

FARMING ON PENANG HILL

A SURVEY REPORT



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2023

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LIST OF ABBREVIATIONS

BKSA	Badan Kawalan Selia Air
COVID-19	Coronavirus disease 2019
DEM	Digital elevation model
DRKKBB2020(P)	Draf Rancangan Kawasan Khas Bukit Bendera 2020 (Penggantian)
DUN	Dewan Undangan Negeri
GIS	Geographical Information System
JEDI	Jaringan Ekologi dan Iklim
MAB	UN Man and Biosphere
masl	metres above sea level
MBPP	Majlis Bandaraya Pulau Pinang
MCO	Movement Control Order
MNS	Malaysian Nature Society
PBAPP	Perbadanan Bekalan Air Pulau Pinang
PEGIS	Penang Geohub
PHBR	Penang Hill Biosphere Reserve
PHC	Penang Hill Corporation
PHRA	Penang Hill Residents' Association
PLC10	Code for "Pemeriksaan pengurusan bagi menjadikan bukit bendera sebagai destinasi pelancongan bernilai tinggi"
PTG	Pejabat Tanah dan Galian
SRTM	Shuttle Radar Topography Mission
SWOT	Strength, Weakness, Opportunities, Threats
THF	The Habitat Foundation
TOL	Temporary Occupation License
UNESCO	United Nations Educational, Scientific and Cultural Organization
USM	Universiti Sains Malaysia

1. INTRODUCTION

The ecosystem of Penang Hill, the range of hills in the centre of Penang Island, is fragile and vulnerable in the face of hill cutting and forest clearing. While these hill forests have been subjected to human clearing for over a century, the area cleared has increased through the years.

Over the two years of 2020–2022, during the periods of Movement Control Order (MCO) put in place to manage the COVID-19 pandemic, increasing incidence of hill cutting and forest clearing for agricultural purposes could be observed over large areas of hill land. It is alarming that precious hill forests as well as old fruit orchards are being replaced with short terms crops like flowers (mainly dahlia) and vegetables, which may exacerbate the problem of erosion and runoff from the slopes. Furthermore, parts of the hill are gazetted water catchment areas, and questions arise as to whether diversion of water for irrigating the farms have significant impacts on reducing water yield for abstraction and treatment for municipal supply.



Given these concerns, a project was conceived with the intention of identifying plausible interventions for enhancing the environmental and economic sustainability of hill agriculture. Before this can be achieved, however, we needed to obtain a basic profile of hill farms and a more holistic understanding of the current extent and status of agricultural activities on Penang Hill. Understanding that any intervention will also need the cooperation and ‘buy-in’ of the people involved, the project also aimed to gain an understanding of the agricultural community on the hill – their history, perspectives, and concerns.

The rationale behind this project is in fact articulated in the Draft Rancangan Kawasan Khas Bukit Bendera (DRKKBB) 2020 (Penggantian) (<https://jpbdd.penang.gov.my/index.php/draf-lapo-ran-rancangan-kawasan-khas-bukit-bendera-rkk-bb-2020-penggantian>) under Kategori Tindakan (Action Category) PLC10 where it states that sustainable and environmentally-friendly agriculture has to be introduced on Penang Hill so that current agricultural activities will not negatively impact upon the environment (page 4-255, Volume 1).

Following this, the specific actions to be taken by the Perbadanan Bukit Bendera (Penang Hill Corporation, PHC), Majlis Bandaraya Pulau Pinang (MBPP) and Jabatan Pertanian (page 4-256, Volume 1) include identifying the farms and types of agricultural activities, identifying the owners and operators of the farms, and running awareness programmes on the importance of sustainable and environmentally sound agricultural activities. A project that aims to understand the current status of agriculture and farmers on Penang Hill, with the intention of promoting more sustainable agricultural practices, is therefore fully in line with official thinking—although still at a drafting stage—as reflected in the DRKKBB2020(P).



2. PROJECT OBJECTIVES

As conceptualized, the project ‘Greening Farming on Penang Hill through the Promotion of Regenerative Agriculture and Food Forests’ has the following general objectives:

1. To gain an understanding of the current status of agricultural activities on the eastern slopes of Penang Hill (this is within the transition zone of the Penang Hill Biosphere Reserve).
2. To become acquainted with the agricultural community and to cultivate an open and collaborative relationship with the farmers.
3. To identify viable interventions for enhancing the environmental and economic sustainability of hill agriculture.

These general objectives were broken down into more specific objectives, as follows:

- a. To gain the cooperation of relevant governmental agencies in order to access governmental information as well as to identify the issues as perceived by government personnel.
- b. To map the study area, achieve a spatial characterization of the farms, and identify their legal statuses.
- c. To obtain first-hand knowledge of the current status of the farms and farming practices.
- d. To gain a qualitative understanding of the farmers, their agricultural practices and rationale as well as their issues and problems from their own perspectives.
- e. To make the acquaintance of the farmers, cultivate good relationships with them, and explore opportunities for introducing sustainable agricultural practices.

3. METHODS

The research site for the project is the eastern slopes of Penang Hill, covering the two gazetted water catchments and the land in between. This area was selected for the high concentration of farms despite it being gazetted hill land under the Penang Structure Plan 2030 (defined as land above the 250-ft (76-masl) contour). It lies within the transition zone of the Penang Hill Biosphere Reserve. Penang Hill was designated a biosphere reserve by UNESCO in 2021. Biosphere reserves are internationally recognized areas where management seeks to achieve sustainable use of natural resources while ensuring conservation of their biological diversity.

From the beginning, the project team sought the cooperation of the relevant government agencies and authorities. As the government agency managing the hill and its development, the PHC is the key agency that the project needs to collaborate with. We held formal meetings with PHC, whose officers then facilitated a meeting (on 22 July 2022) with other governmental agen-

cies. These meetings provided a platform where we presented our project proposal, and obtained feedback from the government personnel as well.

PHC also invited us to a discussion session with hill farmers that they had organized for the Universiti Sains Malaysia (USM) research team preparing the Penang Hill Biosphere Reserve Management Plan, on 17 August 2022. Although the project members were only observers at this discussion session, the opportunity proved invaluable for us to get the contacts and obtain the cooperation of the farmers.

Physical profiling of hill farming was done by mapping to provide a spatial sense of the existing farms in relation to the terrain and hydrology of the study area. A Geographic Information System (GIS) database was created, with satellite images from Google Earth providing the backdrop and over which other map layers were sourced and superimposed (Table 1).

Table 1. Main data layers for mapping the study area

Base Maps and Images	Source
Satellite imagery	Google Earth; https://earth.google.com/web
Contours	Derived from SRTM 90m DEM v4.1;
Slope steepness	https://cgiarcsi.community/data/srtm-90m-digital-elevation-database-v4-1/
River network	Pusat PEGIS
Water catchment boundaries	Perbadanan Bekalan Air Pulau Pinang (PBAPP)
Cadastral lots	Pusat PEGIS

The spatial characterization focused on farm locations and the agricultural lots as identified in the DRKKBB2020(P). Land title information for these 77 lots were acquired from the Office of Land and Mines (Pejabat Tanah dan Galian Pulau Pinang, PTG). Relevant information items, in particular ownership and land use conditions (if any), were captured and linked to the respective lot boundaries in the base cadastral maps so that thematic maps depicting ownership can be created and displayed in the GIS system and also exported for display in Google Earth.

Before conducting field visits, we interviewed several key informants, including an officer of the PHC who is also the head of the Penang Hill Residents' Association (PHRA), and an entrepreneur who organizes stays, tours, and walks on the hill. We also have the benefit of having a long-time Penang Hill resident as a member of the project team, the help of the Managing Director of The Habitat, Penang Hill, and the assistance of staff of The Habitat Foundation.

The project team went on several field visits to collect observational data on farms as well as to speak to farmers. We visited a total of 13 farms and interviewed the farmers and their family members. At most of

these farms, the farmers walked us through their farms and gave us detailed explanations of their agricultural practices. Besides these farm visits, observational data (on agricultural crops, farming practices, and condition of farms) was also collected from walking through or along the sides of other farms whose farmers we did not manage to meet.

The interviews that we conducted with the farmers were in the form of informal conversations. Information collected include family background, living situation and tenancy status; cropping systems, agricultural practices and production issues; marketing and other issues; and views on organic methods of farming.

With several of the farmers, we were able to conduct discussions on the sustainability and viability of current agricultural practices and organic farming methods. We also carried out discussions with organic farming practitioners from other parts of Penang and facilitated a visit by one of the farmers to an organic farm in Seberang Perai. This was followed by a return visit by a group of organic farmers from Seberang Perai to this farmer's holding on Penang Hill, whereby there was exchange of experiences and ideas.



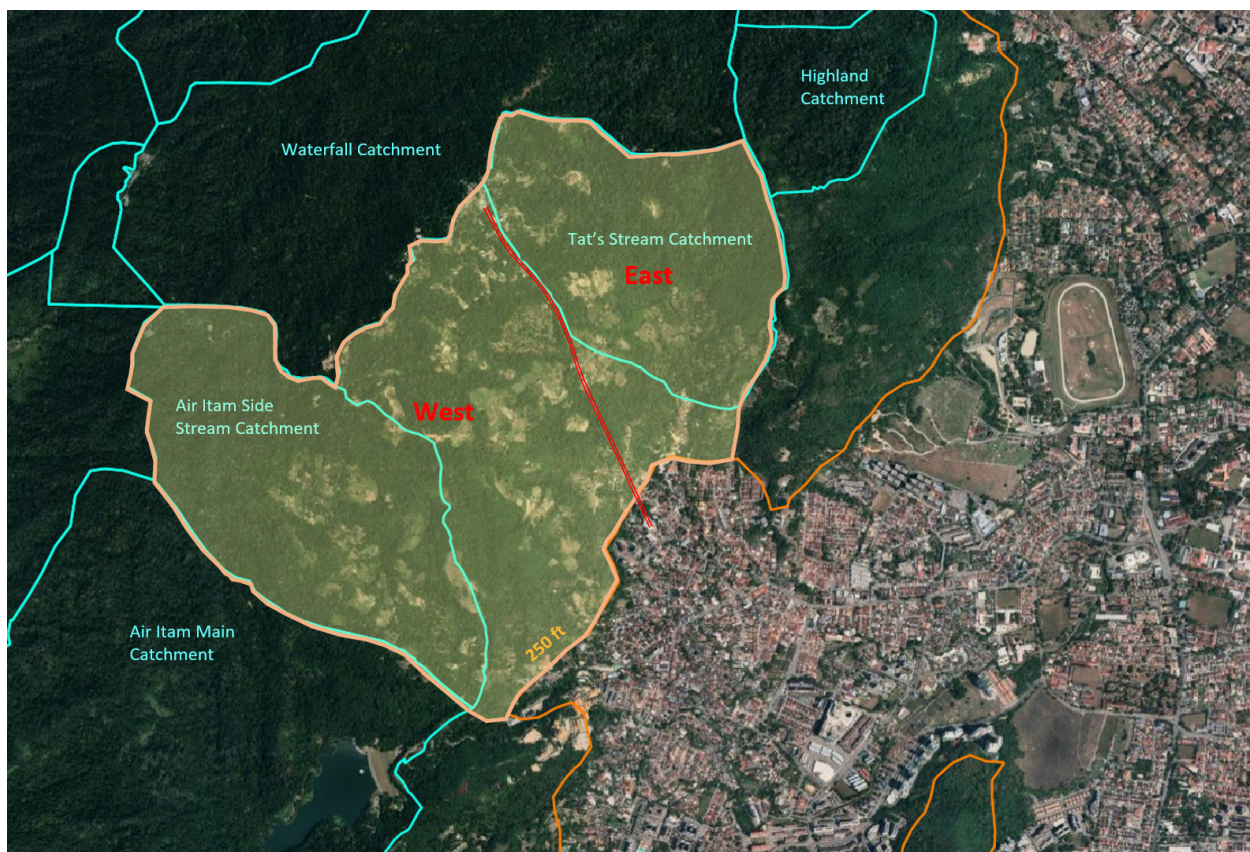
Social survey team interviewing one of the farmers on the hill

4. FINDINGS

4.1 Mapping and spatial characterization

The study area is located on the eastern slope of Penang Hill, bounded by two water catchments, the Tat's Stream Catchment on the east and the Air Itam Side Stream Catchment toward the west. The funicular hill railway divides the study area into the eastern and western portions (Map 1).

Map 1. Location of the study area



The sloping land faces southeast towards Air Itam and Paya Terubong, with the elevation ranging between 250 ft and 2,250 ft above mean sea level (Map 2), and slopes mainly ranging between 15° and 35°, although there are some slopes under 15° and others over 35°.

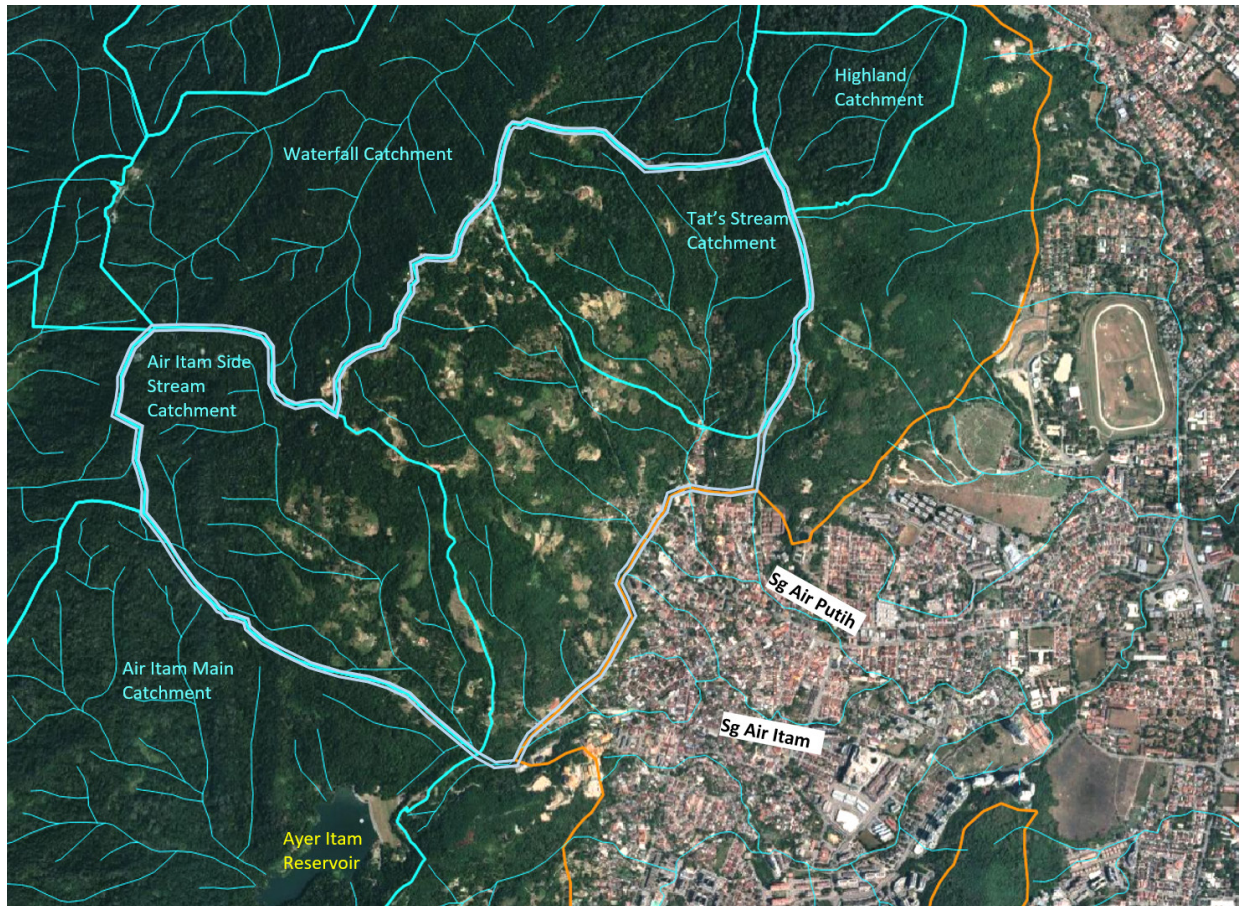
Map 2. Topography of the study area



Examples of the terraced slopes on the hill

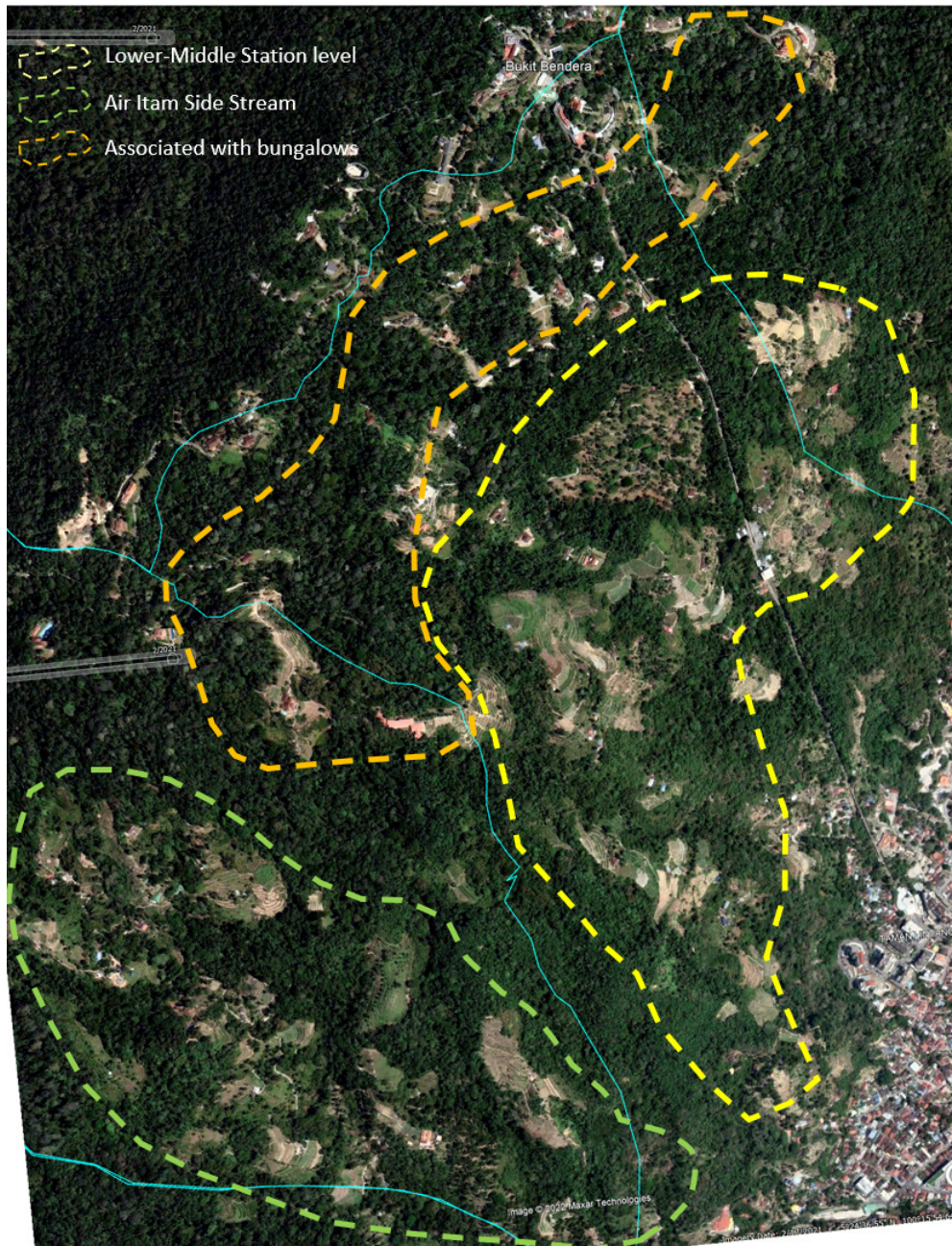
The area is drained by rivulets and streams that join to form Sungai Air Putih and Sungai Air Itam (Map 3). The catchments of these two streams are gazetted as water catchments, and the water yield is tapped by Perbadanan Bekalan Air Pulau Pinang (PBAPP), the licenced water supply operator, to feed the Air Itam Reservoir. Of the 77 agricultural lots identified in the study area, 18 are within the Air Itam Side Stream Catchment and 19 are within the Tat's Stream Catchment.

Map 3. Hydrology of the study area



The hill farms may be grouped into three clusters (Map 4): (i) farms between the lower station and the middle station level, (ii) farms on land with bungalows—these are generally at higher elevations, and (iii) farms within the Air Itam Side Stream Catchment.

Map 4. Clusters of hill farms in the study area

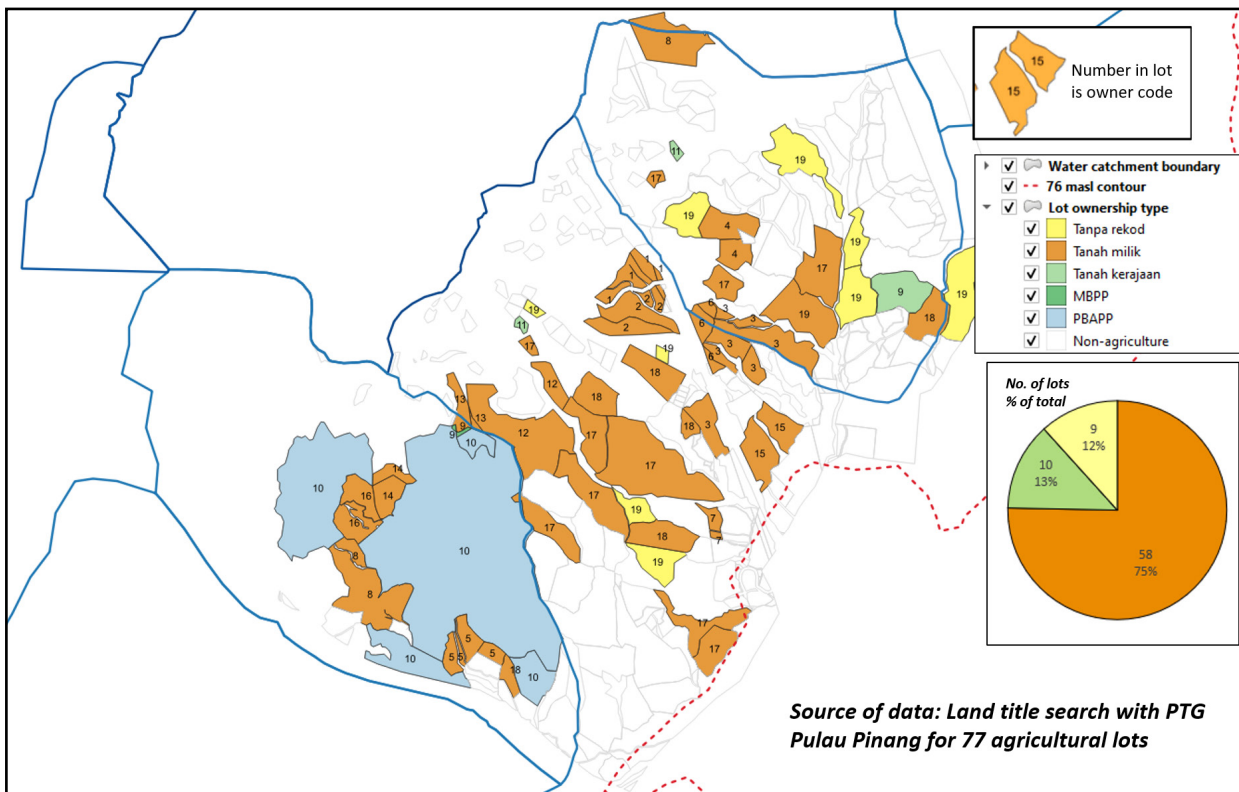


The farmers on bungalow land are usually the bungalow caretakers who would be provided with living quarters. Those who are not on bungalow land would live in homesteads, usually modestly-sized wooden or half-wooden houses, that are on the farms. Most farms are extensively terraced and have mixed horticulture, with fruit orchards as well as short-term crops of vegetables and flowers. A network of paved trails provides vehicular access to the farms but many trails, especially at the middle station level, are only sufficiently wide for motorbikes. These trails are popularly used by hikers, especially during weekends and holidays.

4.2 Land ownership

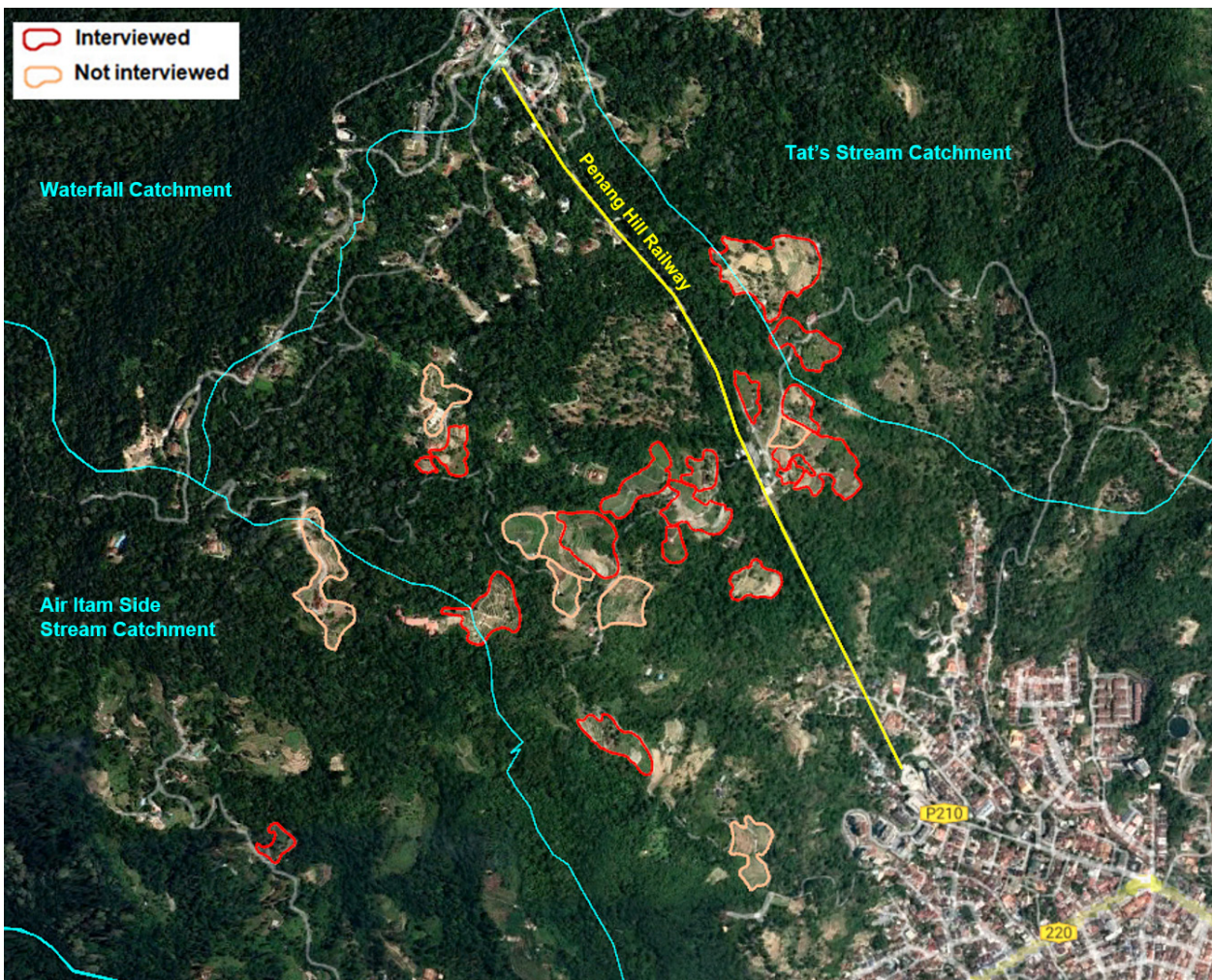
From the land title search conducted, 75 percent of the 77 agricultural lots were found to be privately owned; 13 percent belong to the Penang State Government, the MBPP, or the PBAPP; while land title records could not be found for the remaining 12 percent of the lots (Map 5). Private ownership includes named individuals (single or multiple) and private companies. Most of the private owners are not farmers. During our field survey we encountered only one practising farmer who owns the land that he farms on as well as the bungalow that sits on the land, the property having been bought by his father who was previously the caretaker of the bungalow.

Map 5. Land ownership types for agricultural lots in the study area



Map 6 shows the approximate boundaries of the farms visited, marked out using Google Earth satellite images and ground checks with the farmers interviewed wherever possible.

Map 6. Farms visited and farmers interviewed in the study area



Upon superimposing the farm boundaries layer over the cadastral lots layer in the GIS, it is found that most of the farms are within demarcated lots with some spreading into land without lot boundaries, suggesting encroachment into state land (to be confirmed). It is also found that many farm boundaries do not coincide with lot boundaries. An agricultural lot may contain more than one farm, and a farm may be sited across more than one agricultural lot.

4.3 Profile of the farmers

4.3.1 Tenancy status

Most of the farmers and their families do not own the land they farm and live on, being 'tenants' of absentee landowners or occupiers of state land. Tenure arrangements between the private landowners and farmers differ. While some landowners exact a rent on their tenant farmers, there are others who do not, implicitly allowing the farmers to use their land without any formal arrangements. The farmers say that their ancestors, in times past, had been invited or allowed by landowners to farm and live on their land, and their farms were either passed on to subsequent generations, or 'sold' to other farmers. Usually, when land ownership changed, the new owners continued to allow the extant farm households to continue farming.

Given the restrictions on building development on gazetted hill land, some landowners are looking to sell off their land while, in the meantime, 'tolerating' the existing farming activities of the extant 'tenants' without specific plans on future use of their properties. Some landowners check on their land regularly (and may deploy ground staff for routine checks on their property) especially upon receipt of complaints (about open burning, land clearing, erection of structures, etc.), while others hardly visit.

In this regard, it is interesting to note that ownership of farms may be considered separately from ownership of land. Farms and houses built by farmers are bought and sold or rented, despite the lack of legal ownership of the land on which they are sited. Some of the farm 'tenancies' have changed hands (with or without the knowledge and tacit approval of the extant landowner); in some cases, the incoming farmer 'buys' over the house and farm from the previous 'tenant' and/or pays rent to the previous 'tenant' for use of the house/farm. The change of hands may happen when an existing family ceases to farm (not succeeded by the next generation) and another practising farmer takes over.



In the case of bungalow caretakers who are given permission to farm on bungalow land, the change of hands may be through the recommendation of the previous caretaker-farmer to the owner. The farmer who takes over will also take on the role of caretaker, and may also be allowed by the bungalow owner to conduct other businesses related to the bungalow. For example, the caretakers of Brothers' Bungalow not only run a farm but also monitor the grounds, and maintain and manage the bungalow, including bungalow stays; often catering meals for the groups who come for short stays. The caretaker-farmers are employees of the bungalow owners, but they operate the farms independently.

The farmers on state-owned lots were permitted to do so under temporary occupation licence (TOL) until the 1990s when the PTG stopped issuing TOLs (ref: information from a PTG officer who attended our inception workshop). For these farmers, the legal status of their land tenure is currently in limbo. They understand that they will have to hand their farms over when the government requires it.

4.3.2 Farming families and social networks

The farmers in our study are descendants of farming families, most of whom had grandfathers who started farms on Penang Hill, some dating back before the funicular railway was completed in 1923. Of our 13 interviewees, eight may be considered third generation farmers whose grandfathers initiated the respective family's farm on Penang Hill. The remaining five interviewees are second generation farmers whose fathers started the family farms on the hill. Through the years, some families have expanded their presence on the hill with members opening new farms, while other families may have a diminishing presence on the hill with members who have left farming. There are also families with both members who continue farming as well as members who leave farming. We also found family members who leave, and then return to their family farms after a certain period of their lives away.

Each of the 13 farmers whom we interviewed has relatives who are also farming on Penang Hill. These 13 farmers come from six families, as traced through male lineage. The Yong family is one that has expanded on the hill through three generations. Grandfather Yong, who came from China and started the family farm, had eight children - six of whom were sons. The second generation splintered off to start new farms, and currently, the third generation are farming their respective father's farms. As far as we are able to trace, six members (from five branches) of the Yong family are still farming on Penang Hill. Another example is the Lim family with three members of the second generation and one from the third generation each running their own farms on the hill. On the other hand, we also met two Chang brothers, in their 60s and 70s, who had taken over their father's farm, but whose children are not interested in continuing after them.



Hungry Ghost Festival on the hill attended by the farming community's families and guests



Although some of the farmers continue to live on the hill, there are those who do not but come up every day to work on their farms. There are also people who continue living in their family homesteads but commute down the hill to work. In one case, the father lives down the hill and commutes uphill to the farm, while his son continues living on the hill but commutes downhill to work.

While the farmers may get together on common issues, they do not seem to have a formal organization that represents them. Nevertheless, the PHRA and PHC relate to the farmers as a distinct grouping. Politically, the farms come under the Air Putih state constituency (DUN). Staff from the offices of the state assemblymen of Air Putih and Paya Terubong have made outreach efforts toward the farmers, but we did not investigate this further.

The two Taoist temples at the Middle Station level, one on each side of the railway track, functioning as the foci of religious activities, appear to be centres of social networking and interactions. We witnessed the 'hungry ghosts' (*por thor*) prayers at the Pek Kong temple, located to the west of the railway, which was attended not only by the residents from the nearby areas but also well-wishers and hikers from downhill. We were told that the temple was constructed and is maintained by the farmers and residents. A group of hikers and devotees, who are not residents of Penang Hill, also contributed towards the building fund of the temple. But some farmers complain that recreational hikers are a nuisance because they often pluck the farmers' fruits and remove their plants without permission. However, there are also hikers who buy produce from the farmers, and some make regular visits to particular farms where they also hang out with each other.

4.3.3 Transportation and development

The primary means of transportation are the funicular railway and motorbikes. For farmers at the middle station level, particularly those whose farms are located to the west of the railway, where the narrow cement track leads directly down to Air Itam town, motorbikes are the main means of transportation. The tracks leading to the middle station level are too narrow for cars.

Development has affected the farmers in ways that were perhaps not anticipated. In our conversations with the farmers, two cases have been cited. First, when the funicular railway was changed to the present faster one, the farmers lost a way of transporting heavy and bulky goods/equipment (such as bags of fertilizers, cement, etc.) up and down the hill. The large open carriage that was used for these purposes was replaced by a much smaller one which does not cater for the farmers' needs. Nevertheless, the improvement in the funicular railway probably contributes to the convenience of the farmers who choose to live down the hill (usually to accommodate children and spouses who want to be nearer to their schools or work places). Second, it is perceived that when the Penang Bridge

was built, it allowed the agricultural produce from Perak to come into Penang easily, thus providing stiff competition for Penang Hill farm produce.

There is tension between the farmers' desire for improvement in access roads on the one hand and their fear that access roads will lead to landowners evicting them and reclaiming their land on the other. A few years ago, an issue that had united the farmers was the idea mooted by the PHRA to construct a road linking the Middle Station farms to Viaduct Road, providing road access from these farms to the jeep track. However, the farmers petitioned against this because they were afraid that the easier road access would lead to the landowners being more inclined to evict the farmers and regain their land for development or tourism activities. This episode is perceived to have negatively affected the farmers' relationship with, and membership in, PHRA. On the other hand, the cooperation extended by and among PHRA members in the wake of the extensive landslide occurrences in November 2017 is perceived as having had an opposite, and positive, effect.



Example of some of the access roads connecting the farms



View from the front coach of the upgraded funicular train

Photo by Evelyn Teh

4.4 Farming systems and practices

4.4.1 Farming systems and crop types



Dahlia and okra



Chilli



French bean intercropped with choy sam



Soursop and banana on terraces



Lemon grass and ginger



Mixed horticulture

The farms usually have a mix of perennials (fruit trees) and short-term crops. The fruit trees include soursop, durian, avocado, banana, abiu (yellow golden fruit), papaya, and mangosteen. These perennials are grown on the natural slopes or on broad terraces, depending on the steepness of the terrain. Vegetables grown include the leafy types such as the brassicas (choy sam or sawi, kailan, pak choy), fruit vegetables (brinjal, chilli, okra), beans and peas (french bean, long bean), and flowers (dahlia, roses). On one farm, the farmer focusses on his fruit trees while he has two foreign workers who grow vegetables on terraces. Some farms also have ornamental plants, and one farm specialises as a nursery for ornamental plants.

Most of the farmers practise rotational multiple cropping and inter-cropping for the short-term crops that are grown on terraces. In fact, among the farms we visited, there was only one where the farmer practises monoculture (see Case Study A). The most common cropping system for short-term crops is rotation between vegetables and flowers (mainly dahlia). The farmers also practise fallowing the land. They explain that both fallowing and crop rotation are practised in order to avoid declining yields and to prevent pest outbreaks.



Active terraces

Fallowed or abandoned terraces

The farmers generally use both chemical and organic fertilizers. According to the farmers, the sole use of chemical fertilizers 'hardens' the soil, while the sole use of organic fertilizers does not result in sufficiently high yields. They would use organic fertilizers as the basal dressing and chemical fertilizers as top dressing. Besides the commercially-produced organic fertilizers, quail dung and chicken dung are also used. Many of the farmers prefer quail dung over chicken dung for its perceived higher efficiency, and they organize to do bulk purchases to reduce costs.



Some examples of fertilizers used by the farmers

4.4.3 Pests, disease and weed control

In general, the farmers consider the use of chemicals as essential for the control of pests, diseases and weeds. The farmers use a wide spectrum of agri-chemicals for disease, pest, and weed control, especially for the short-term crops. A variety of fungicides, insecticides, and termiticides are used, which may be broad spectrum or specific, and may be of the contact or systemic types.



Some examples of agriculture chemicals used by the farmers

The list in Table 2 is just a small sample of the types and brand names of agri-chemicals spotted in the storage sheds of some of the farms we visited. Spraying of agri-chemicals is intensive, for example, weekly for chillies and bi-weekly for dahlia. Plastic mulch is used for weed control for the longer-duration plants—in particular chilli, but not for dahlia.

Table 2. Examples of agri-chemicals used in the hill farms

Trade Name	Type	Mode of Action	Active Ingredient
Agr Cylac 10EC	Fungicide	Systemic	Hexaconazole
Antracol 70 WP	Fungicide	Contact	Propineb
ZA 570	Herbicide	Contact	Glufosinate-ammonium
Bimec 1.8EC	Insecticide	Contact, insect neurotoxin	Abamectin
Cyper H2O	Insecticide	Contact, insect neurotoxin	Cypermethrin
Prevathon 7.5 SC	Larvacide	Contact, insect neurotoxin	Chlorantraniliprole
Termifos 212	Termiticide	Contact, insect neurotoxin	Chlorpyrifos

4.4.4 Perceptions of organic farming

Of the farms we surveyed, we encountered only one where the farmer produces and uses mainly organic fertilizer (elaborated as Case Study B below) in his orchard after having experimented and found that the yield and quality of his fruits are better with the organic fertilizer. Nonetheless, after having visited farms in Cameron Highlands, he is of the opinion that farming vegetables organically is not a viable option for him.

Perceptions about organic farming differ among the farmers. Some farmers perceive that organic farming needs to be done in plant houses, which are not allowed on Penang Hill. Others even associate organic farming with hydroponics.

4.4.5 Water supply

Water is tapped from springs further up the hill, piped over long distances, and stored in ponds. Where several farms share a water source, communal pipes bring down the water which is then diverted through pipes belonging to individual farms. From our observation, sprinkler irrigation using gravity is commonly deployed. These have replaced past practices of digging retention ponds (swales) in-farm and using watering cans for irrigation. Water supply increases during the rainy season and decreases during the dry season, but is generally not mentioned as a problem by the farmers.



Pipes tapping water from further uphill and stored at retention ponds

4.5 Farming systems and practices

Practically all farms that hire labour use foreign workers. The foreign workers are usually from Indonesia (we met several from Sulawesi). We were told of the presence of Bangladeshi workers, but did not encounter any. We encountered only one farm where the workers are from Myanmar. Hiring costs per worker usually range from RM1600 to RM1800 per month. The Myanmar workers we encountered at one farm are paid a higher rate, at about RM2500 per month. The workers are usually allowed to stay in wooden shacks on the land, and in some cases, the farmers would buy provisions for the workers.

From the farmers' perspective, they are currently experiencing labour shortage and increasing wage demands. While the Covid-19 pandemic may have restricted the entry of foreign labour, the farmers generally attribute the lack of foreign workers to the fact that Indonesians are finding equally, if not more highly, remunerative jobs back in Indonesia.

The ‘labour shortage’ is therefore related to relative wage levels in the host and home countries. In some cases (depending on the produce), paying for labour would cut substantially into farmers’ profit margins and make their enterprise unviable economically.

In response, some farmers stop hiring labour and manage on their own. This would limit the land area, and the volume and type of crops grown. Some farmers cut down the number of workers, with many retaining only one worker. In one case, a farmer had a kind of “contract cropping” arrangement with his workers, where he would “buy” the agricultural produce from the workers and then sell it to the market retailers. We were also told that there are cases of foreign worker-farmers leasing the land from local “tenants,” but we did not encounter any such cases.

4.6 Production issues

Besides labour shortage, the farmers also face other production issues, the most commonly mentioned ones being:

1. Price increases of farm inputs. Costs of chemical fertilizers have escalated markedly, particularly with the advent of the Ukraine war due to reduction in imports. Although the costs of organic fertilizers are now comparable if not lower than imported chemical fertilizers, farmers still use the latter in combination with the former to boost yields.
2. Where pesticides are concerned, the problem is not only with price increase. Increasing pest resistance has led to the declining effectiveness of pesticides.
3. There is loss of fruit crops to wildlife, usually monkeys, bats, and squirrels, and also petty theft by hikers and passers-by.
4. Due to the lack of access roads (as mentioned earlier), it is difficult to transport farm inputs (fertilizers, pesticides) up the hill.

4.7 Marketing issues

The marketing channels used by the farmers depend on the volume of each produce that they have available for sale. Wholesalers (usually located in George Town) will only buy produce in larger volumes. Most farmers do not have sufficient quantities for them, and would usually sell to retailers in the Air Itam market at the base of the hill. To go further than Air Itam would require more time and effort. The farmers also have their respective networks of customers, usually weekend hikers and households around Air Itam, whom they contact through WhatsApp social media. Sometimes these customers may also contact them to place their orders directly.

One of our interviewees lives on and runs a nursery very close to Middle Station. As she is easily accessible by people who embark or disembark the funicular railway at the Middle Station, farmers often hand their produce over to her to sell by consignment. Furthermore, she has been befriended by some hikers who have set up an outdoor makeshift kitchen in her backyard. The hikers come by to hang out, using the kitchen to make instant noodles and other simple meals for themselves. These hikers are also customers of the agricultural produce that is left there on consignment.

Farmers’ marketing options are therefore limited in various ways—by the small quantities of each type of produce, short shelf-life of certain types of produce, and restricted transportation options (usually taken by individual farmers by motorbike or the funicular railway). The farmers prefer to sell directly to customers who would be willing to pay higher prices compared to wholesalers and retailers. But this channel is limited by the number of customers known to the farmers and available at the time that the agricultural produce is ready for sale.

CASE STUDY A

A monoculture farm

Farmer A is a third-generation hill farmer. The ancestral farm started by his grandfather is presently operated by his uncle. His father had branched out to farm further upslope, partly on state land where he managed to obtain a TOL and grew mainly flowers. Farmer A took over the operation of the farm about two to three years ago after his father suffered a stroke. Farmer A's primary business is elsewhere, and he operates this farm as a supplementary (side) business activity. He essentially implements a business model that predicated consistent and continuous production of a single produce at sufficiently high volumes for an assured wholesale market channel.

On this farm, estimated at about 5.5 acres, the primary crop grown on a commercial basis is the French bean, which is grown on well-maintained terraces. As seen in many other farms, he deploys sprinkler irrigation, using water tapped from a stream source further upslope. He uses old car tyres to construct steps on the across-slope walking paths, which helps to check rapid downslope rainwater runoff. Besides French bean, he grows other crops on a minor scale for his own consumption - such as sawi, yam, ginger - and he also maintains some fruit trees such as durians and ambra (*Spondias dulcis*).

Farmer A focuses on French beans because its price is relatively stable throughout the year. The prices of crops tend to fluctuate depending on weather, demand (possibly seasonal), and supply volume (competing supplies from Thailand and Perak, for instance, drive prices down). However, by just growing a single crop commercially, he also addresses his labour and marketing issues.

Planting French beans is labour intensive. Since he has to attend to his main business on most days, he largely depends on his workers to care for his crop. He hires three workers from Myanmar whom he pays RM2,500 per month (and provides lodging and food as well), considerably higher than the average rate paid by the other hill farmers. Focusing on one crop commercially makes it easier to routinise his crop management practices (including application regimes for fertilizers, weedicides, insecticides), enabling his workers to handle the farm in his absence. He grows between five and six crops of French bean in a year on a staggered schedule to ensure year-round harvesting. This way, he is able to produce sufficient quantities of his single produce to sell to a wholesaler in George Town on a regular basis, thereby having an assured marketing channel.

Farmer A does not see the need for crop rotation provided that there is sufficient fertilizer application. He claims that he has not encountered any problem with pests and diseases, which are chemically controlled. Since he has only operated this system of continuous monoculture for about two years, its probable longer-term effects, for example pest population build-up and increased resistance to pesticides leading to disease outbreak, remain to be seen. Furthermore, intensive and prolonged use of agri-chemicals increases the risk of ground water contamination, particularly as this farm is within a water catchment area.

CASE STUDY B

An organic farm

Farmer B is a third-generation member of a large family of Penang Hill farmers. The ancestral farm that was started by his grandfather before the Japanese Occupation (World War II) is now run by his cousin, and he has many other cousins who are still working the farms that were handed down by their fathers. This farm, which he took over 20 years ago, was started by his father. It is almost 4 acres, and his father had been paying rent to the previous landlord. A few years ago, the land was sold and the current owner does not collect rent. Farmer B used to plant vegetables but he has stopped because the present owner discourages it. Although this new landowner has not stopped him from cultivating fruit trees, he feels that his tenancy is now insecure and has therefore put more focus of his farming activities at another piece of land on the opposite side of the railway, having taken over its use from his sister.

He has since switched to fruit trees, with particular focus on the abiu (yellow golden fruit, *Pouteria caimito*), which presently constitutes his largest income source. The other fruit trees grown in his mixed orchard include durian, coconut, guava, longan, and banana varieties. He keeps stingless bees which he considers to be an important pollinator of the abiu and longan flowers and also derives some income from the kelulut honey they produce.

Farmer B is an innovative farmer. Having been introduced to the abiu about 20 years ago, he persisted to work out better management practices for this crop, which he achieved, and has been successfully producing high quality fruits from his 200 abiu trees for 10 years now. Golden fruit takes five years to grow from seed to fruit production. It fruits throughout the year, but peaks from July/August until October.

Nematodes and fruit flies are the main pests. If a tree is damaged by nematodes, the whole tree has to be cut down. He used to burn the branches to avoid the nematodes spreading to other trees. But since open burning is not allowed any more, he can only try his best to control the nematodes. To avoid infestation by fruit flies, the fruits have to be individually wrapped

when they are as small as a berry. It is very time consuming work. Once the fruit is attacked by a fruit fly, the pulp will turn black.

Farmer B continues to work on better management practices for varieties of grape and longan from Taiwan and seeking ways of wrapping the guava fruits to maintain good yield and quality. He only uses organic fertilizers on his fruit trees. He makes fish amino fertilizer on-site. He collects fish guts from the market and leaves them to ferment with jaggery in blue plastic drums (he has about 20 of them) for six months. The resulting liquid part is decanted into a larger tank, diluted with water and hosed out through a network of pipes for application to the plants as and when needed. He is convinced that the organic fertilizer makes the fruits sweeter. The residue from the fish entrails and bones fermentation, which is mainly rich in calcium, is applied as top dressing to the durian trees.

Although growing abiu is labour-intensive, Farmer B does not hire any workers because he finds that the increased cost of hiring would substantially reduce the net income he derives from his farm.

Farmer B prefers to sell his fruits directly to customers rather than wholesalers or retail outlets. His wife has a fruit stall in the Air Itam market. There are also customers who call and ask him to deliver to them. He operates a drinks and fruit stall on the hiking trail near his house, but this stall is only opened during the weekends when there are a lot of hikers.

The abiu fruits are sold at RM18 per kg, a higher price compared to those sold by other farmers. He guarantees the fruits that he sells, and if any fruit is spoiled, customers can bring it to him for a replacement. The abiu fruits have a very narrow window within which they have to be sold. They ripen very quickly after being harvested (a matter of days), and if they are not eaten by then, they will spoil. Farmer B's wife said that their biggest challenge for now is marketing. They can harvest up to 100 kg during the peak season but they don't have sufficient channels to sell all their produce.



A Penang Hill farmer harvesting choy sum on a misty morning

5. DISCUSSION

5.1 Economic viability and future outlook

The farmers whom we met are mainly second and third generation descendants of farming families on the hill. Some descendants have left the hill, but these are the ones who remained. Some farmers are ageing but their children are in other types of occupations and will probably not take over their farms. However, some ageing farmers have children who are considering reverting to farming because their current jobs pay too little.

The future prospects of hill farms, therefore, have to be viewed in relation to the rest of the economy and the alternative means of livelihood available to this sector of the population. In the foreseeable future, the farms will continue to exist as long as hill farming presents as an attractive alternative in relation to other job options.

Nevertheless, the production and marketing issues faced by the farmers pose a challenge to the economic viability of their farms. Chief among

these are the increasing costs of fertilizers and pesticides. The effectiveness of the pesticides that they have used in the past are decreasing due to increasing pest resistance. Labour shortage is also a persistent production issue.

In some ways, the production and marketing issues are intertwined. For example, labour shortage and the increasing cost of labour constitute major stumbling blocks for maximising production on their farms. However, the reason that labour is relatively costly is related to the relatively low market prices of their produce. Low market prices are in turn related to limited markets and marketing channels, which may be restricted due to the small quantities of produce, the short shelf-life of produce, and the lack of road access and resultant restricted means of transportation.



While most of the farmers continue with time-honoured agricultural practices such as managing the fertility of the soil through crop rotation and mixing organic and chemical fertilizers, there are indications that these methods are increasingly strained in the face of the decreasing effectiveness of pesticides, compounded by the increasing price of these pesticides and other farm inputs.

In our study, we met two farmers who have used new methods to respond to these challenges as presented as Case Study A and Case Study B (refer to Box 1 and Box 2). These two farmers have adopted radically different approaches: Farmer A's response is to switch from the prevailing practices of crop rotation and inter-cropping of vegetables and flowers to mono-cropping, thus enabling him to yield a single produce in sufficient volumes to supply to wholesalers. His choice of agricultural produce is based on price level and stability, which ensures a steady income stream that allows him to pay a much higher wage rate to retain his workers.



Photo by Evelyn Teh

On the other hand, Farmer B resorts to making his own organic fertilizer and uses physical rather than chemical methods to control pests in his orchard. By not having to buy fertilizers and pesticides, he cuts down on production costs, but has to put in more time and effort. Even so, he feels that he cannot afford to hire labour, doing all the work himself. Furthermore, his major agricultural produce, abiu, has a very short shelf-life, and with his limited marketing channels, he has not fully resolved his marketing issues.

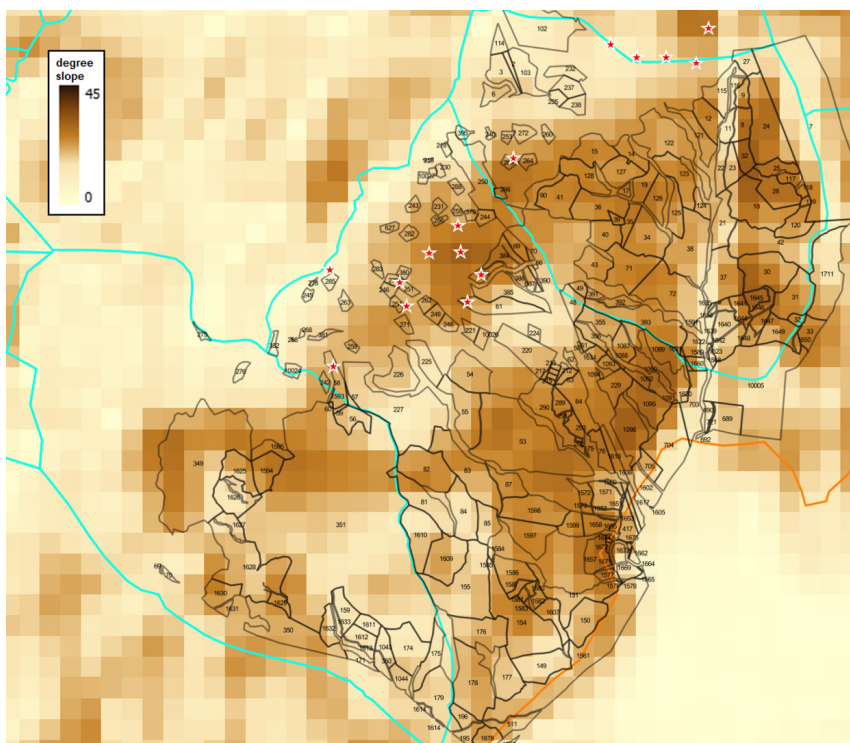
5.2 Impacts of agricultural practices on the environment

In general, environmental concerns in relation to hill farming pertain to (i) soil loss, erosion, and landslides, (ii) diversion of water in water catchment areas leading to lowered water yield for population water supply, and (iii) leaching of chemicals (pesticides and fertilizers) into the water sources for population usage. Detailed field sampling, monitoring and measurements are needed to quantify these environmental impacts, which are beyond the scope of the present study. Nevertheless, we present some qualitative observations below.

5.2.1 Soil loss, erosion and landslides

Exposed soil surfaces are likely to experience accelerated soil loss. Most farms are terraced or have large parts that are terraced. When questioned, the farmers say that their terraces had largely withstood slope failure and damage during the heavy rains on 5 November 2017 when landslides hit many sites on the Penang Hill slopes. This claim is supported by examining the locations of landslide scars using Google Earth imagery acquired in the wake of the disaster and finding that they are largely outside the main farming areas. The explanation may be that well-maintained terraces, with shallow trenches parallel to raised beds, function as berms to direct water flow along contours, hence reducing the downslope gush of rainstorm waters.

However, it was noticed that the terraces at many farms have exposed soil that appear sandy. This indicates that soil wash from the exposed surfaces would have caused leaching of the finer clayey particles, rendering the soil to be of weaker structure and impoverished. Plastic mulch cover used for weed control for selected, longer-term vegetable crops may also have reduced bare soil exposure to some extent. For most cases, though, there is scope for better management of the terraces not only to reduce soil loss but also to maintain long-term fertility.



Map 7. The Nov 2017 landslide occurrences on Penang Hill

Note:

The more severe landslides mainly happened:

- where the natural slopes are steep
- where there have been slope cut-backs (e.g. along the jeep track)

5.2.2 Water diversion

The practice of tapping water from springs and streams further up the hill reduces river flow, thus affecting water catchment yield. This practice appears to be rampant among the farmers, both within and outside of the water catchment areas. In the past, farmers used to dig ponds to retain rain water (swales) and carry the water from the ponds in watering cans to irrigate their crops. Now almost every farm has at least one pond, which stores water brought in by hoses from sources upslope, to ensure water supply throughout the year. Many farms, especially those cultivating dahlia and short-term vegetables, are equipped with sprinkler irrigation installations that operate by gravity. There has been no investigation (that we know of) on the amount of water abstracted for use by the hill farms.



Different sizes of ponds dug by farmers to store water for their farms

5.2.3 Contamination of ground water by agri-chemicals

As mentioned in 4.4.3 above, there is widespread use of agri-chemicals on the hill farms. The farmers may be aware of the toxicity of these chemicals (one farmer was seen wearing protective goggles while spraying his chilli crop), but they argue that there would be practically no yield if they do not spray. There has been no investigation (that we know of) on the level of contamination by and toxicity of these agri-chemicals in the leachates from the farm and their effects on water quality, especially within the water catchments.

6. CONCLUSIONS

This study has achieved its objectives first, of gaining a systematic knowledge of current agricultural practices on the Penang hill farms, and second, of deepening our understanding of the farmers' situation, including their family background, tenancy status, and perceptions of various issues. Project team members have also managed to make the acquaintance of several farmers, and the potential exists of cultivating a working relationship with a few of them.

6.1 An appraisal of the prospects of introducing sustainable agriculture on the hill

The study's final objective is to explore opportunities for introducing interventions that could lead to more sustainable farming practices on the hill. For this, we conduct a SWOT analysis to identify the strengths, weaknesses, opportunities and threats based on the understanding we have of the situation of farming on Penang Hill (Table 3). Table 4 lists the criteria that such interventions need to fulfil.

Table 3. Sustainable farming on Penang Hill: A SWOT analysis

<p style="text-align: center;">STRENGTHS</p> <ul style="list-style-type: none"> • Traditional farming practices as currently practised by majority of farmers (terracing, crop rotation) are not yet extremely detrimental to the environment • Farmers generally understand the environmental threats of chemical pesticides and fertilizers 	<p style="text-align: center;">OPPORTUNITIES</p> <ul style="list-style-type: none"> • At least one organic farmer identified, providing an opportunity for introducing more sustainable farming practices that are economically viable • A successful pilot may encourage more farmers to follow suit • Commitment by the state to support sustainable agriculture within the Penang Hill UNESCO Biosphere Reserve
<p style="text-align: center;">WEAKNESS</p> <ul style="list-style-type: none"> • Insecure land tenancy, which discourages long-term investment in soil conservation • A generally aging cohort of farmers; younger generations move away from farming • Labour scarcity and costs • Difficulty in transporting inputs and goods • Marketing and distribution channels for products are not well developed 	<p style="text-align: center;">THREATS</p> <ul style="list-style-type: none"> • New, more harmful farming practices (e.g. intensive monoculture) that are being introduced may gain salience if shown to be more profitable • Farmers abandon farming, leaving terraces to deteriorate and collapse • Private landowners evict the farmers with no definite plans for future use of the sloping hill land in environmentally benign ways

Table 4. Enabling conditions and interventions for piloting improved hill farming practices

Committed farmers	Preferably one or more practising farmer(s) who is/are willing to pilot farming practices (permaculture, food forest concepts) that are more sustainable in both environmental and economic aspects
Land tenure security	Given the prevalence of absentee private land ownership, it is essential to find landowner(s) who is/are willing to commit to long-term use of the land for piloting sustainable farming
Start up and sustained support during the establishment stage	Adequate financial support for experienced practitioners who can work with the farmer(s) and are committed to providing technical backstopping for the project and for its operation through its establishment phase
Congenial relationship between farmer and support group	Committed project leader and technical support team who can connect on the same wavelength with the farmer(s) to establish and sustain a good working relationship

First, we need to identify farmer(s) who would potentially be receptive to piloting more sustainable farming practices, such as permaculture and forest farming. Second, long-term commitment is required for such a pilot farming project, and therefore, we need to identify at least one landowner who would be willing to commit his/her land for such purposes on a long-term basis. Third, we need adequate funding that can financially support the start-up and establishment of such a pilot farm. Fourth, such a project requires sustained technical support from experienced farming practitioners, and at least one lead organizer (if not a support team) who can connect with and develop a good working relationship with the farmer(s) and facilitate the liaison between the technical support team and the farmers. Finally, the project cannot be successful if the intervention is only at the level of production. There needs to be intervention in the whole process: from agricultural production to product development and marketing. New marketing channels have to be created with the aim of increasing the value of agricultural products that are sustainably produced. The concept and practice of sustainable agricultural production must be championed.



Photo by Evelyn Teh

6.2 Building relationships with the target farmer

The project team has initiated further interactions with the farmer of Case Study B (Farmer B) by putting him in contact with practising organic farmers in Seberang Perai through organizing exchange visits for exposure and sharing of experience and knowledge. We brought Farmer B to visit the Hillside Organics farm in Kubang Semang, Permatang Pauh Tengah on 27 October 2022 where he observed how biodynamics principles are being put into practice in a 3-year-old venture to develop a food forest agricultural environment. In return, the farmer from this organic farm, together with 2 other organic farming practitioners, made a return visit to Farmer B's Penang Hill farm on 2 March 2023. Some direct communication between the farmers has occurred.

On 26 March 2023 we brought Farmer B and a farmer friend of his, from outside the study area, for a guided tour of the Kairos Vanilla Orchid farm in Permatang Pauh, Seberang Perai Tengah to familiarise him with this epiphytic orchid. That both farmers bought cuttings of the orchid is indicative of their interest to try planting in the environments of their respective farms.

The project has also made an attempt to help Farmer B in the marketing of his abiu fruit. A video clip has been made to document his organic practices and the superior quality of his abiu fruits. This video is an attempt to differentiate his organically-grown fruits from others, and will be circulated on social media.

We believe that continued efforts to engage with and introduce Farmer B to environmentally-benign farming practices that are proven to be economically sound will motivate him to further adopt sustainable agriculture practices.



Screenshot of the promotional video for abiu fruit



Visit at Hillside Organics farm in Kubang Semang



Exchange and visits by organic farmers at Penang



Guided tour of the Kairos Vanilla Orchid Farm



Exchange visit to a farm in Pinang Tunggal, Kedah

6.3 Looking forward

The presentations on the findings of this project to The Habitat Foundation on 23 March 2023 and to relevant government agencies, convened by the Penang Hill Corporation on 6 April 2023 were well received and generated interest for specific follow-up projects and activities.

1. The project team will pursue the idea of piloting more sustainable farming practices with target farmer(s) within the Penang Hill UNESCO Biosphere Reserve (PHBR), towards the UN Man and Biosphere (MAB) Program goal of improving relationships between people and their environments, with the PHC as the lead agency.
2. The Jabatan Kejuruteraan MBPP will pursue registration of the existing hill farms and acquainting the farmers with guidelines for slope maintenance per the Garis Panduan Keselamatan Aktiviti Pertanian di Kawasan Berbukit, Pulau Pinang 2021.
3. The Badan Kawalan Selia Air (BKSA) and/or PBAPP are considering conducting a hydrogeological study (i) to determine the water yield of catchments within the PHBR, and (ii) to determine the existing water use for agricultural activities and whether such water use can be more efficiently managed to ensure a sustainable balance between agriculture, ecology, and water supply needs.

In conclusion, this project has provided the background for a better understanding of the farming situation on Penang Hill, thus laying the foundation for concerted efforts to improve the situation for both the farming community and the environment.

