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| RESEARCH ARTICLE

Arabica Coffee Bean Growing in the Chiang Rai and Chiang Mai Areas of Northern Thailand and How to Make the Farming More Sustainable

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| ABSTRACT
The problem statement for this study was how to improve the sustainability of the Arabica coffee bean growing industry in Chiang Rai and Chiang Mai in Northern Thailand. The focus from that was how to improve the quality of the beans to optimise sale price whilst also maximising yield to optimise income. Another issue arises, particularly in the era of global warming and increased environmental concern, which is embracing commercial imperatives whilst also being environmentally friendly. To that extent a general toolkit of actions can be proposed for the production process but concurrently seeking not simply to sustain the Arabica industry but the whole local environment, its flora and fauna and farming and other families. The final question then becomes how relevant general concepts are in specific local areas of particular terroir (simplifying, soil, climate and topography, particularly altitude) and how adaptive they need to be not only in terms of the geophysical environment but also the human environment and its traditions. Detailed testimony was received from local farmers.

| KEYWORDS

Arabica, Chiang Rai, coffee, Northern Thailand, sustainability, agroforestry, regenerative agriculture, carbon capture, carbon offset.

| ARTICLE INFORMATION

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1. Introduction

This paper concerns itself only with Arabica coffee bean. Arabica is grown in the mountainous North of Thailand. The other main coffee tree species, robusta, is grown in the South of Thailand. Robusta, with very little exception, is grown as low-value commercial coffee that might be used to make instant coffee or coffee flavourings, the latter, for instance, for the bakery industry.

Arabica cultivation is a relatively recent introduction to Thailand and has substantially higher sales value than robusta. It is grown in areas previously associated with slash and burn (swidden) cultivation of opium poppy by migratory tribespeople such as the Akha. People cleared substantial forest areas, grew the opium poppy, and then moved on and repeated the process. Similar slash-and-burn agriculture happened at multitudinous points globally.

Whereas grandiose schemes to wholly re-design the current agricultural system, including globally, are suggested, even including extensive recycling of human sewage to create a circular economy in arable agriculture (Cameron et al., 2015) they seem to make little headway, perhaps through economic, cultural and political elements, vested interests included, rather than scientific inabilities.

The Arabica coffee industry, including in Northern Thailand, takes a relatively narrow but important view, essentially based on the original deforestation of so much land in the area by swidden agriculture, looking to stop further deforestation, to re-instigate forest, run commercially successful farming activity in and through bio-diverse surroundings and create a pleasant, healthy, environment for human work and leisure. These aims are not mutually exclusive, in fact entirely compatible. However, loss of forest

has been high even in very recent years, albeit that deforestation peaked globally in the 1980s (Ritchie, 2021). That is the past, with agroforestry and regenerative agriculture the currently on-trend approaches, often simply redressing the damage of the past and often in the simplest of ways such as intercropping, a major focus of agroforestry ("The Road to Successful Agroforestry Initiatives",n.d.). Such agroforestry is a very positive fit with contemporary aims in both agriculture and the wider society, reducing carbon footprints, improving farm resistance to climate change, increasing farm incomes through diverse cropping and, maybe, even enabling carbon credit programmes to be actioned as yet another farm income source ("The Road to Successful Agroforestry Initiatives", n.d.).

Globally how to move from swidden agricultural practice is an entrenched debate. By its nature, swidden farming is unsustainable, in that it extracts and quickly moves on, nutrients never replaced and the ability to withstand soil erosion reduced as the soil loses its water-retentiveness. More sustainable farming practice has been a matter for debate, promotion and action. In Thailand this movement was championed by the monarchy, specifically King Rama 9, from the 1950s. It was actioned by the state bureaucracy through sometimes restrictive control of stateless tribespeople (e.g. McKinnon, 2005). but also through educational, promotional and financially supportive work of the Royal Projects. However, arguably (Azavedo, 2023) more important was market forces, meaning the high income available to farmers through transitioning to Arabica cultivation. Sustainability for families and their farming enterprises grows and lack of income in a location is generally the cause of migrant or nomadic people moving on (Kussumo et al., 2023).

A short guide for Arabica farmers' potential sustainability-improving actions may be easily set-out, guided by a mission statement around the best balancing of crop yield and quality. The aim is to get a good price, but increasingly to be concerned for sustaining the environment in an age of global warming. That also sustains the business. Farmers may manipulate a large number of variables to achieve these aims, but mostly employ a not-too-extensive tool set:

1.1 Disease Resistance

Two areas are of particular relevance here, cultivars for disease resistance and hybridisation for disease resistance. The backdrop is that Arabica coffee trees are highly disease prone, mainly through coffee leaf rust and coffee berry disease.

That Catimor varietal is a good choice for Peru is well-documented (Borjas-Ventura et al., 2020) Catimor is also widely adopted in Northern Thailand (Noppakoonwong et al., 2014) Hybridisation can be undertaken to produce disease resistant strains. In fact Catimor CIFC 7963-13-28 is a specific hybrid Catimor varietal developed for disease resistance which is used in Northern Thailand. However Catimor CIFC 7963-13-28 is a poor performer in drought so farmers must be careful in planting (see below). It may also be questionable with global warming (Hantawee et al., 2008).

1.2 Shade

Shade planting of coffee trees could mean planting under the forest canopy but it is more likely to refer to planting in the shade of trees previously planted for commercial cropping, but now redundant (eg cherry trees in Chiang Rai). Often, though, the reference is to planting in the shade of recently introduced trees for commercial cropping. The aim is to get shade but also often strong commercial sales value, macadamia and avocado being good contenders because of high commercial value of their crops. However, anything that produces shade can be adopted, for instance bamboo or simply planting in the shade of a mountain. Macadamia has extreme value, but if a coffee farmer also roasts his beans macadamia he can use spare roasting capacity too.

The purpose of shade growing is not simply to keep the heat off the coffee plants but to create a localised micro-climate where soil temperature and humidity are controlled and a generally more biodiverse and sustainable local environment created. Pests are reduced through their predators, such as birds, thriving (Alemu, 2015). Crop yields and coffee cherry sizes increase (Muschler, 2001). Anhar et al., (2021) see shaded planting as an important weapon against climate change.

1.3 Soil Management

The focus here is different for differing terroir. In one case this refers to nutrient preservation and enhancement, often simply an application of fertilisers. In other locations the concern will be more with preservation of the soil from erosion. Ultimately soil erosion, nutrient loss and fertiliser application are related variables, but topography plays a strong role. Steep slopes, as may be found in Northern Thailand, offer problems from soil erosion (Okoth, Ng'ang'a, & Kimani, 2007). Note that climate change is increasing the possibility of very heavy downpours of rain. On steep slopes, mulching is recommended to maintain soil moisture, slow run-off velocity and improve water infiltration into the soil, so controlling soil erosion and nutrient loss. Field division can be helpful, too especially if physical barriers are introduced to slow water flows. Such barriers may be of simple vegetation.

Whatever is done by way of managing soil erosion, in all areas, fertilisation is normal in Arabica tree care. Coffee trees need a lot of potash, a lot of nitrogen, and some phosphoric acid. Movement away from chemical fertilisation is to be encouraged. Composting Coffee pulp and husk, by-products of coffee processing, produces a readily available fertiliser source (Dawid, 2018) and offers circularity, lowering wasted by-products of coffee production.

Interest in regenerative agriculture has become very current but not as strongly in Northern Thailand as in many other areas, the point being that the terroir in Northern Thailand makes concern with erosion more immediately obvious. Regenerative agriculture is very much concerned with soil health. There are two aspects, regenerating the soil from damage done, but also a developing concern to avoid damaging the soil, for instance less use of heavy machinery, pesticides and fertilisers. Soil analysis has a substantial part to play. Decrease in these inputs can also reduce costs substantially. Cuellar (2024) has spoken of 20% lower use of inputs and a 20-30% gain in coffee beans produced through adoption of biochar, a kind of charcoal. Biochar is produced from organic materials and stored in the soil to remove carbon dioxide from the atmosphere.

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In Colombia, interviewed by Castellano (2024), farmer Daza pointed out the breadth of change brought by Regenerative Agriculture in this high adoption rate country of its processes and philosophies. He particularly covered that employing fewer pesticides, herbicides and fungicides required and enabled the employment of more local labour on the farm, to the benefit of those workers, their families and the local community

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1.4 Water Management

Water is critical to coffee bean processing, more or less so according to the actual processes adopted. Two obvious uses of water are to separate beans from the cherries and in fermentation, where remaining mucilage is removed and distinctive flavours developed. Wash process involves soaking the beans in water tanks, followed by rinsing, and then sun drying. Wash process is normally adopted by Northern Thai Arabica Farmers. In that area, water availability is not an issue, but it can be elsewhere, for instance Brazil (Oliviera, 2020) where irrigation may be required, if only occasionally. What is always an issue is effluent, effluent that is a mix of water and organic material. For the Bolaven Plateau growing area in Laos it is estimated that 23 million litres of untreated coffee processing effluent flows into the rivers of the Plateau annually ("Sustainable participatory water", n.d.). As effluent contains organic material it can block watercourses it runs into, create a bad-smelling environment and one potentially harmful to human health. Additionally the effluent is rich in sugar and this lowers levels of dissolved oxygen, so endangering aquatic life ("Sustainable participatory water",nd). In the Chiang Rai area, water recycling is being experimented with but real change simply occurs with movement to natural (dry) processing of the coffee beans.

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1.5 Supply chain integration

It is important to consider not only the sustainability of the farm but also the sustainability of farming families through family businesses. Farming families and businesses can be very adaptive but there tend to be common patterns of thought (Azavedo, 2023) which are to develop and sustain the business by developing the family business to additional points along the coffee supply chain than only growing and processing the bean. A typical pattern is that the farmer will undertake bean roasting, coffee shop ownership, supplying other coffee shops, selling bean online or it could be a step aside from that supply chain to embrace agritourism to include farm visits and homestay. The overall aim is simply earning more through presence at more points in the coffee supply chain and allied supply chains such as tourism and so increasing the sustainability of the farmer's business.

2. Literature Review

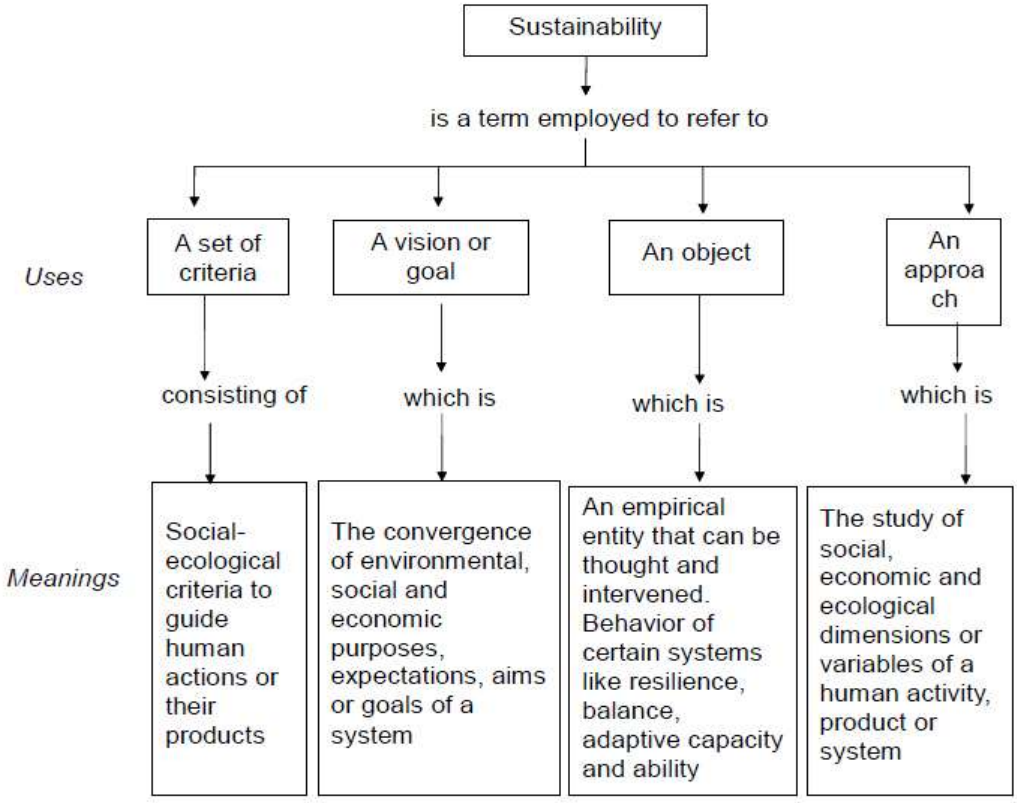
The researcher began by reviewing wider available views of sustainability. The idea was to start with a simple, generally applicable, definition of sustainability out of the literature. Heinberg (2010) gave a very clear statement of position: "The word "sustainable" has become widely used to refer merely to practices that are reputed to be more environmentally sound than others" Heinberg offers a tone that is maybe realistic but not ideal. Perhaps the point is that possibility is very boundaried, the current Anthropocene (Steffen, Crutzen, & McNeill, 2007) geological epoch driven by consumption and population growth (Robertson, 2021) but these set against finite resources. Put another way sustainability becomes a matter for political and, economic and business decision makers should they rise to the task of choice between competing priorities, but often Civin (2023) finds sustainability just a marketing slogan rather than the fundamental principle of responsible behavior.

Giovannoni & Fabietti take up the view of the matter of implementation of sustainability as "mere rhetoric" (Giovannoni & Fabietti, 2013). The authors see difficulties in practice in an integrated approach toward sustainability in organisations. Relevant roles are played by the multiplicity of management, governance structures, business models, measurement and reporting systems. Whether the various elements are pulling in the same direction is open to question and the extent of unified reporting open to question, let alone final reporting, in a single unified document.

Salas-Zapata and Ortiz-Muñoz (2018) aim was to clarify the meaning of Sustainability albeit to a background that seemed ambiguous or confused, the latter often meaning that they surveyed works, most of which simply failed to attempt a definition of Sustainability despite that word being in the research report's title. Where found definitions were often not operationalised, diverse and sometimes contradictory. However, when Salas-Zapata and Ortiz-Muñoz (2018) undertook their own research they found four uses of the Word "Sustainability". Those are employing the word as representing a set of criteria, as a vision or goal, as an object or as an approach as below in Table 1:

Table 1

The Four uses of the word "Sustainability"



Note: The author has slightly simplified the analysis of Salas-Zapata and Ortiz-Muñoz (2018) in presenting their findings in Table 1.

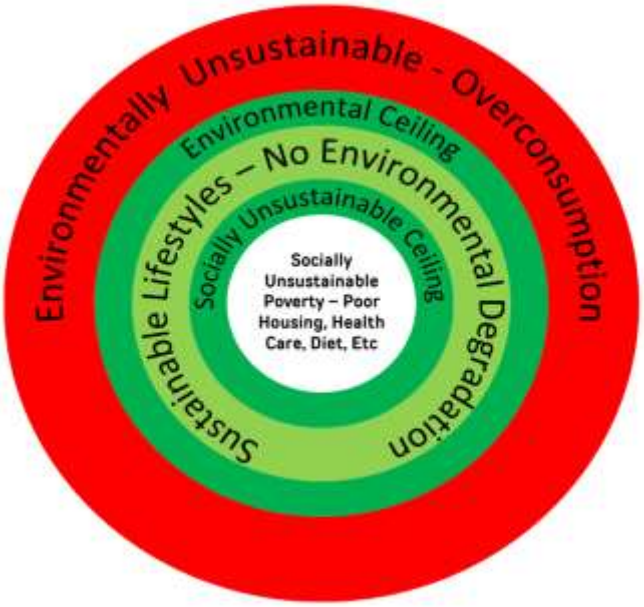
Something immediately apparent from Salas-Zapata and Ortiz-Muñoz's diagram is repetitive use of a number of words, specifically social, ecological, environmental, economic. In plain English these appear to be keywords when considering sustainability, maybe when modelling and constructing sustainability.

Perhaps where these words find most meaning is in the work of Raworth (eg Raworth, 2017) who re-envisages the economic system to social ends of ensuring that all are guaranteed access to life's essentials such as food, housing and health care whilst making sure that the environment is neither degraded nor destroyed. The aim is to erase global poverty but within the limited availability of natural resources. Respecting the planet is a key element. Raworth's work has come to be known as Doughnut Economics, aligning with the title of a conference presentation and her first book in 2017.

The Doughnut chart at Figure 1 below is a simplified distillation of Raworth's basic proposition, albeit drawn by the researcher.

Figure 1

Raworth's basic Doughnut proposition simplified.



Note. The chart comprising figure 1 was drawn by the researcher Mark Azavedo as a distillation of Kate Raworth's work eg Raworth, K. (2017). Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist. Chelsea Green Publishing.

Raworth's aims are to fulfil a grandiose and highly political, even polemical, vision or mission. Lavilley (2021) even asks "Are we Really Talking About Economics"? (Lavilley, 2021). Frankly, Raworth's work and works, the latter meaning writings, appear to the researcher simply as advocacy and nothing more, with that advocacy directed toward a regenerative and distributive economy (Deller, 2018). It appears up to others to undertake the actioning that might see changes in economic and social life and process. Raworth does not offer a route map just seven principles that those undertaking the action might bear in mind (Raworth, 2017). These include changing the goal (from GDP growth to the Doughnut), seeing the big picture (better integration between society and the environment – the economy seen as dependent on society and the living world), nurturing nature (from rational economic man to socially adaptable human), getting savvy with systems (from mechanical equilibrium to dynamic complexity), designing to distribute (to design out inequality through re-distributing income and pre-distributing wealth), creating to regenerate (pursuit of a circular through designing items to be re-used and re-purposed) and being agnostic about growth (no longer seeing GDP growth as a must and considering how life might be lived without it).

This is anything but a program for change, just a recommendation of change. Zhivitskaya (2018) speaks of Raworth not offering "any real policy advice". Zhivitskaya (2018) offers as an example that "practical policy questions, such as tackling the complexities of integrated environmental and economic accounting are outside the scope of idealistic vision"

However, others have often been more practical in their approach, embracing specific actions in the real world and thereby, perhaps, seeing important incremental achievement. That may be only in a particular sector, organisation or business. Worthwhile change may take place from the actions of a single SME. Similarly a case study approach to considering sustainability may provide clarity which appears to be missing from attempts at the bigger picture, such as Raworth's which seem to offer words but not discernible action.

A case that might be considered is a Californian start-up called Air Protein. The business has a core mission to produce protein from air, the most obvious saving from this being no need for agricultural land with attendant deforestation. Fermentation is the basis of production, but fermentation uses carbon dioxide in the air rather than sugar, using a unique microbial strain.

To remove land from the equation in protein production is innovative in the extreme and with the potential for massive food sustainability enhancement. However, more usual is to consider land, agricultural land, at the heart of protein production. Staying with agriculture perhaps the most significant area of innovation is Precision Agriculture, aiming to increase efficiency and productivity, reduce input costs, and improve environmental sustainability (Cropin, n.d). This is highly evidence-based and plot specific. The area is monitored and data harvested to guide the farmer, given the specific terrain of the plot to optimise input

variables, such as water and fertiliser, and optimise crop yields. Fertiliser waste reduction is a common result of this monitoring, using the latest technical equipment, then taking action from findings in levels of fertiliser application. Drones are of particular use in establishing crop rotations, optimal grow times and harvesting. Irrigation systems can be automated according to data received to minimise water wastage and maximise crop yields. Summarising, farmers who embrace precision farming see higher yields, better soil health and improved environmental impact (FGS, 2020). Climate change is a specific where precision agriculture has found a combative place. Gelles (2017) has famously characterised Kendall-Jackson Wineries, which has become something of an exemplar in sound environmental practice, as a place of "Falcons, Drones, Data" (Gelles, 2017). In fact that characterisation misses the robots, for instance used to prune vines. From raptors to robots seems an appropriate description. The raptors and owls are to act as natural predators against pests in the company's biodiverse winery environments that encourage soil enhancement and erosion control through adopting native cover crops. Particularly pertinent in an age of rapid climate change, and given the wineries' locations, is water and irrigation. Irrigation is controlled and precision-focused. Water is recycled, and rainwater is harvested. Solar power produces nearly 30% of the wineries' energy needs, together with clean energy to power 1,300 homes.

The well-resourced adaptation for sustainability, including in the face of climate change, is an unlikely possibility in other areas of agriculture, Arabica coffee bean production included. Arabica coffee only grows well in regions with high altitudes and cool climates, with an average annual temperature of 17-23°C. In some cases mitigation can, in theory, be made by increasing the altitude of growing zones. Colombia, Ethiopia, Guatemala and Mexico have been exampled but there is a big rider in that aspects other than altitude also need to be appropriate (Merga & Alemayeu, 2019). Terroir aspects, such as soil, need to be appropriate but also for instance infrastructure appropriate for transport.

Perhaps above all Arabica coffee bean globally tends to be synonymous with small farmers, holding plots of very limited size, generating limited income and limited access to farm loans. For instance looking at Colombia it can be found that Valle del Cauca has 75,800 hectares under Arabica production, split between 26,000 farms, owned by 23,000 families ("About the different Colombian Coffee Areas", n.d.). Again in Colombia the Nariño Arabica growing region has 40,000 smallholders with less than 2 hectares, in fact with an average of 1 hectare ("About the different Colombian Coffee Areas", n.d.)

Costa Rica is experiencing a massive drop in rainfall, annual rainfall reducing from 2,907 millimetres in 2010 to 1,759 millimetre in 2023. Considering the Tarrazu and West Valley region the Arabica growing is across 22,000 hectares, most of which is covered by small farms of a maximum of 2.5 hectares. Irrigation systems are desperately needed and one farmer has recently spent over $200, 000 having a system installed (Pena, 2024) but he has the income from a 50 hectare farm as an enabler.

Turning now to Northern Thailand it can be noted that the area is defined as the provinces of Chiang Mai, Chiang Rai, Kamphaeng Phet, Lampang, Lamphun, Mae Hong Son, Nakhon Sawan, Nan, Phayao, Phetchabun, Phichit, Phitsanulok, Phrae, Sukhothai, Tak, Uthai Thani, and Uttaradit. Across the region there are 5.9 milliom farms of all types with an average farm size of 4.04 hectares (Kwanmuang et al, 2020). These are small farms but of great significance is that 43.6% of farms fell in the range 1.6 to 4.8 hectares. Those below 1.6 hectares have increased rapidly from 22.5% to 26.55 between 1996 and 2012 (Kwanmuang et al, 2020).

For specifically Arabica coffee bean production the three most important provinces are Chiang Rai, Chiang Mai and Mae Hong Son, in that rank order. The current researcher considered the Arabica-growing interviewees of Lilavanichakul (2020) in the Mae Suai area of Chiang Rai Province. The participants fell into two groups and the task was to combine these and calculate the weighted average across all farm sizes. The participants totalled 104 people and the weighted average for farm size worked out at 3.384 hectares. To consider farm size is often done to have an easy indication of farm income, even wealth. Unfortunately looking at farm size is a very imprecise indicator. One farm may have many hectares of near worthless cherries, another may be cropping macadamia highly profitably on very few hectares. Planting matters, as does soil quality, as does water availability to mention just a few variables. However to straightforwardly consider income is also fraught with difficulty in that will participants respond with that detail at all or will they, for instance, respond with an inflated face-saving figure in a "face" society? Overall the consensus seems to be that it is best to look straightforwardly at income. Meesaeng (2022) does that for farm households in Pangkhon village, Chiang Rai Province, offering a 2020 figure of THB 280,000 (then USD 8,969.47, now USD 7,660). Meesang (2022) concludes "Coffee has become a commercial crop that transforms the cash income of the community significantly (Meesang, 2022)."

Nonetheless these farmers could not truthfully present on direct questioning about their investments in sustainability on drones and irrigation systems as out of pocket expenses. Nor would they be able to access loans even for less costly improvements. Likely the researcher's discussion with Chiang Rai and Chiang Mai farmers would be at a very modest level, for instance introducing shading, as important as that is.

3. Methodology

Farmer views for developing sustainability of Arabica cropping in their area would be obtained through individual semi-formal interviews. The research was to strongly follow the phenomenological approach of interacting with participants closest to the perceived issue or issues, meticulously drawing on their opinions drawn from their lived experience and set within a qualitative framework of enquiry.

Interviewees would be from Northern Thailand's two main Arabica-growing areas, Chiang Rai Province and Chiang Mai Province. Specific participants would be established through purposive sampling of those with relevant life experience in being Arabica coffee bean farmers who were willing to be interviewed. Within that last limitation attempts would be made to interview farmers who were at different stages of their Arabica coffee business, from those of many years of experience to those whose Arabica career had only started recently.

Demographic information would be asked of participants, so descriptive statistics gathered, but analysis of the interviews would be solidly within qualitative traditions. Specifically, thematic content analysis would be used. On the one hand deep detail would be revealed but on the other the aim would be to seek consistent themes in participant contributions. Occasional categories would appear as a tier below themes.

4. Results and Discussion

In-depth face to face interviewing was undertaken at coffee events variously in Bangkok and Pattaya in autumn 2023. The researcher interviewed a number of farmers, in fact five from Chiang Rai and four from Chiang Mai, Thailand's second largest Arabica coffee bean producing area. Participants were included from Chiang Mai to see if there was any difference from Chiang Rai opinions and to some extent that was the case, raising questions as to the usual approach of talking broadly about Northern Thailand. The farmers are described at Table 2:

Table 2

Demographics of Farmers Interviewed

Farmer No.	Gender	Age	Farming Location
1	Male	44Yrs	Chiang Rai
2	Male	53Yrs	Chiang Rai
3	Male	29Yrs	Chiang Rai
4	Male	29Yrs	Chiang Rai
5	Male	25Yrs	Chiang Rai
6	Female	39Yrs	Chiang Mai
7	Male	40Yrs	Chiang Mai
8	Female	27Yrs	Chiang Mai
9	Male	58Yrs	Chiang Mai

Note. Attribution to author, Mark Azavedo

Following now are the farmer interviews, albeit edited. Subsequently the thematic analysis is offered as Discussion:

Farmer 1 (Male, Age 44 - Chiang Rai) answered lengthily, his broad points on quality and consistency. It is valuable to reproduce verbatim his three main points:

"1) The first thing is the components of various knowledge, which are an important part of growing, harvesting, processing to meet the standards of coffee. Because of the past 15 years of experience that I studied and harvested, that experience saw that knowledge of coffee cultivation, harvesting coffee, and standardized coffee processing is still difficult for farmers. In addition, farmers do not see the real problem of not meeting coffee standards. The answer is that gaps, capital groups and farmers are profound, leading to monopolized marketing. By some buoy [sic] groups.

2) The coffee industry that forms too much coffee production for the family is unable to control the quality of the standard coffee as it should be. By holding the wrong attitude and vision "that it can do a lot." which leads to standard coffee that has too much volume. So it makes the coffee market cannot push to be an international standard.

3) Coffee processing by farmers the coffee growers themselves in each process do not have a clear knowledge of how to standardise coffee. Which is an important problem. Because there is still a lack of specific understanding and a lack of depth in the various processes of coffee cultivation, care to grow and harvest of coffee which leads to understandable processing.

Important things that should not be missed

Of farmers' groups "modern coffee people" slice [sic], environmental and natural treatment

Through the coffee processing process in each step that is effective and environmentally friendly and close to nature. As well as reducing forest burning problems, destroying nature, reducing haze problems. As well as encroaching on the area by cutting down trees and destroying forests As well as using other chemicals that affect the way soil conditions deteriorate. Waste and attenuation of soil quality which leads to the sustainability of the Thai coffee farmers group"

Farmer 2 (Male, Age 53 - Chiang Rai) offered: "Promote good quality coffee and has a market to support. May include promoting coffee plantations as a tourist destination. There are activities for tourists to do together. To see the production process as more difficult to get quality coffee".

Farmer 3 (Male, Age 29 – Chiang Rai)

"1) Much is changing globally. The need is to keep up through innovation.
2) Learn to develop varietals of coffee that taste better.
3) Developing varietals that can stand climate change."

Farmers 4 and 5 (Male, Age 29 & Male, Age 25 - Chiang Rai) both answered that the need was for quality. Both suggested that they need support. The researcher asked a supplementary question of each around what was meant by support and from where? The Researcher suggested "from the Government?" Both farmers recoiled, one wide-eyed" "No". Their reference was to support from within the farming community and their particular concern the passage of knowledge by whatever means possible. Farmer 5 went further and considered farmer co-operatives as a model for sustainable business in Arabica coffee farming. In fact in other research the writer (Azavedo, 2023) had come upon almost un-thought passage of knowledge within the farming communities, farmers effectively mentoring each other. That could just be talking together over evening coffees in the villages. Equally, it could be talking as farmers were working together, their approach being co-operative, not competitive. Increasingly farmers were advocating semi-formalised co-operatives, especially for collective marketing of coffee bean.

Farmer 6 (Female, Age 39 - Chiang Mai) contributed: "Ours is a small coffee plantation on a mountain of Sa Merng District in Chiang Mai. We grow the traditional Arabica. One of the problems we face each year is that the harvest isn't sufficient to sell as commercial grade coffee. So, we began improving the quality of the cultivation, caring, and processing. We also participated in the Thai Specialty Coffee Awards competitions. In the first year, we won the ninth place in Thailand. That award instilled us with confidence in the quality of our coffee. We won the award in 3 consecutive years (ranking in the top 10 and top 20 of the country). Therefore, we decided to focus on quality instead of quantity.

In this year, we were selected as one of the 24 Thai farmers to participate in the Q Project Thailand. We passed the Q course and became a certified Q Arabica grader. We did all this to improve the quality of the coffee in our plantation. It also gave us the opportunity to export our specialty coffee for the first time.

These are the strengths and the methods we utilize to promote the sustainability of the Arabica industry in Thailand, while also putting our plantation on the map in the eyes of people both in Thailand and abroad."

Farmer 7 (Male, Age 40 - Chiang Mai) suggested: "My personal opinion is that we should promote planting from the selection of species and taking care of trees as well maintaining forest areas to be fertile.

For us to develop sustainable coffee we should develop a good plantation, good processing farm. We should not focus on marketing, selling downstream where the origin is not well improved".

Farmer 8 (Female, Age 27 – Chiang Mai)

"In our farm xxxxxxx Estate we do a coffee farming under the layered shade-grown coffee to maintain the eco-system in a natural way, we also hire the local to work in our farm to improve the well-being of locals. In our business chain we start from growing [upstream] to serving cup of coffee to customer [downstream] so that we can control the coffee quality consistency along the supply chain, our vision is to make the quality consistency and good quality in terms of flavour and volume so that we can export to the world market in the near future"

Farmer 9 (Male, Age 58 – Chiang Mai)

"Our family business contains the uniqueness of location of plantations, micro climates: the watershed forest that indicates great sustainability. Which give the coffee the unique flavours. Combined with bio-processing, sending our coffee more unique, outstanding in the industry, which affects the sustainability of the business in the future"

Broadly the interviewed farmers' discussion points aligned well with the short guide above for Arabica farmers' potential sustainability-improving actions. Sustainable, environmentally friendly actions are heavily embedded in the farmers' comments. That fed through to the thematic content analysis and its consequent themes and categories. There were of course outliers for instance, perhaps somewhat surprisingly, only farmer 8 mentioned a mission to employ local labour, create jobs for locals. Farmer 8 was also the only farmer to mention supply chain integration. Perhaps also surprising was that only Farmer 3 considered Arabica varietals and hybridisation in detail (though Farmer 7 mentioned choice of species [sic] in planting decisions). Only Farmers 4 and 5 mentioned the need for support from within the farming community for farmers with Farmer 5 going a little further in suggesting there might be value in farmers' co-operatives. It is also important to say that consideration of farmers' points should not be just a "numbers game" of how many said what but deeper levels of thought given to qualitative replies by the researcher. For instance Farmer 3 may be focused on varietals and their development, very lengthy processes, because he has longer timescales than others who may well concentrate on process development, still quality-seeking, but relatively speedy.

The two Main Themes that emerged through Thematic Content Analysis are Biodiversity Preservation and Commercial Success. The farmers were very contemporary in their approach in seeing the two as not at all in conflict, quite the opposite. A bio-diverse local environment, re-invigorated forest floor included, is not only an environmental success story but also a commercial one of greater Arabica yields and of larger berries (e.g. Muschler, 2001)), etc which can sell for higher prices because of improved quality e.g. into specialty grades. Specific contributions include from the re-instigation of natural pest control, less erosion of soil and increased nutrient richness of soil. It is no exaggeration to talk of recreation of the diverse forest environment of complementary flora and fauna (Udawatta et al., 2019).

The Biodiversity theme breaks into categories. By far the most obvious point to make is that movement away from swidden farming, even semi-nomadic, automatically creates bio-diversity gains. All farmers interviewed are static producers. Beyond that, the most obvious category in supporting, even re-creating, bio-diversity is shade planting. This was particularly mentioned by Farmers 6 and 8. Farmer 6 grows Arabica in the shade of the existing forest canopy. Farmer 8 described carefully layered shade planting in emulation of the natural forest environment and its eco-system. Farmer 1 summarised all elements in environmental protection in something of a footnote (see above) to his substantive points. Oddly, he managed to leave off a water conservation project that he is currently instigating.

The Commercial Success theme has a very obvious primary category of quality. Farmers 2, 4, 5, 6 and 8 used the specific word "quality" in their interviews looking at their aims for their farms' bean production. Farmer 1 also spoke of "quality" directly, but the context was poor quality control. This reaches toward a basic question of what is quality? Farmer 1 was talking of consistency batch to batch as a continuing difficulty in Chiang Rai. The buyer needs to know exactly what they are getting. Farmer 9 was talking about something of outstanding characteristics in the mouth and throat when drunk and constantly referred to "uniqueness". Effectively Farmer 9 was pursuing the unassailable uniqueness of his bean as its route to commercial success. Farmer 7 perhaps aligned the points of Farmer 1 and Farmer 9. He saw many as overly believing that marketing represented the route to commercial success, whereas reality was the need for all aspects of production, meaning plantation and processing, to be improved first. Farmer 8 added control along the supply chain as needed in her declared mission: "our vision is to make the quality consistency and good quality in terms of flavour and volume so that we can export to the world market in the near future"

5. Conclusion

This paper, reflecting the views of farmers interviewed for both this and other research (Azavedo, 2023), not to mention views expressed in the specialty coffee trade press, has tended to focus on improved bean quality as the way forward to improved farm incomes and improved sustainability of the industry in Northern Thailand and elsewhere. Improvement in the bean results in improved sales values and sales volumes. Reality for farmers is trying to balance quality and quantity, specifically improving levels of both, to a "sweet spot". Increasing quantity is a necessary concomitant of increasing quality for maximum returns. Increasing quantity must not be to the detriment of improving quality if the aim is to maximise income and sustainability of the farming businesses in so far as they are focused on bean growing.

However, farmers look to a number of possible additional income streams, including out of planting shade trees, such as Macadamia and Avocado, to improve bean quality and yields, but also to add significant income to the farm. Nonetheless, what is often discussed is farming businesses looking to value addition propositions and moving to additional points along the Arabica

coffee supply chain, for instance for the farming business to begin roasting coffee beans (macadamia too), for it to open a coffee shop, then maybe more coffee shops or selling roasted beans wholesale to other coffee shops. Online sales to the general public is another option frequently seized upon. Lastly there is diversification into tourism through Farmstay/Homestay and also through farm tours. Often the constraint is the availability of finance and loan finance to the farmers and their businesses both on the farm and for farm-related businesses. That is a major point detracting from farmers tackling the long-term sustainability of their businesses. Farmer co-operatives might be helpful, very helpful, but reality is often in the hands singularly of the finance industry, though Government policy can be more or less supportive of the agricultural sector and more or less supportive of the finance industry in its dealings with farmers. Contemporary income streams, such as carbon offset, must be given fuller consideration. Any external support must take into account localised conditions, terroir included, but also noting different points in the development of different areas. For instance, there was a broad difference in responses from Chiang Rai and Chiang Mai farmers. Chiang Mai farmers often talked of striving for extraordinarily high quality, "uniqueness" a word often used by one farmer. Chiang Rai farmers often spoke of striving for consistency.

Much was considered beyond the scope of this study. Future research would be of benefit into the nexus of finance availability and Government support as limitations on expansion of the Northern Thai Arabica industry and how to move forward on financing. Likewise such future researchers should consider the limitations of sample size in this study and that the home areas of participants were limited to Chiang Rai and Chiang Mai Provinces, leaving it open as to what would have been responses in the more recently developing Arabica areas in Mae Hong Son, Nan, Tak and Phayao.

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