how to optimally mitigate adverse effects remains little studied. This paper helps to fill this gap. Specifically, interviews with industry and farmer respondents uncovered an increased amount and intensity of precipitation, an escalation in the frequency and severity of droughts, a rise in the frequency and severity in periods of elevated temperatures, and a shift in seasons for the optimal production of tea are the major factors affecting the tea production in the studied area. Overall, farmers had only minimal understanding of how climate change affects their production, and tended to react to rather than proactively prepare for change. This paper then records and assesses agronomic responses by farmers to those changes, and posits agronomic and cultural recommendations to make production more economically and socially sustainable.

Keywords: *Tea production, Climate Change Adaptation, Vietnam, Thai Nguyen Province.*

1. Introduction

Climate change refers to any change in climate over time. In order to adapt to these changes, individuals and communities must alter their habits. This is particularly true with activities related to agricultural production, and failing to do so negatively increases socio-economic risk, decreases food security, and further limits adaptive capacities of communities and producers. Producers in countries with developing economies, such as Vietnam, are no exception and require a more immediate reorientation and collaborative response in agriculture and policy making (Viet, 2011; Thanh et al., 2013; Tran et al., 2016).

According to Tran (2007), the average temperature in Vietnam increased by 0.32°C between 1961-1990 and will continue to rise in the following decades. For example, the average temperature in the capital, Hanoi, is predicted to increase between 2.5 to 4°C by 2100. Similarly, rainfall patterns have changed, increasing in the northern and decreasing in the southern part of the country. Rainfall in Hanoi is predicted to increase by 2-5% by 2100. The increase in temperature and precipitation will intensify the frequency and severity of both droughts and floods across the country (Chaudhry and Ruysschaert, 2007; Viet, 2011).

According to a report issued by the FAO (2011), the impacts of climate change on agriculture in northern Vietnam are also pronounced. Between 1958 and 2007, the annual mean temperature rose approximately 0.5-0.7°C. The region now experiences higher winter temperatures and a marked decrease in average

annual rainfall. This has resulted in severe droughts, considerably increasing the demand for water in agriculture. It has been predicted that this demand may double or even triple by 2100 (FAO, 2011). Higher temperatures and changing rainfall patterns also continue to increase pest and fungal pressures. Perhaps most significantly, growing seasons, particularly in the production of tea in areas such as Thai Nguyen Province, are shifting. If there is not a timely and coordinated response, the potential for dire consequences to local agriculture is real.

This importance of climate change to Vietnamese agriculture has received considerable treatment in the literature. Studies range from focusing on the adaptability, resilience, and food security in relation to agroforestry (Nguyen et al., 2013); building stronger rural-urban links to improve food security (Thanh et al., 2013); identifying ingenious or folk knowledge in coping with climate change (Ngoc and Hanh, 2015); and determining how the perceptions of climate change of provincial officials affect mitigation strategies (Van et al., 2015). Yet, the effects of a changing climate on the production of tea remain little explored. This is particularly troublesome as climate is a decisive factor in determining optimal crop development and the industry provides considerable employment in areas more remote and economically disadvantaged (Viet 2011; Chang and Brattlof, 2015). This paper helps to fill this gap by focusing on tea production in the northern Vietnamese province of Thai Nguyen to determine how climate change is affecting farmers, how farmers understand and are responding to those changes, and what effective adoptive measures would make production more economically and socially sustainable in the face of continued environmental change.

2. Study Area

Thai Nguyen Province is located approximately 80 kilometers from Hanoi in the north of Vietnam (See Figure 1).

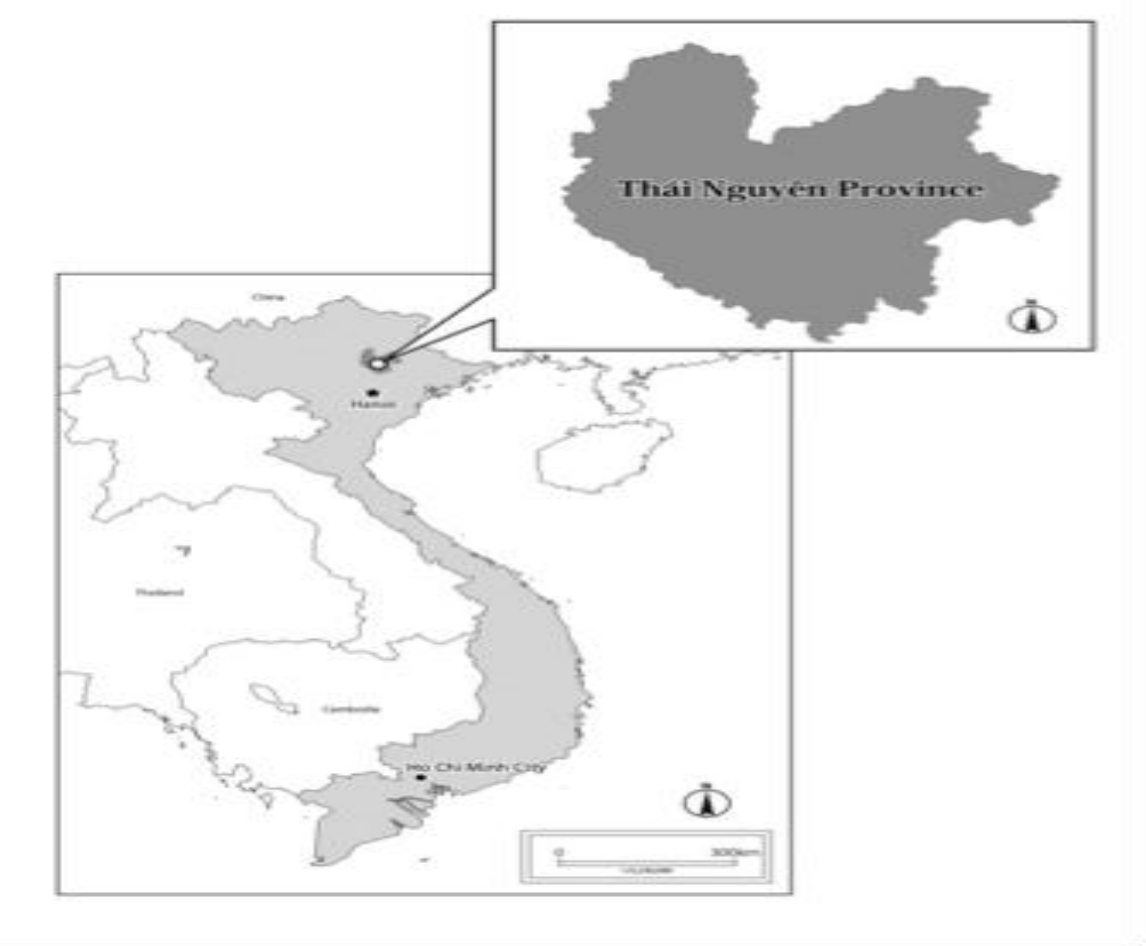

Figure 1. Map of Vietnam with Thai Nguyen Province

Source: Adopted from Nguyet, 2015

Thai Nguyen is the second largest tea area in Vietnam in term of production and area cultivated. Currently, there are 21,000 hectares of tea grown in the province. The average yield is approximately 1.09 tons of dried tea per hectare. The annual dried tea production in 2016 was 185,000 tons. Tea exports and export turnover slightly increased between 2015 and 2016 (Figure 2). This is a trend expected to continue in the near future.

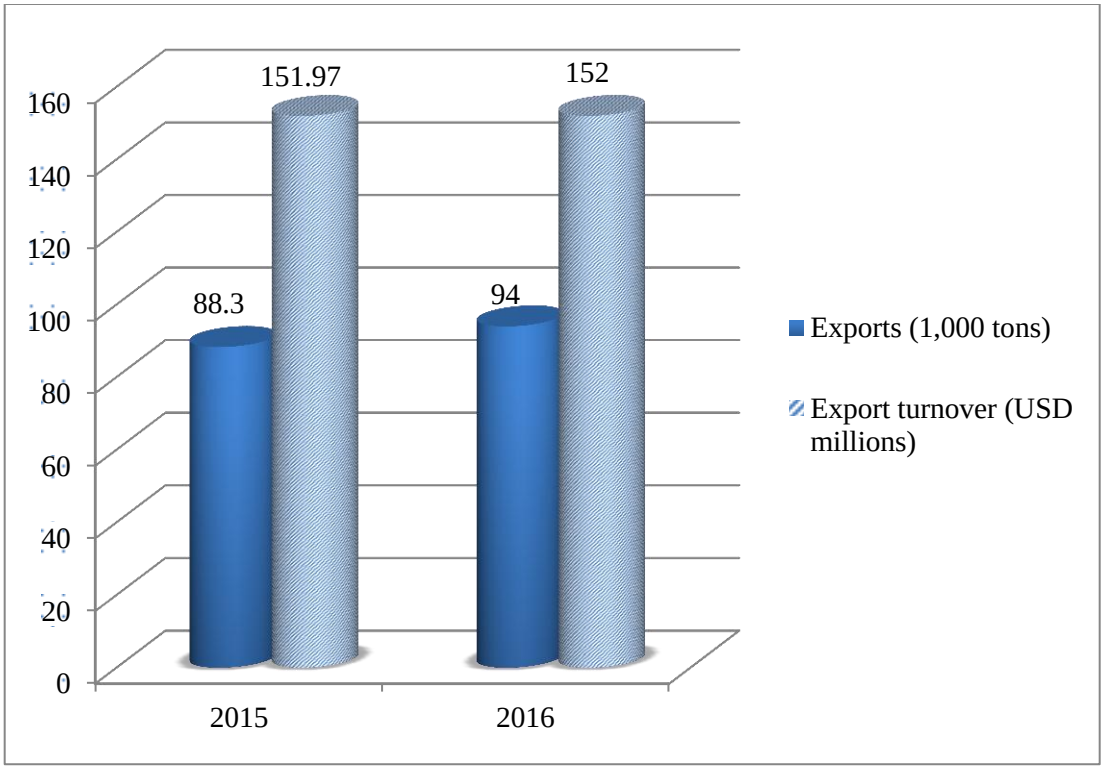

Figure 2. Thai Nguyen Tea Exports and Export Turnover

Source. Adopted from Nga, 2016

There are a number of steps in the Thai Nguyen tea production value chain including planting, cultivation habits, collecting, transporting, processing, packaging, labeling, storing, and selling. In 2016, there were 29 businesses, 30 cooperatives, 50 trade villages, and 60,000 tea farming-households that participated in this value chain (Nguyen, 2016). Overall, tea production in the province can be classified into three main regions or macroclimates based on a variance in climate due to elevation. This study was operationalized to identify how changes in climate have affected the production of tea across these three macroclimates, record indigenous agronomic responses by farmers to those changes, and then posit specific suggestions for more sustainable production in the face of continued environmental change. Based on Nguyet (2015), the three macroclimatic regions in Thai Nguyen are as follows:

- Tan Cuong, Phuc Triu, and Phuc Xuan communes in Thai Nguyen City form the lowest elevation at 30-100m
- Song Cau town in the Dong Hy district forms the medium elevation at >100 - 200m
- Trai Cai of the Dai Tu district and Vo Tranh and Duc Tranh of the Phu Luong district form the highest elevation at >200 - 400m (See Figure 3).

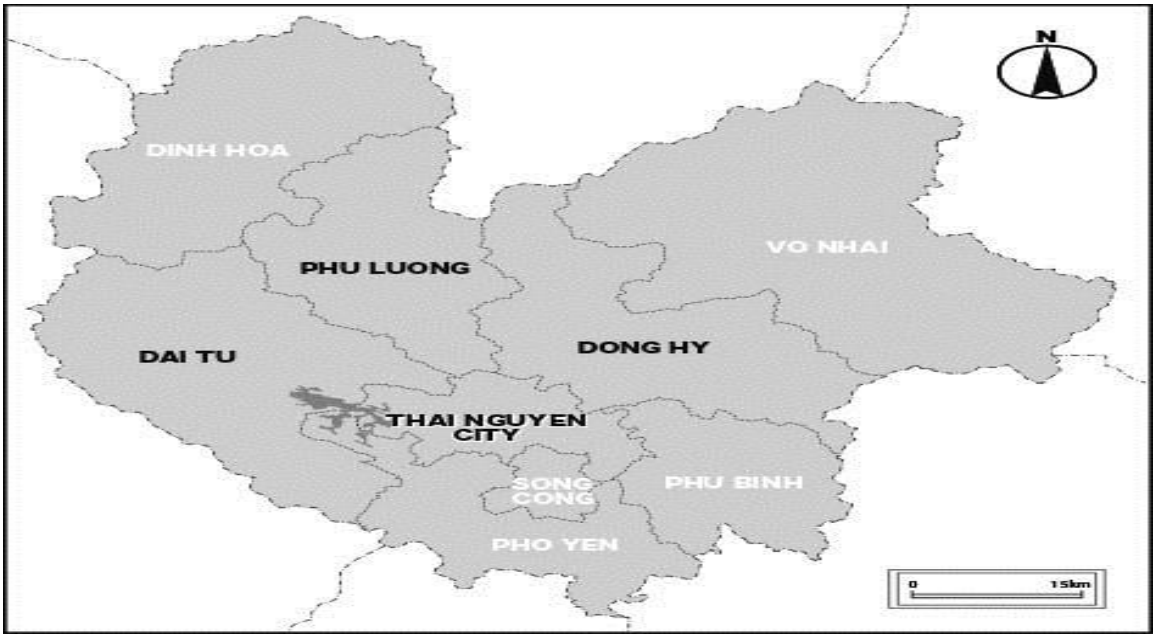

Figure 3. The macroclimatic regions of tea production in Thai Nguyen Province

Source. Adopted from Nguyet, 2015

3. Methodology

Data was collected using interconnected methods. First, deep interviews were conducted with local tea experts. Then, full-time tea farmers, producers, and traders representing each of the three macroclimates were interviewed. Guided in design by Boyce and Neale (2016), interview schedules were constructed to obtain detailed information about the thoughts and opinions of individual respondents. Interviews were largely unstructured and following Zang and Wildemuth (2009), typical 'conversations' were conducted without hypotheses and to develop, rather than test, theory. Interviews with farmers occurred in their homes and tea plantations, permitting opportunities for micro-explorations of social dynamics through participant observation. As per Sin (2003), this place-ness of respondents and its relation to the interviewer were regularly reassessed during fieldwork

A total of 26 farmer respondents were interviewed as case studies, many of whom were also later re-interviewed for further clarification. It is interesting to note that while interviewed farmers typically completed only ten years of formal education, they averaged over 25 years of practical experience in tea production. The mean cultivation area was 0.59 hectares producing a higher than average 1.67 tons of dried tea annually.

4. Results

Based on interview data (i.e., with tea farmers, producers, traders, and experts) and our observations, climate change was found to have had a number of direct impacts on tea production in Thai Nguyen Province. Although tea comprises a major agricultural crop of Thai Nguyen and local changes in climate have been obvious in recent years, there have not been any studies specifically examining how it affects production. Each major change will now be discussed in terms of this impact and the resulting agronomic responses of local farmers. Importantly, during the data collection process farmers often mentioned that both the occurrence and severity of these climatic changes are more recent phenomena, and noted that adequate, on-farm, and currently practiced solutions remain rare.

4.1. Increased amount and intensity of precipitation

The amount and intensity of rainfall across the region is in flux. This has accelerated rates of decomposition and the rotting of both the roots and young leaves of tea plants. Additionally, the rise in intense precipitation events have led to more severe pressure from fungal pathogens and have resulted in increased soil erosion. In response, farmers have largely sought shorter-term and more immediate solutions rather than proactively managing future potential risks. Perhaps the most common practice is the digging of temporary ditches during and following larger precipitation events to drain excess water from fields. Additionally, farmers are now creating soil beds that incorporate larger rocks to facilitate the

draining of water at quicker rates. This practice was more commonly found in flatter areas. The use of mulches to cover rows was also noted, although not yet a universal practice. In response to increases in pest pressures, farmers have been forced to employ more part-time labor to increase the number and intensity of pesticide applications. The timing of these applications will be discussed in a later section.

4.2. Increased frequency and severity of droughts

Along with an increase in the amount and intensity of precipitation, farmers now struggle to cope with more common and severe droughts. A lack of precipitation prevents tea from reaching maturity, and if coupled with high temperature can kill plants. As a response farmers are again being forced to employ more labor to water fields regularly, although the timing of these applications is not always optimal.

4.3. Increased frequency and severity of higher temperatures

The third major change is the more frequent periods of severely high temperatures. High temperatures burn both tea buds and young leaves. Tea propagated by fasciculated roots, such as is common with hybrids varieties, are particularly vulnerable. During fieldwork in the summer of 2017, the region experienced long periods of heavy rain combined with temperatures over 37 °C. Respondents noted that tea roots appeared "cooked" (Figure 4). The percentage of damage (i.e., defoliation and/or death) and loss (harvest rounds missed) ranged from 20% in more sloped areas to 70% in flat areas. Finally, the rise in temperatures has resulted in an increase in insect pest pressure.

Figure 4. Damaged tea as a result of a combination of increased precipitation followed by high temperatures

Source: Photographed by the authors

Similar to the threat faced by the increased frequency and severity of droughts, farmers are again employing more labour to meet irrigation demands. Additional labour is also being used to apply more pesticides. Some farmers noted they cover their tea with black netting to reduce the impact of heat on plants.

4.4. Shift in growing seasons

More traditionally, farmers harvested during the year and pruned in winter, with the most valuable crop being the first harvested in spring. One interesting finding of this study was that an entire shift in growing seasons has occurred. With winter climates now warmer, farmers are investing considerably more into winter tea production. The quality of the leaves and flavor are better, resulting in prices more than double or even triple previous harvests. As a result, pruning now happens in spring.

5. Discussion

There are a number of considerations that merit discussion when considering how to best mitigate the negative effects of and possibly even take advantage of the potential benefits of climate change. First, this study surprisingly found no significant differences in how climate change is

affecting tea production across the three macroclimates in Thai Nguyen Province. For example, even at areas of higher elevation, prolonged rain incidents adversely affect production when water cannot drain. Stated more broadly, although it is believed that tea grown at higher elevations will suffer less adverse effects due to climate change, no clear relationship between elevation and manifestation was found.

Secondly, one of the key findings of this study was that tea farmers in Thai Nguyen Province are not always aware of the realities of climate change or how to efficiently adopt their practices to best mitigate that change. The majority of respondents were reactionary, rather than having specific plans of preemptive action to implement techniques appropriate to evolving local conditions. This is something that needs to change as more complicated solutions to ever more severe climate will be required. Extension agencies should encourage farmers to design solid plans to better prepare for and adapt to climate changes. A first step would be the establishment of seminars and workshops on climate change in both agriculture and tea production more specifically.

Next, the present planting density of tea trees needs to be reduced. While such high densities are maintained with the idea of an increased harvest and to avoid additional spraying and cutting between rows, they are no longer practical. A crowded canopy greatly limits the circulation of air, providing optimal conditions for an increase in fungal pathogens. While under previous climate regimes such agronomic practices may have been suitable, this is no longer true. The expanded use of mulch between tea rows would provide a good solution to deal with soil erosion (caused by larger volume and more intense precipitation events), droughts, and high temperatures, while reducing the labor requirements attributed to grass cutting. Furthermore, the creation of soil beds with layers of materials that help remove water quickly is now necessary. The soil beds should be high and the ditches between rows should be deep enough for tea roots to avoid flooding.

Next, there has been a considerable effort by the provincial government to expand the acreage of tea under hybrid varieties. The impetus for this is largely to reduce the lengthier period of time from planting to harvest common with traditional varieties, increase harvest yield rates per hectare, and take advantage of higher market values all to increase profits. This paper argues that the further expansion of hybrid varieties merits reconsideration, specifically as many have been found to be ill-suited to the effects of climate change under local conditions. In particular, hybrids are best grown on flat areas as their roots do not penetrate deep into the soil (i.e., and therefore also tend to accelerate erosion on slope lands). Having roots located near the surface increases the possibility of damage due to high temperature and precipitation events. Furthermore, it must be considered that most of the flat areas converted to tea were previously under wet paddy rice. Hybrid tea roots struggle to break the previous hardpan, remain near the surface, and are therefore prone to increased rates of decay. If hybrids are planted, the creation of high soil beds through layers of materials underneath that can quickly drain water from fields would benefit farmers, particularly in lower elevations. Of the two commonly hybrid varieties grown locally, "Kim Tuyen", is best adapted to changing conditions. On the other hand, "777" fairs worst under local conditions and is therefore not recommended for future plantings.

This study also found that tea grown from seeds is better adapted to the changing climate. For example, tea grown from seeds has roots that reach deeper into the soil profile than tea propagated. As a result, if a plantation is flooded for a shorter period of time, the deeper reaching roots ensure higher rates of survival. However, if the plantation is flooded for more than a week, both tea grown from seeds and from propagation will be adversely affected and likely die.

Recommendations for adapting to both drought and elevated temperatures focus largely on gaining some control over temperature and available water through lower cost technology advancements. The most obvious type of water management is to introduce some form of sprinkler watering system. If possible, a drip irrigation system would permit the highest level of control while reducing runoff and waste. An expansion in the use of black netting would also help to reduce the negative impacts of extreme temperature. Watering should only occur at dawn or dusk to prevent loss though evaporation. Fertilizers and pesticides should not be applied before watering or large precipitation events.

Furthermore, glass houses made with durable frames (e.g., from steel), covered with clear plastic sheets, surrounded with black netting, and with sprinkler water systems would considerably reduce some of the adverse impacts of climate

change in local production. Such systems would help to reduce flooding by rain water, allow for the reduction of heat (i.e., in summer), and help to increase temperatures when it is colder (i.e., in winter). Additionally, the use of such glass houses would permit an additional two harvest rounds per year for a total of ten while advantageously offering reductions in disease and pest pressures. Installation costs of over US$100,000 per hectare are relatively high when compared to the income of tea farmers, but considerable benefits would be accrued if those costs were subsidized by a government or development program.

Cultivation habits were also found to significantly impact the ability of tea to cope with climate change. As an example, if fertilizers were uniformly scattered across the top of a field, tea roots would remain closer to the surface. Consequently, in periods of elevated perception and temperature, the roots are more prone to rot or burning. As such, it is recommended that fertilizers be applied to holes and ditches between tea rows.

Some studies have suggested that at lower elevations tea should be replaced with crops that are better suited to flooding such as rice (FAO, 2011) or by extension possibly even lotus root (Kingsbury et al., 2010). Under local conditions however, tea has considerably higher income earning potential. While such a replanting may make strong agronomic sense, farmers are unlikely to be willing to make these transitions.

Finally, this paper argues for the reduction of tea produced as a monoculture. Intercropping tea with nitrogen-fixing crops would provide one part of the solution to climate change. In particular, *Popcorn cassia* is known to advantageously provide shade through its canopy and improve soil quality. It has also been recommended by extension agencies in the past. However, further research is needed as to its suitability and the specific adaptation of this plant to local conditions. While no academic research was found that supported these claims, some farmers believe *Popcorn cassia* has a tendency to harbor pests and/or compete with tea for nutrients. As an alternative, tea farmers preferred planting *Tephrosia candida* to provide shade to their tea farms and improve the soil (Figure 5).

Figure 5. Young tea plants intercropped with Tephrosia candida

Source: Photographed by the authors

Due to the potential concerns surrounding the use of *Popcorn cassia* noted by many tea growers, *Tephrosia candida* merits considerable future research as a viable and more sustainable alternative.

6. Conclusions and Recommendations

This study found that climate change is directly impacting tea production in Thai Nguyen Province in northern Vietnam. Unprecedented durations and intensities of rainfall compiled with increased temperatures are affecting growing conditions, shifting growing seasons, and adding new levels of economic and agronomic stresses to farm families. Surprisingly, these changes varied little across the three macroclimates within the region. Overall, this study used a mixed method approach of data collection to document current

practices of farmers seeking to circumvent issues related to climatic changes and to posit a number of recommendations to improve the economic and environmental sustainability of local production. In so doing it identifies research and development needs, a fundamental background step to dealing with issues of climate change in agriculture (Simelton et al., 2014).

More specifically, this study recommends the selection of specific varieties of tea better capable of coping with more extreme flood and heat events. Additionally, the creation of high soil beds to facilitate the flow of water away from fields should be encouraged. Alternatively, intercropping *Tephrosia candida* with tea would help to provide shade for tea and improve the quality of the soil. Finally, while initially expensive, infrastructural investment in glass houses and/or drip irrigation systems would optimize the ability of farmers to better control facets of their production. A simple addition of piping to more easily apply liquid fertilizers and bio-pesticides in plantations would also reduce labor costs.

Perhaps most importantly, this study found that farmers were not always aware of climate change or how to mitigate its adverse effects in their fields. With no preemptive plan, farmers were often making important decisions to reduce damage following more severe climate events. Extension services should encourage farmers to better prepare for changes prior to their occurrence. An initial step would be the establishment of basic and intermediate level seminars and workshops on both climate change as a concept and also its effects in tea production. As climate continues to shift, more comprehensive preemptive planning and extensive collaboration between all stakeholders will be invaluable.

REFERENCES

[1]. Boyce, C. and P. Neale. (2006). Conducting In-Depth Interviews: A Guide for Designing and Conducting In-depth Interviews for Evaluation Input. *Pathfinder International*. Watertown, USA. May.

[2]. Chang, K. and M. Brattlof. (2015). *Socio-Economic Implications of Climate for Tea Producing Countries. Market and Policy Analyses of Raw Materials, Horticulture and Tropical Products Team.* Food and Agriculture Organization of the United Nations. Rome.

[3]. Chaudhry, P. and G. Ruysschaert. (2007). Climate Change and Human Development in Vietnam. *Human Development Report 2007/2008*, Human Development Report Office, Occasional Paper, New York.

[4]. FAO. (2011). Strengthening Capacities to Enhance Coordinated and Integrated Disaster Risk Reduction Actions and Adaptation to Climate Change in Agriculture in the Northern Mountain Regions of Viet Nam. *Retrieved July 2017*, from http://www.fao.org/climatechange/34068-0d42acdf5fb7c4d80f3013c038ab92ce6.pdf

[5]. Kingsbury A., Y. Maeda, and M. Takahashi. (2010). Marketing the Slippery Local with the Contrived Rural: Case Studies of Alternative Vegetable Retail in the Urban Fringe of Nagoya, Japan. *International Journal of Sociology of Agriculture and Food*, 17:89-107.

[6]. Nga Thi Nguyen. (2016). *An Overview of Thai Nguyen Tea Industry*. Retrieved from http://vietcotra.vn/tin-moi/tong-quan-ve-nganh-che-thai-nguyen-c9a94.html

[7]. Ngoc, L. and B. Hanh. (2015). *Indigenous Knowledge- A Human Capital Response to Climate Change in Agriculture at North Central Region, Vietnam*.

[8]. Nguyen, N. (2016). *An Overview of Thai Nguyen Tea Industry.* Retrieved July 2017, from http://vietcotra.vn/tin-moi/tong-quan-ve-nganh-che-thai-nguyen-c9a94.html.

[9]. Nguyen, Q., M. Hoang, I. Oborn, and M. Noordwijk. (2013). Multipurpose Agroforestry as a Climate Change Resiliency Option for Farmers: An Example of Local Adaptation in Vietnam. *Climate Change*, 117:241-257.

[10]. Nguyet, L. T. (2015). Phân tích cấu trúc các tổng hợp thể tự nhiên tỉnh Thái Nguyên phục vụ mục đích sử dụng hợp lý tài nguyên, phát triển bền vững (An Analysis of Natural Structure of Thai Nguyen Province for Sustainable Development). *The Institute of Science and Technology*. *Ph.D. Thesis*: 148.

[11]. Simelton E, V. Dam, R. Finlayson, R. Lasco. (2014). *The Talking Toolkit. How Smallholding Farmers and Local Governments Can Together Adapt to Climate Change*. World Agroforestry Centre (ICRAF), Hanoi, Vietnam.
[12]. Sin, C. (2013). Interviewing in 'Place': The Socio-spatial Construction of Interview Data. *Area*. 35(3): 305 - 312.
[13]. Thanh, H., T. Anh, L. Quang, D. Giang, and D. Phuong. (2013). Food Security in the Context of Vietnam's Rural-Urban Linkages and Climate Change. *International Institute for Environment and Development Country Report.* December. 4 - 37.
[14]. Tran, H. (2007). *The Impact of Climate Change on Agriculture in Vietnam*. Retrieved August 2017, from http://vietsciences.free.fr/timhieu/khoahoc/quadiacau/anhhuongkhihau-nongnghiepvn.htm.
[15]. Viet, N. (2011). Climate Chagne and Agricutural Production in Vietnam. In W. Filho (Ed.). *The Economic, Social and Political Elements of Climate Change*. New York: Springer. 227 - 243.
[16]. Zhang, Y**.** and B. Wildemuth. (2009). Unstructured Interviews. In B. Wildemuth (Ed.). *Applications of Social Research Methods to Questions in Information and Library Science*. Westport, CT: Libraries Unlimited. 222-231.

Thông tin tác giả:
1. Aaron Kingsbury
- Đơn vị công tác: Maine Maritime Academy, USA and regular Visiting Scholar at Thai Nguyen University of Agriculture and Forestry, Vietnam.
- Địa chỉ email: *aaron.kingsbury@mma.edu*
2. Dương Hoài An
- Đơn vị công tác: Trường ĐH Nông Lâm Thái Nguyên
3. Phạm Văn Tuấn
- Đơn vị công tác: Trường ĐH Nông Lâm Thái Nguyên

Ngày nhận bài: 10/10/2018
Ngày nhận bản sửa: 02/12/2018
Ngày duyệt đăng: 28/12/2018