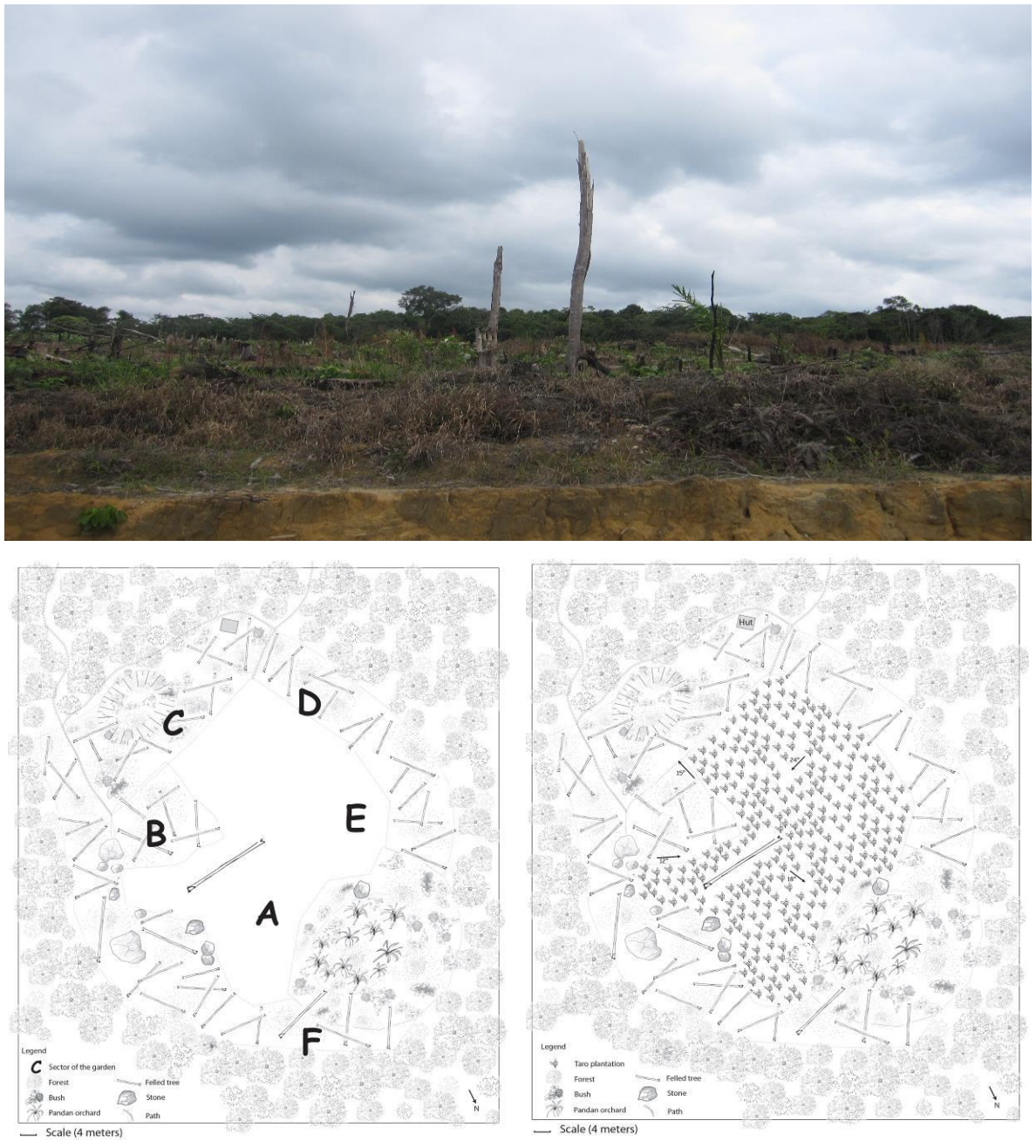
JOURNAL OF TROPICAL ETHNOBIOLOGY

Vol. IV No. 1 January 2021 P-ISSN 1693-6892
E-ISSN 2722-0257



The Ethnobiological Society of Indonesia

The Making of a Montane Taro Garden

Manuel Boissière — French Agricultural Research Centre for International Development (CIRAD), Forests and Societies Research Unit, Univ. Montpellier, France

Corresponding email — manuel.boissiere@cirad.fr

ABSTRACT

Taro (*Colocasia esculenta*) is an essential crop in Papua New Guinea, especially in the highlands where taro grows at high altitudes (above 2,000 m) and sweet potato is absent. Taro and its cultivation are part of the collective memory of the Oksapmin society, in Sandaun province. The creation, maintenance, and harvest of a taro garden follow elaborate techniques and rules, the knowledge of which is not universal among villagers. This article describes the making of a taro garden by Oksapmin cultivators. The process is divided into two parts: activities related to the "mother garden", where cuttings for the garden-to-be must be harvested, along with activities and techniques involved in preparing the new taro garden. The author discusses the significance of taro gardens in Oksapmin society.

Keywords: Agricultural practices, Papua New Guinea, Oksapmin, technical systems, local knowledge, yields

INTRODUCTION

In Oksapmin, a group of villages located in the Sandaun Province, Papua New Guinea, taro gardens are a riotous ocean of broadly sagittate green leaves - evidence of a seemingly chaotic plantation - tumbling down a slope or covering a small valley. At first sight, it is difficult to distinguish the mosaic of plots making up the garden. Each of these green, leopard-like spots, belongs to a family or sometimes to several families of cultivators. At harvest time, the gathered taros are shared seamlessly, with no conflict, proof of the meticulous division of each portion of the garden, which is decided at the beginning of the cultivation. Taro gardening used to be the sole domain of men, but this is no longer the case, although men continue to control most of the cultivation know-how, including knowledge of the high diversity of taro cultivars, no less than 180 in the valley.

Studies treating montane taro cultivation in Papua New Guinea include Stewart and Strathern (2002), Sillitoe (1983, 2002), Bourke (1976), Panoff (1972), Bayliss-Smith (1985), and Jackson and Wagih (1996). This article describes the techniques used to make taro gardens in Oksapmin and is based on field visits in 2001 (Brutti and Boissière 2002, Boissière, 2003). It presents the fruit of my observations in addition to measurements made during two months of taro garden preparation and establishment. The research questions I aimed to answer were, what is the place of taro garden in a New Guinean society? What are the technical steps involved in making a taro garden?

DOI: https://doi.org/10.46359/jte.v4i1.44

With the villagers' consent, my approach was to create a taro garden under their guidance. This experience gave me a better understanding of the palette of techniques used in each step of taro cultivation. I participated in collecting the cuttings and establishing a new garden, including felling trees and other forms of land clearing.

Following a short presentation of Oksapmin society, I describe the place of taro in the valley's agricultural system, followed by the techniques used in the "mother-garden" (i.e., the source of taro cuttings) and those used in opening the new taro garden.

METHODS

The Oksapmin, a Garden Society

Oksapmin is located near the mining town of Tabubil, at about 1,600 m asl. in the high valley of Trangap (Figure 1). Ok Tedi Mining Limited (OTML) has run a copper mine in Tabubil, near the frontier with Indonesian West Papua, since 1981 (Brutti, 1999, 2000).

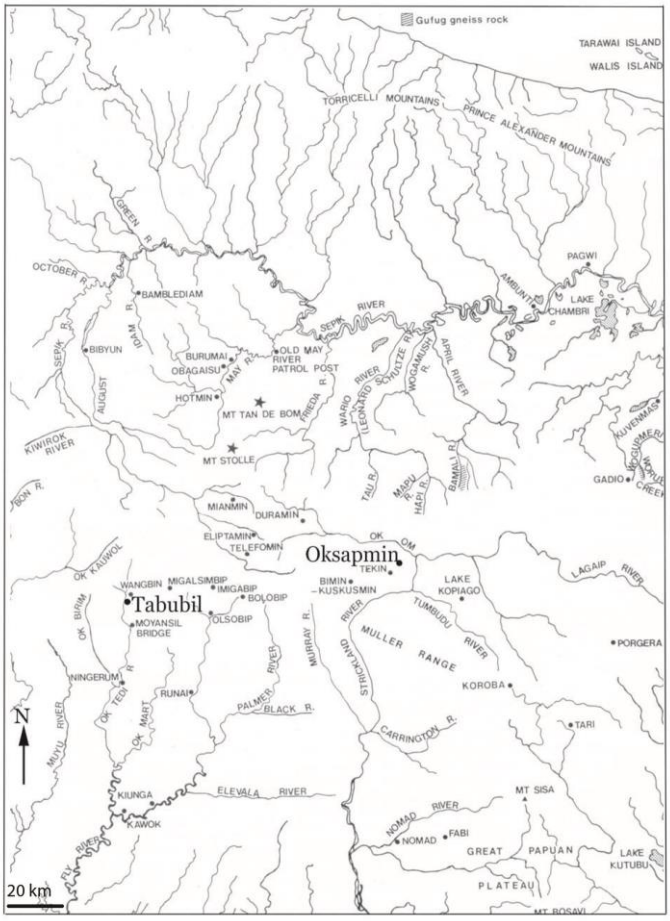


Figure 1. Map of Oksapmin and surroundings

The Oksapmin governmental station, which was created in 1964 at the initiative of the Australian Baptist mission in Tekin village, encompasses more than a thousand inhabitants. The villagers depend primarily on agriculture for their subsistence but also on trading with the nearby mining town. To trade, they cultivate non-traditional vegetables (e.g., lettuce, broccoli, carrot, cabbage, and garlic). Traditional agriculture is based on sweet potato

(*Ipomoea batatas* (L.) Lam.), taro (*Colocasia esculenta* (L.) Schott.), bananas and plantains (*Musa* spp.), nut pandan (*Pandanus julianettii* Martelli), as well as many other local vegetables. Oksapmin society does not have a tradition of chiefs. Instead, they recognize important people, called *kak-hän* (literally "man-chief"), who mediate between parties involved in a conflict. The status of the *kak-hän* is not hereditary and can be lost if the holder is deemed unworthy.

Among agricultural activities, taro garden cultivation uses ancient agricultural practices, completed with taboos and specific knowledge belonging only to the Oksapmin. In contrast, sweet potato gardens are a more recent activity and involve fewer "coded" practices. Taro gardens are generally planted at higher elevations on mountains, whereas sweet potato gardens are most frequently located on the valley floor and on gentle mountain slopes, closer to the settlements. Over the years, taro gardens have been increasingly relocated further up the mountains away from the village because they are planted in old secondary forest. Also, space is needed for cultivating the newly introduced marketable vegetables (Boissière, 2003) and suitable arable land is decreasing with population growth. Another reason for moving taro up the mountains is that taro has higher soil nutritional requirements than sweet potato (Sillitoe, 2002). For this reason, cultivators prefer sweet potato gardens even though taro is preferred over sweet potato for the status it confers (see Connell, 1978, for an example in the Solomon Islands). During my survey, a *kak-hän* in Oksapmin named DHD told me a story that clearly illustrates how sweet potato gardens have progressively pushed away taro gardens.

Long ago, the ancestors came, and they cut the forest, removed the stones, and cleared and created the first gardens. The ancestor *Auyon* came and taught his children how to plant the taros, as we still do today. Long ago, taros were planted right next to the houses, then higher and higher up the mountain. *Ahnawit* had a taro garden where DHD now grows a sweet potato garden. When there were still houses of spirits, *ap yawol*, the taro gardens were protected. When they disappeared, the gardens had to be moved up in the mountain, otherwise, sickness and insects would attack them. When the *ap yawol* were still there, the taro gardens could remain where they were. No more. His father said to DHD that when the land is no longer suitable for taros, his children would no longer have taros. His father, therefore, advised him not to move too quickly towards the mountains and to leave space for the forest and his children.

Sweet potato is a relatively recent introduction into New Guinea (ca. 300 years ago) in comparison to taro cultivation, which is believed to be much older (ca. 9,000 years), as attested to by analysis of archaeological remains from the Kuk site (Denham *et al*., 2003, Golson *et al*., 2017, Matthews and Nguyen, 2018). The natural range of wild taro seems to include New Guinea; Matthews (2004) argues that: "Archaeological records for taro are scarce because the plant is a soft herb with no hard part. The oldest clues are soil erosion and earthworks that may or may not reflect taro cultivation, 6,000 years ago or earlier in highland New Guinea, and starch granules that are possibly from taro, on stone tools dated to approximately 28,000 years ago in the Solomon Islands. In wild and apparently natural habitats by swamps, streams, and waterfalls, wild-type taro is distributed from northeast India to southern China, Southeast Asia, Australia, and New Guinea. Genetic studies indicate that domestication occurred independently in more than one region."

Taro may have been domesticated from its wild form, apparently present naturally in New Guinea, even if the centre of its origin may be in Northeast India and Southeast Asia (Matthews, 1995; Matthews and Nguyen, 2018). Perey (1974) showed that oppositions exist between taro and sweet potatoes: ancient cultivated plants and more recently cultivated ones, high altitude zones and the valley floor, cold regions and those having a more temperate

climate. This opposition is also reflected in the diet, whereby sweet potatoes and taro are never eaten together at the same meal (Perey, 1974). In gardens, taros and sweet potatoes are never grown together as a mixed crop.

The garden of *Gohyam*, the study garden described in this article, was made in close collaboration with the clan of DHD, and his family. DHD had lost his taro garden when his wife died, a few years previously. His garden was quite distant on the mountain, and while mourning for his wife, he was unable to visit it regularly. Because a wild pig ravaged it, DHD no longer had any taro plants with which to start a new garden. DHD decided to purchase a garden as a source of cuttings (mother-garden) and I worked with him and his children in a new garden. The garden DHD lost was not at *Gohyam*, but in another place on the mountain. However, as *Gohyam* was on his clan's land, he had rights to the place and had once, 20 years previously, made a garden there.

RESULTS AND DISCUSSION

The Mother-Garden: in the Beginning, There is a Collection of Cuttings

A mother-garden serves as a source of taro cuttings to be planted in new gardens. We consequently looked for a garden with growing taro plants ready to be harvested which we could acquire. Some definitions of the terminology of taro parts (Figure 2) are needed. According to Matthews (1997): "Side-shoots are highly variable in colour and morphology. Individual plants may display both direct shoots and stolons. Stolons are defined here as side-shoots in which at least the first internode has a narrow and constant diameter (the first internode lies between the parent corm and the first node). Without this definition, it can be difficult to distinguish an elongated side-corm from a child corm mounted on a short stolon. An elongate side-corm can display a distinct (protruding) node on a swollen internode. See also Matthews (1995) for the different parts of the plant. According to Wilson and Siemonsma (1996): "Corm pieces, whole small corms, cormels [small corms coming from lateral buds] and stolons can be planted, but suckers and head-sets (corm apex plus 15-30 cm attached petiole bases) are usually preferred." In the text, when I refer to ready-to-be planted taro, whatever its part (stolon, side-shoot or head-sets), I use the term cuttings.

Raison-d'être of a Mother-Garden

Sweet potato cuttings are not sold because they are found in abundance within gardens. However, taro is planted one by one, and even if it is a clonal culture, each plant is precious and there are far fewer vegetative offshoots, the basis for cuttings, than on sweet potato plants. A grower's attention is directed towards each individual and how it will be propagated. It was clear from the beginning that no villager would offer us the hundreds of cuttings we would need to start our garden.

Taro cuttings can be purchased in bundles, traded as part of exchanges, and more rarely sold in the ground with the rest of the garden. In this case, it is the entire harvest that is being sold, not the land. The land ownership returns to the initial owner once the crops have been collected.

We bought the garden of W, an Oksapmin villager and kinsman of DHD. The garden cost only 200 *kina*, even though, according to DHD, it had a value of 300 or 400 *kina*. One kina was 0.26 euros in 2001. To give an example, in 2001, one Kina used to buy a dozen sweet potatoes or a kilogram of vegetables (e.g., tomatoes or broccoli). W offered us the

garden at such a low price because of his kinship with DHD. W was selling his garden because his wife was not helping him with it. This way, he could get rid of the harvest, which would be too much work for him to collect alone. However, although he lost that year's harvest, the sole source of taro in his family, he retained the land rights.

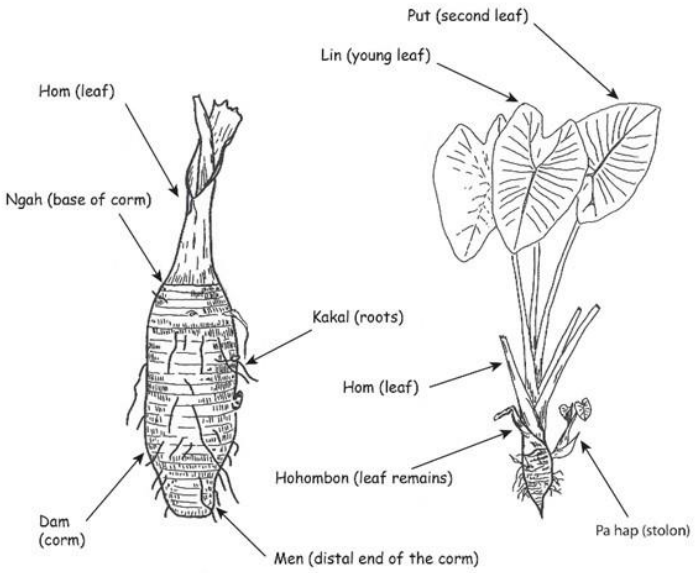


Figure 2. Vernacular terms for basic parts of a Taro plant

Plan and Size of the Mother-Garden

Figure 3 is a schematic drawing of the mother-garden, known as *Youdil*. The garden was located on the north face of the mountain at 2,060 m asl. that is, about 500 m above the valley floor, and with a steep slope (roughly 33 degrees). I estimated the total surface area of the garden to be 529 m^2.

The Harvest in Numbers

The harvest of taro corms and cuttings took a total of seven days. On average, six people (from 2-11 people) worked to bring in the harvest. The aim was to collect all the corms, to separate them from the cuttings (head-sets) and to carry everything back to the village, then later, to carry the cuttings up to the new garden. This garden, which had yet to be cleared, was situated on top of a mountain on the other side of the valley. It took a total of 128 person-hours to complete these tasks. We collected some 464 kg of taro corms and, of the 1,072 taro corms collected, there were 753 large, 284 medium and 879 small cuttings. Small cuttings (side-shoots) will not generally produce a corm, and some of the large and medium corms were already rotten. The total number of collected corms therefore differed from the total number of cuttings. The yield of the *Youdil* garden was about 8.8t/ha, lower than that of the Bimin gardens (ca. 9.9 – 10.9t/ha, calculated by Bayliss-Smith, 1985), which are located not far from Oksapmin. About 50 different taro cultivars were growing in the *Youdil* garden.

Other cuttings brought by DHD were added to the cuttings collected from the *Youdil* garden. Once preparation of the *Gohyam* garden was well under way, DHD revealed that, even after the destruction of his taro garden by a wild pig, he had still managed to gather a

few cuttings from his old garden, and he had planted them in secret places all around the valley. In each of these places, for example along a barrier or a butte that was difficult to reach, he planted only about a dozen taros. That way, they remained secret. His intention in doing so was to keep a reserve of cuttings until the day that he could rebuild a taro garden. DHD felt that the time had come and he seized this opportunity to transplant his remaining taros in *Gohyam*. DHD brought 22 small cuttings and 16 large ones.

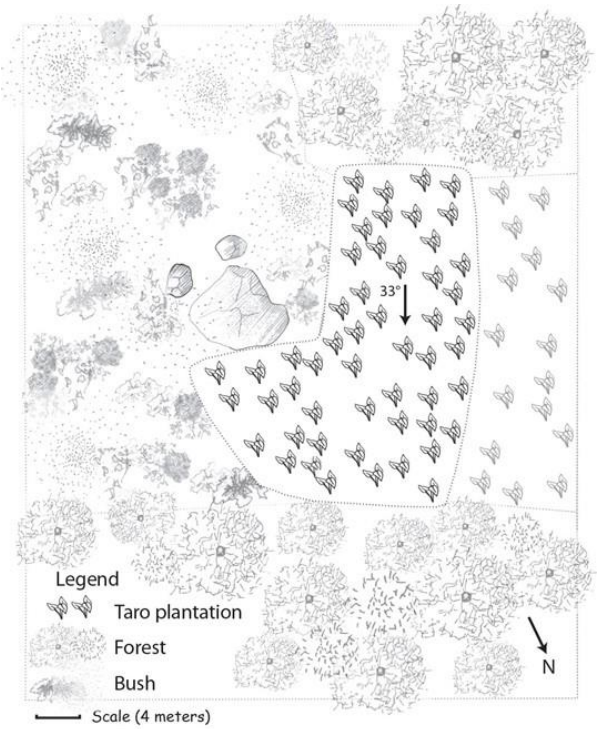


Figure 3. Drawing of *Youdil* Mother-garden

Harvesting Techniques

The preferred tool for collecting taro is the digging stick. The Oksapmin term for "stick" is *kau*. Two types of digging sticks were used in taro gardens: 1. *Pa kau* designated the stick used for harvesting taro. *Pa* signifies "taro". This stick, made from the wood of *kapen*, was sufficiently strong to lever things. 2. *Pa san kau* (*san* for "cutting") designated the stick for planting cuttings. In general, *klindan*, a dense and hard wood, was used to make this stick. A description of how this stick was used is given in the section on planting.

There were two basic stages in collecting the cuttings:

a. For the collection itself, the soil around the taro plant was dug up using a *pa kau*. In so doing, the root system was severed from the corm (*hom*). Once the stick was firmly planted next to the taro, it was forced further so that it passed under the corm. The corm was levered out of the soil by the stick in such a way as not to damage it. The plant was then grabbed by the leaf bases and pulled out of the soil. Similarly, all the small shoots of taro that grew around the mother plant were dug up. The excavated corms were placed in a heap nearby.
b. Once sufficient corms had been harvested for the day (corms are perishable and cannot be left in the garden), the corms were cleaned by removing the roots and senescent leaves, with a knife. The first two outer leaves, basal on the corm and called *hom*, were cut, followed by the inner whorls of leaves approaching the corm apex, called *lin*. The last

> leaf (innermost of whorl) was generally left and rolled up in the previously cut leaves and wedged between two petioles. Only now was the corm separated from the cutting (*Pa san*) using a knife; the cut was made as close as possible to the place of leaf insertion on the corm. The cut was made in order to leave a round, convex bit of corm at the extremity of the cutting. This bit of corm was very important because the new roots of the cutting would form at this point. For small taros (side-shoots with corms of ca. 10 cm long), the corm was not removed, only the far end was sliced off to encourage the development of the root system, and the leaves were left intact. Cuttings and corms for food were piled in separate places.

The success of the future garden depended on the way the cuttings were collected and prepared. Once removed from the soil, the taro is vulnerable. To ensure that it is not damaged, each taro needs to be brought, one by one, to the place where it is cleaned and stored. At harvest time, DHD reserved a part of the garden where large-leaved taros grow, a variety which was villagers' favourite. Once the cuttings were collected, a few people harvested this patch. These harvested corms were eaten during a feast after we returned the garden to W. On the first day of harvesting, we formed a small committee to visit the garden, evaluate its state and reserve the best corms. In the days that followed, we invited more people to join us in the garden. People who helped us dig up and carry back cuttings received the number of corms they could carry home at the end of the day.

Organization of Work

For the first few days, while the cuttings and corms were being collected, people worked in pairs. One person unearthed the corms, and the other cleaned and separated the cuttings from the corms. The division of labour for transporting the harvest was balanced between the person who carried the corms, which were comparatively heavy, and the person who carried the cuttings, which were lighter but more awkward. This division of labour was maintained throughout the harvest.

DHD managed the operation. He decided which part of the garden was to be harvested first, in our case, the lower part. In this area, he asked us to first dig up the largest taros, along with those that were a particular favourite, here a variety known as *kombes-han.* This was because rodents had already begun to wreak havoc in the garden, which had been left too long without being harvested.

When the time came to carry the harvest back to the village, DHD divided the loads between different people, sometimes up to 25 kg per person. The journey from the village to the garden took a little over an hour because of the steepness of the slope. On the way back it took less than an hour. Once in the village, the cuttings were stored in a *pitpit* grassland *(Saccharum spontaneum* L.) not far from the house for a few days, so that they began to form roots.

Taro Cultivars

Table 1 below lists the local names of the taro cultivars collected from *Youdil*. DHD identified about 50 cultivars (plus 13 sub-cultivars) from the *Youdil* garden. Before the evangelization of the valley, taros could be used in rituals and women were forbidden to eat them. This situation was almost identical to the neighbouring valley of Bimin (Bayliss-Smith, 1985). The recognition of the different taros required a knowledge that not all villagers in Oksapmin possessed. Some people, who did not cultivate taro at the time of the study, were

"converted" to sweet potato cultivation, a more "democratic" type of plant, whose cultivation was open to everyone. Only a masculine elite had knowledge of taro cultivars and their cultivation.

Table 1. Taro cultivars collected at *Youdil*

No	Category	Variety	Sub-variety
1	Alpon-han	Lelungwe	Lelungwe kan
			L. gahpol
			L. berom
			L. tahas
			L. name
2	Alpon-han	Kombes-han	Kombes-han
			K. mangal/bisil
			K. ombit
3	Alpon-han	Apmon	-
4	Alpon-han	Atanolim	-
5	Alpon-han	Kweikikyap	-
6	Alpon-han	Aminkol	-
7	Alpon-han	Halgep	-
8	Alpon-han	Gilis	Gilis pi
9	Alpon-han	Asimnoh	-
10	Alpon-han	Tomsan	-
11	Alpon-han	Mengal	-
12	Alpon-han	Ibitaloh	-
13	Alpon-han	Gayalop	-
14	Alpon-han	Kesipa/Undop	-
15	Alpon-han	Andimnoh	-
16	Alpon-han	Blipteng	B. kumkumba
17	Alpon-han	Hanpa	-
18	Alpon-han	Deblonam	-
19	Alpon-han	Yawin	-
20	Tenhan	Damgwe	-
21	Tenhan	Holbinah	-
22	Tenhan	Yohan	Y.
			Yohan
			Y. nesu (sang)
			Y. ulot
			Y. hotan
23	Tenhan	Kinip	-
24	Tenhan	Bisil	-
25	Tenhan	Opsenal	Opsenal
			O. gibilgwe
			O. disik
			O. siglop
26	Tenhan	Samkol	-
27	Tenhan	Samelan	-
28	Tenhan	Silibap	-

29	Tenhan	Apdandes	-
30	Tenhan	Balangal	-
31	Tenhan	Un	-
32	Tenhan	Kaliame	-
33	Tenhan	Balusin	-
34	Tenhan	Teyopgwe	-
35	Tenhan	Wakum	-
36	Tenhan	Natohem	-
37	Tenhan	Hutambes (kobeyap)	-
38	Tenhan	Bakapsup	-
39	-	Pinop	-
40	-	Huhunwap	-
41	-	Hulipit	-
42	-	Hop	-
43	-	Ambiap	-
44	-	Bahangsul	-
45	-	Dimaneng	-
46	-	Putul	-

In Table 1, two taro categories are distinguished: *Alpon-han,* taros whose corms are typically cooked in house fire ashes, and *Ten-han,* those traditionally cooked in a *momo,* an earth oven. Long ago, taros belonging to these two categories were treated distinctly and cultivated in separate places. This distinction was no longer made at the time of the present study.

The vegetative characters used to identify local taro cultivars are primarily found in the sheathing leaf base. Concerning the varieties of taro cultivated by the Wola, Sillitoe (1983) reported that the colour of the flesh and leaf stalk of the corm are useful characters for varietal identification. In Oksapmin, corm colour indeed helped identify it, but a good local specialist could name each plant without unearthing it. The taro cultivars were recognizable only based on the colour of the petiole (sheathing leaf base). Petiole colours included white, rose, yellow, green, and black. The colour of the petiole nerve and margin also varied, the margin could be unpigmented, green, or brown. Another character to consider was the presence or absence of designs on the petiole. Spots or lines and their direction enabled an experienced identifier to name the taro variety. Figure 4 provide some examples of taro petiole diversity.

The Genesis of a Taro Garden

The first step in making a taro garden, i.e., collecting corms and cuttings, was done in parallel with the opening of the new garden. The two overlapping phases together took about two months.

Site of the *Gohyam* Garden

The garden was located on the top of the mountain that dominates the hamlet of the DHD's clan. The site was inside the clan's territory. The site is located in a natural basin at an altitude of 2,150 m (whereas the hamlet is at ca. 1,500 m asl), in the middle of an old, over-grown taro garden opened by DHD in 1981. In 1992 and 1995, DHD opened a few gardens around this place. A nut pandan grove was located in a hollow in the middle of the garden.

DHD regularly visited this forest for hunting because wild pigs abounded in this region and when the pandan trees were fruiting. The walk from the village took about 90 minutes. The path climbed steeply through sweet potato gardens then followed a muddy forest path encumbered with mossy trunks.

Figure 4. Some taro cultivars collected from the Youdil mother-garden are illustrated in the photos. Note the differences between the sub cultivars (petiole nerve and margin colour)

Surface Area and General Plan of the Garden

The garden was bigger than the mother-garden, in this case, 2,526 m^2 in *Gohyam* compared to 514 m^2 in *Youdil*, a five-fold difference. This difference is because a single taro plant develops a certain number of stolons by vegetative propagation. More space was needed in *Gohyam* to plant the taros harvested in *Youdil.* Figure 5 is a general plan of the *Gohyam* garden.

Clearing

After the land had been surveyed and the general outline of the plot delimited, the opening of the garden could begin. The first step was to clear the land. The site was fairly flat, densely forested, and had a considerable understory layer. Clearing took us a total of six days, that is, 68 person-hours of which 50 hours were devoted to clearing the garden itself and 18 hours were used in clearing the garden edge. On average, four people worked per day, although on some days there was only one person and on others as many as five. The first

step in the clearing was to reopen the path between *Gohyam* and the nearest sweet potato garden, the property of DHD. Nearly an hour's walk separated the two gardens.

The second step was clearing small trees, lianas, herbs, herbaceous ferns, arborescent ferns, and bushes in the garden site. DHD decided what the limits of the future garden would be. He felled the most difficult trees, those that menaced the health of the central pandan grove. The large trees in the centre of the garden were cut in such a way as to fall towards the centre (Figure 5). No fence or other barrier was constructed to protect the garden. Figure 6 shows the garden divided into 6 sectors, from A to F.

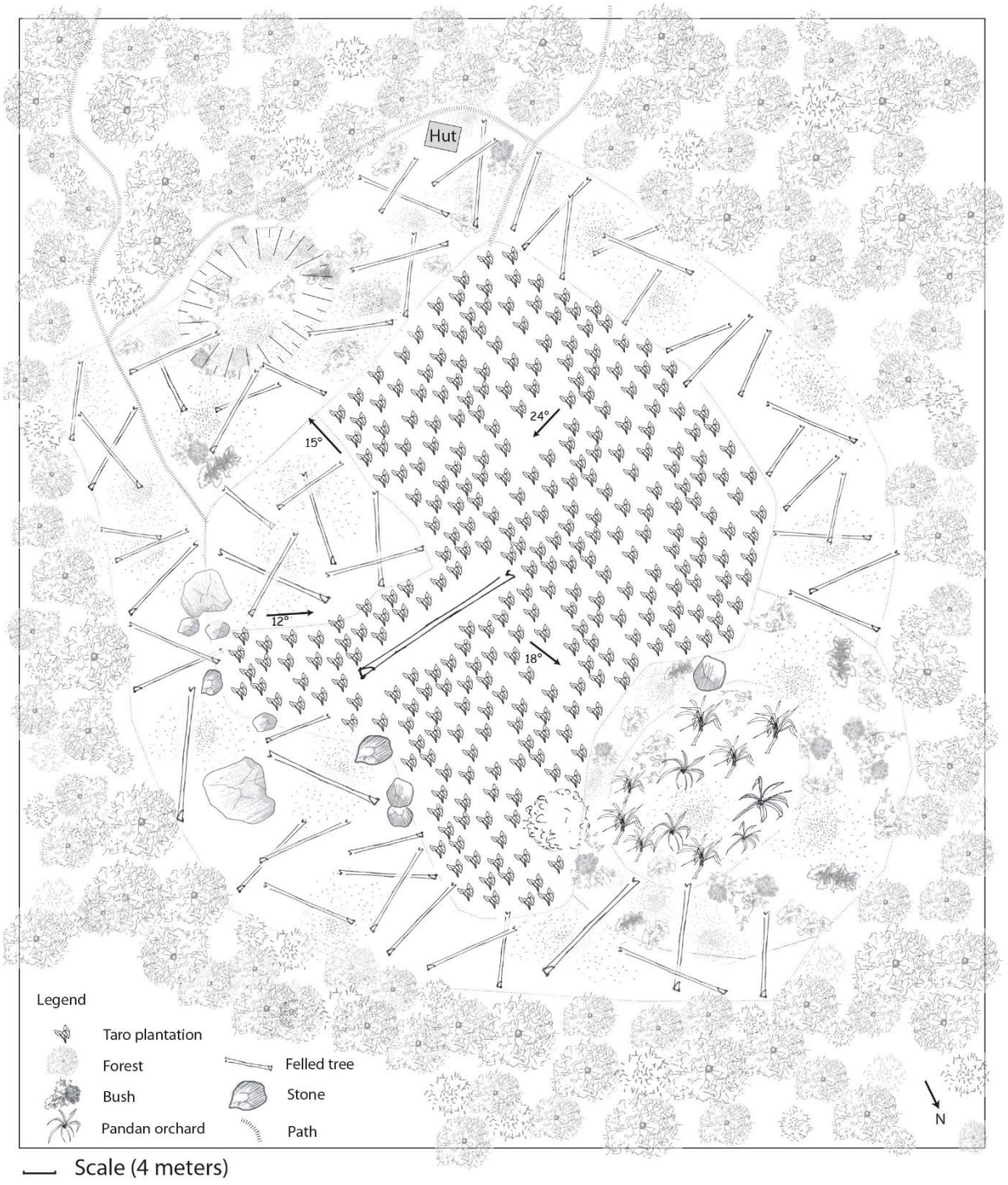


Figure 5. Drawing of Gohyam taro garden

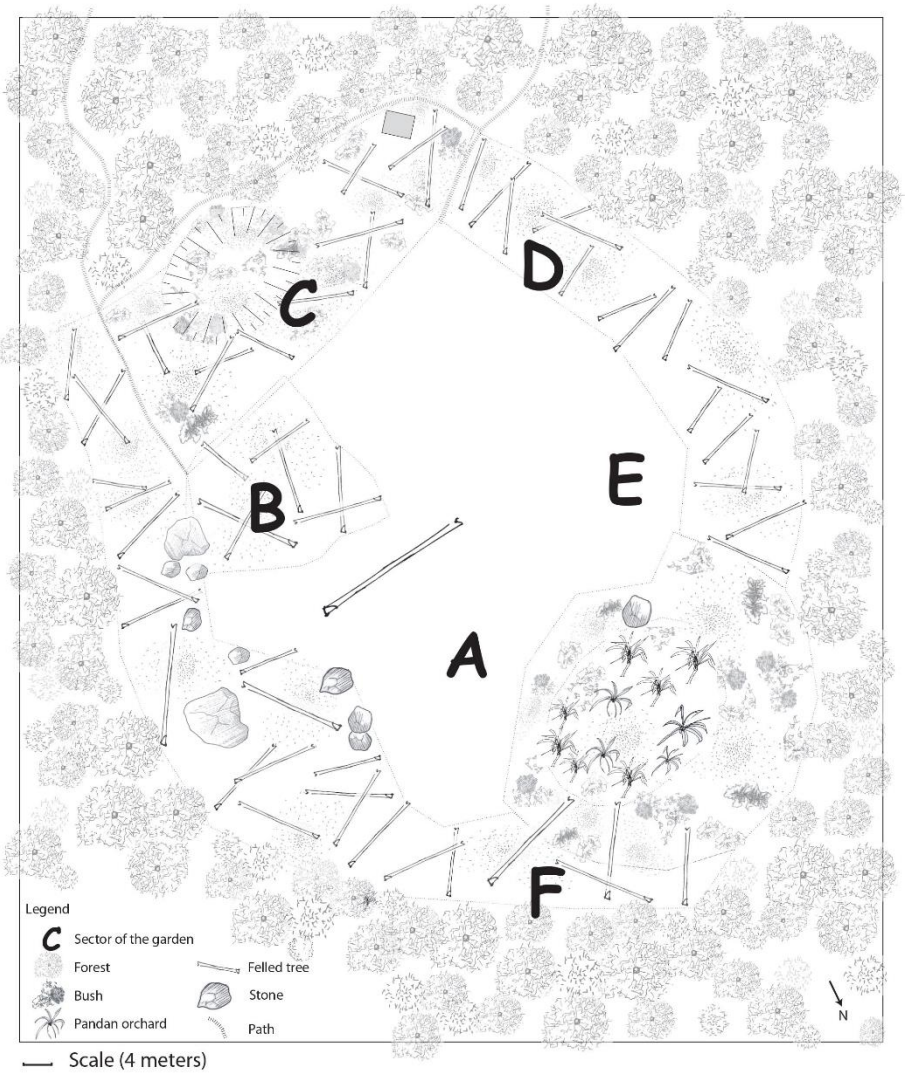


Figure 6. The six sectors of *Gohyam* taro garden

After most of the small trees had already been cut, the medium-sized trees started to be cut with a machete. Medium-sized trees had also to fall towards the centre. Their trunks should cross, like in a giant game of pick-up sticks. The cut trees had to be distributed throughout the perimeter of the zone to be cultivated. If the trees were to all fall in the same zone of the garden, it would be more difficult to burn the cut material afterwards.

The small trees, bushes and scrubby plants were cut as close as possible to the roots. Bigger trees were cut about a meter above the ground, because it was easier to cut them at this height with an axe. Contrary to what is recorded for Bimin at a similar altitude, all trees, bushes, and scrubby plants were cut in *Gohyam* (Bayliss-Smith, 1985).

Two methods were employed for tree cutting (Figure 7): one method was to cut the trees situated at the lower end of a slope first and then to progressively work up the slope. This prevented the trees at the top of the slope from being blocked by those below. The other method was to start by cutting the young trees at the top of the slope. The logs accumulated on the large trees. When the large trees were cut everything fell at the same time. The decision as to which technique to use depended on the location of the trees and their density. Another factor was the presence of lianas, as these prevented smaller trees from falling. One variation of the second technique, which was used when there were many lianas, was to begin cutting a tree, then to leave it standing, and then to do the same to several neighbouring trees.

Finally, a large tree was cut, which brought down the rest of the previously prepared trees. The way in which the first cut was made on the side of the trunk facing downslope was decisive.

Unlike their Bimin counterparts (Bayliss-Smith, 1985), Oksapmin cultivators thought that taros grew best on completely cleared land. For this reason, open glades were created in the forest bordering the garden so that the future taro plants could receive a maximum amount of light. Once the trees had been felled, we cut and cleared the trees and bushes bordering the periphery of the garden. We did not completely clear this zone. Our aim was only to make sure that the young taro plants in our garden were not shaded by plants growing outside it.

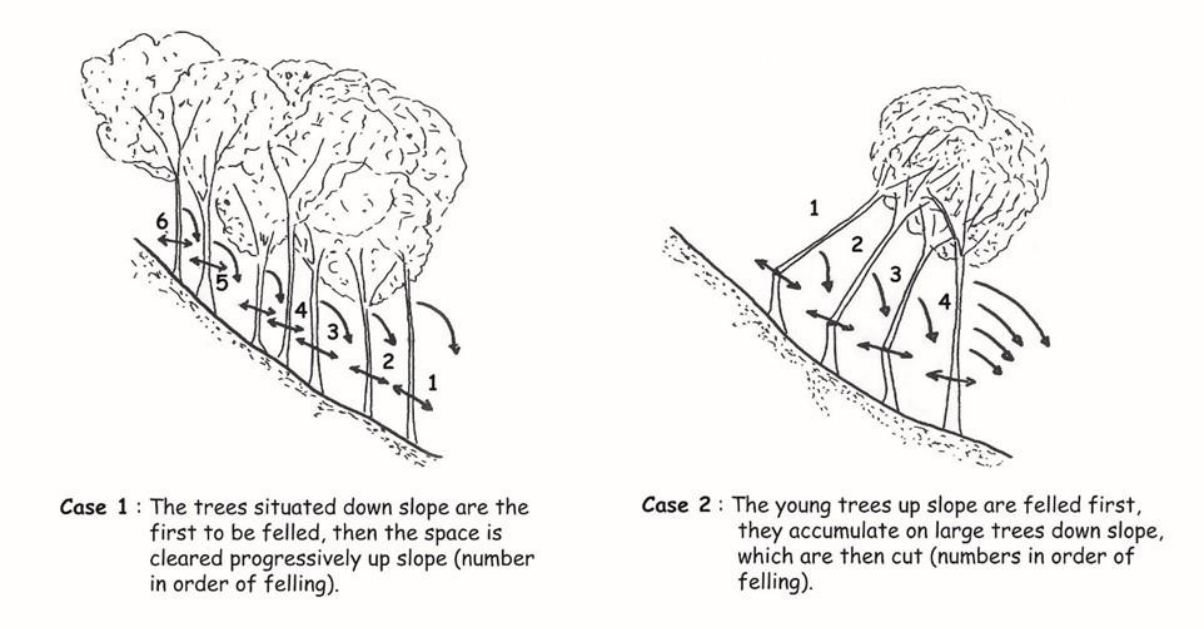


Figure 7. Two felling techniques used in when clearing gardens on a slope

Drying

After cutting, the time the parcel was left fallow depended upon the season. In our case, less than a month was sufficient for the tree stumps to become dry enough to burn. During this drying period, no one visited the *Gohyam* garden.

Parcel Cleaning and Burning

Cleaning took 11 days or 179 person-hours. There were on average four people working per day although on some days there was only one person and on others as many as five. DHD showed us the sector (A) where we would begin work. Everyone began to cut up the wood in this sector. Small trunks and branches were cut from the trees, then cut up into smaller logs with a machete and left in place. At first, we did not pile up anything in the zones where we were going to burn the logs and debris. The large tree trunks were cut with an axe, about every two metres, to form large logs. They were then cut into four pieces by two people working on each side of the log. Each person alternately struck the log along its length with an axe. Each cut was made at a place close to the previous cut but from the opposite side. In this way, the first person could remove the axe as the second pushed their blade deeper into the wood. When the 2-metre trunks were quartered, the logs were put aside.

Once a surface area of about 100 m^2 was cleared, and the trees cut into logs, we began to prepare the fires. For this task, we either worked alone or in pairs. A fire was lit from branches and dry leaves. Then dry trunks were thrown in the fire, followed by the quartered trunks, rotten trunks, wet branches, humid leaves and roots. This way, the land around the fire was cleaned all the way down to the ground until the soil was naked. It was important to burn only the material in the immediate vicinity of the fire so that there was plenty left for other fires. In our case, the fires were not only a way to get rid of encumbering wood from the future garden, but to enrich the soil. Each fire was set two or three metres from another. Once two or three fires were lit, we prepared additional fires. For a surface area of 100 or 200 m^2, we made about six fires. DHD would plan the approximate location of the future fires, the zones where he would plant taros, and the next garden sectors we were supposed to prepare.

Fires were made concentrically, so to enlarge the central space where planting would begin first as rapidly as possible. In this way, we arrived at optimal exploitation of the garden. Figure 8 illustrates the daily progression and position of the fires (total = 95) we burned on about 2,000 m^2 of garden land. The main drawback of this method is that it creates a cloud of thick, dense smoke over the entire area to be cultivated, but by working two sectors of the garden at a time, we avoided creating too much smoke.

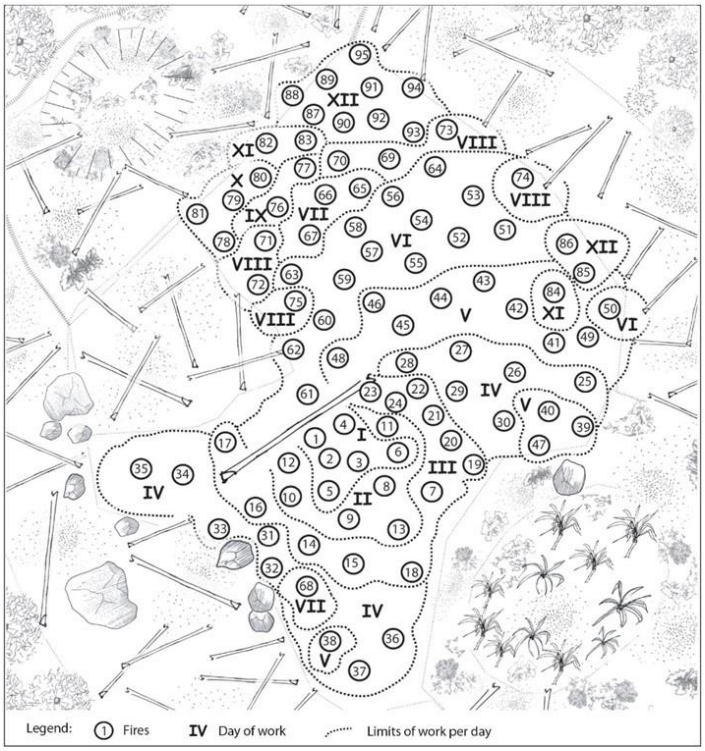


Figure 8. Location of the fires in *Gohyam* taro garden

A second technique for preparing a fire on a steep slope was to build a scaffold. Two or three trunks were set in the soil, and long trunks were piled against them to form a barrier. Then two or three more trunks were placed in the direction of the slope to support the fireplace. This arrangement allowed the fire to be ventilated from the bottom (Figure 9).

A third technique was to prepare the fireplace without lighting it immediately, then to light it from the base. This method required more considerable skill than the other two because the ordering of the wood and debris had to be perfect to ensure the fire burned well. This was the technique that DHD often used. When this method was used, there was practically no wood left unburned.

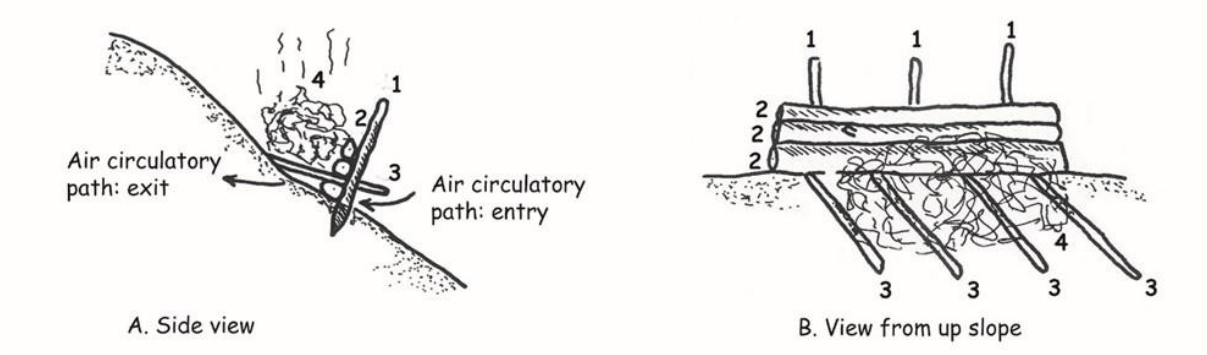


Figure 9. One variant of fire construction on a slope

For the first few days, we only brought young taro cuttings (mostly side-shoots) to *Gohyam*, the large ones were left at the village because they needed a few more days to form roots. These side-shoots could be planted right away and would develop normally. Every afternoon, before going back down to the village, we would bind them in bundles and hang them on a stick or place them on a high rock so rats would not eat them. From the first day, one of the women accompanying us began to sow broccoli seeds in the zones where the ashes had already been spread.

At the end of each day, we would go back to the village with the fires still burning. While we were cleaning the garden, DHD would take time to clear the scrub from around the pandan grove. Planting typically happened at the end of the day when people were tired. Some would watch the fires burn and others would plant. If the land was not planted quickly after cleaning, the yield would not be good. The cuttings were also perishable and had to be planted quickly. Young taro cuttings can only withstand exposure to the sun for a short time (Sillitoe, 1983), so we planted them first, along with Chinese cabbage and tobacco seedlings.

The fire sites acted as garden markers. The seedlings belonging to a person were planted on the ashes from the fire that person made. Each person remembered where they built and made a fire, and the zone of ashes marked the spot. The garden was, therefore, divided into a shared space, i.e., the zones of taro plantation and the private space, i.e., the circles of ashes where individual cuttings were planted.

Each morning when we arrived at *Gohyam*, the fires were still warm, and we moved the wood that had not yet been burned to a new fire, ready to be lit. Sometimes, two old fires had enough firewood left to form a single new one. Once the old fire had finished burning, the still warm ashes were spread around the fire site. The largest and best taros were those which grew on these ash spots. Some incompletely burned piles remained in the garden and would be burned again later or simply thrown along the garden side. When our garden was nearly ready, DHD added a few fires, which he reserved for the taro cuttings coming from his secret gardens.

Planting

Planting should take place at the beginning of the rainy season (Perey, 1974), in November or December, because taro needs moisture. In *Gohyam*, the planting phase overlapped the clearing and burning of the garden. It took ten days to complete planting, or 41 person-hours with, on average, two people working on this task (the number of workers could vary from one to four).

Once sufficient space was cleared to the ground starting from the concentrically burned fires, planting could begin. For this purpose, two digging sticks were made, one for

each cultivator; the digging stick was about a metre long, heavy and with a coarsely fashioned point at one end. The day we planned to plant, each of us brought a bunch of large cuttings (head-sets) from the village to *Gohyam*.

Planting involved the following steps: 1) the stick was thrust into the ground, about 20 cm deep; 2) it was worked around in all directions to enlarge the hole, then pulled out; 3) a cutting was placed in the hole; 4) the stick was thrust twice more into the ground near the cutting and moving the stick towards the plant, the soil was brought up around the taro. We tested the cutting, by using our feet, to see if it was correctly planted and anchored in the soil.

Cuttings were planted at a distance of about one metre apart, especially the largest ones. The garden land was systematically used. The location of each new planting was calculated with a view to optimal utilization of space. The least preferred cuttings (in culinary terms or physical condition) were planted in the zones with no ash, or where the soil was known to be less fertile. Each cutting was planted according to the following four possibilities (+/- in order of decreasing fertility, and see Figure 10): 1) in the circle of ash zone, centre; 2) in the circle of ash zone, periphery; 3) in the naked soil zone, between circles of ash zones; and 4) in the poor soil zone.

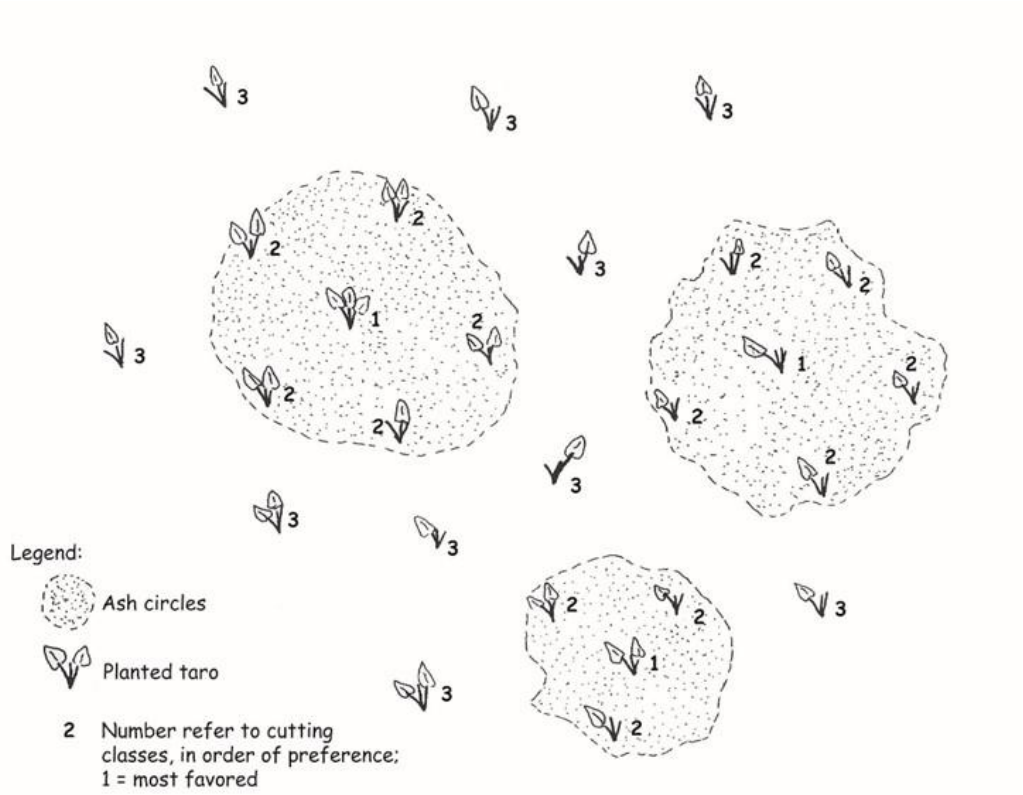


Figure 10. Positions of taro plants as a function of ash remaining from fires

The different taros were planted in the fire zones or between them. The Maenge of East New Britain used the same dichotomy to plant their taro. “Rubbish taro” (i.e., “number of cormlets above 5, buds scattered on the tuber, petiole under 5 feet when reaching maximum height, petioles often drooping, petioles often green”) were planted outside of fire zones. Quality taro or “taro of the fire” (i.e., “Number of cormlets under 5 or cormlets absent, buds arranged in concentric rings on the upper part of the corm, petioles above 5 feet when reaching maximum height, petioles erect, often with bright colours”) were placed in the ash covered zones (Panoff, 1981). According to Panoff (1981), only the latter taro type was used

in ceremonial exchanges. Taro cultivation in New Guinea is connected with its ritual usage, cultivation techniques and spells (see also Sillitoe, 2002 for the Wola).

Large taros were planted sufficiently far apart so they develop without being crowded by other plants, but two or three side-shoots could be planted in the same hole. The side-shoots should then be about the same size, otherwise, the largest one would grow at the expense of the smallest. Studies by Bourke (1976) and Bourke and Perry (1976) have shown that medium (51-60 mm) and large (> 65 mm) cuttings size classes give the best results in terms of harvest compared to small cuttings (< 45 mm). This difference in yield can be attributed first to the greater vigour of the large cuttings and, second, to the rapid formation of large leaves, which will shade out any competing plants in the vicinity. Once we had planted the best and biggest taros strategically in the most fertile zones, we filled the remaining space with the small cuttings.

The planting operation was entirely directed and controlled by DHD, who reserved the planting of his preferred taro cultivars for himself. He made provision for the hundreds of small cuttings to be planted on the steep slopes or at the periphery of the most fertile soils. When planting, the spot was first tested by thrusting the digging stick into the soil. If there were too many roots or stones, then the hole would be refilled using the foot and a new spot tested. If the fires were still too hot, we dug the holes and left the cuttings nearby. We left the smoking land with its gaping holes until the soil had cooled.

We spread the ash from the fires, and, at the end of the day, we planted some cucumber and cabbage seeds in beds. Plants like cabbage were sown by spreading the seeds on the surface of the soil whereas, cucumber seeds were sown individually in small holes. We transplanted the seedlings after they developed several mature leaves.

Maintenance

The study ended once the cuttings were planted and did not include garden maintenance nor its harvest. Harvesting techniques were studied when we collected cuttings from the mother-garden, *Youdil*. When harvest time arrived, *Gohyam* served, in its turn, as the mother-garden for the intended extension of its boundaries. In total, more than 400 person-hours were necessary for the construction of the *Gohyam* garden, not including maintenance and harvesting. This value is at the low end of the range proposed by Perey (1974), who reported between 400 and 800 person-hours for a sweet potato garden measuring about 2,000 m^2. Labour depends on the kind of land being cleared. A sweet potato garden requires clearing grassland and shrubs, and may take longer than clearing a secondary forest.

Once everything was planted, a long waiting period (about a year) ensued. During that period, the cultivators would regularly visit to harvest fast-growing vegetables (such as cabbage and broccoli), to hunt nearby, and to harvest nut pandan fruits. A hut was constructed in a cleared area, usually on the garden edge so as not to obstruct the garden's growth, and men would stay overnight from time to time, maybe to collect a few tobacco plants and hunt cuscus, birds and wild pigs. The presence of people allows regular surveillance of the garden and is particularly important towards the end of growing year, when the corms have formed and are increasing in size, which attracts thieves as well as wild animals such as pigs and rodents. Villagers did not think that fences were necessary at such a high altitude because garden topography already made access difficult for domesticated pigs, which roamed freely. As for wild pigs, villagers said that a garden was most vulnerable to these animals when they sensed that it had been abandoned, then the pigs would ravage the garden, as was the case when DHD was in mourning. Periodically, about every three months

in the growing season, the taro garden had to be weeded and cleaned. Hence, there were three weeding sessions before harvest.

CONCLUSIONS

Oksapmin belongs to what Haudricourt (1964) named "the civilization of yam", referring to the cultivation of tubers, a culture of clones in which, "each season the same individuals are harvested so that they may be replanted in the next". Oksapmin agriculture is characterized by two modes of clone cultivation: polyculture of sweet potatoes, and monoculture of taro, although some other crops were planted at the edge of the taro garden. Long considered as fragile and vulnerable to parasites (Morren and Hyndman, 1987; Paiki 1996), monoculture is the traditional mode of cultivation by the Oksapmin society. This fragility is offset by the parallel cultivation of sweet potato and cash crops, the latter sold at the mining town of Tabubil, but also by the great number of taro cultivars grown in high altitude gardens. Each taro cultivar displays different degrees of resistance to the various pests, growing many different cultivars reduces overall garden vulnerability. According to local growers, the distance between taro gardens and the inhabited area is a gauge of the adaptation of agricultural practices to the menace of parasites. They reported that, in the olden days, when taro gardens were located close to houses, they had to conduct fertility rituals in the gardens in order to protect them. The question remains open as to whether at Oksapmin, we are witnessing a transition from agriculture based on taro to one based on sweet potato as Bayliss-Smith (1985) reported is the case for Bimin, or are we observing the co-habitation of two types of agriculture as suggested by Morren and Hyndman (1987)? Although sweet potato gardens are slowly but steadily predominating in the valley, taro gardens still predominate at higher altitudes, where sweet potato polycultures are absent. And even if most villagers have both sweet potato and taro gardens, some indeed specialize only in one or the other.

The opening of a taro garden is an activity that requires the participation of several cultivators, the number varying according to the size of the garden and parental ties. However, according to Stewart and Strathern (2002) and Sillitoe (1983, 1996), sweet potato gardens can be cultivated by one person, whereas taro gardens need a group of workers, because of the ecology of the plant. According to these authors, the taro should from the garden all at once, and a new garden should, therefore, be ready to receive the cuttings. According to Sillitoe (2002) the obligation of harvesting the garden all at once favours exchanges and distribution of the harvest between relatives. This was the case for the *Youdil* garden, which could not be collected until the *Gohyam* garden was chosen, and, above all, once a sufficient number of DHD's relatives had accepted to work in the new garden. *Youdil* was abandoned and sold by W because he was the only one to work it.

Taro gardens play an important role at several levels: nutritional, maintaining knowledge in danger of dying out, and because they strengthen social relationships. Lastly, there are the taro cuttings, which circulate from one garden to another, never staying in the same place for more than two years, and which are moved further from the village, a fabulous genetic heritage in perpetual motion. Here, it is not just the gardens that are itinerants, but also the resources. However, it only takes the loss of a single cycle of cultivation and the disappearance of this wealth may well be irreversible.

ACKNOWLEDGEMENTS

I thank the Oksapmin villagers for their hospitality and patience with my questions and while making the taro garden. Thanks also to Lorenzo Brutti for helping me prepare this study in Okspamin. I am grateful to Dawn Frame for translating this text into English and for her critical editing of it. I also thank Cécile Pinon for her drawings of Gohyam taro garden. This study was done with the financial support from the Fyssen Foundation.

REFERENCES

Bayliss-Smith, T. 1985. Subsistence agriculture and nutrition in the Bimin valley, Oksapmin sub-district, Papua New Guinea, *Singapore Journal of Tropical Geography* 6 (2): 101-115.

Boissière, M. 2003. La mémoire des jardins: pratiques agricoles et transformations sociales en Nouvelle-Guinée, *Annales de la Fondation Fyssen* 18: 111-128.

Bourke, R. M. 1976. Which size taro to plant? *Harvest* 3(4): 127-128.

Bourke, R. M. and Perry C. H. 1976. Influence of sett size on growth and yield of taro (*Colocasia esculenta*), *The Papua New Guinean Agricultural Journal* 27(4): 115-120.

Brutti, L. 1999. « Après nous le déluge »: Les effets de la présence d'une compagnie minière sur le système agricole et le commerce des produits cultivés dans la région de Oksapmin (Papouasie Nouvelle-Guinée). *JATBA, Revue d'ethnobiologie* 41(1): 183-200.

Brutti, L. 2000. Site of complementary long-term research : Trangap / Oksapmin, *in* C. Kocher Schmid et R. Ellen, *Tropical rainforest peoples today, volume V*, Pacific region Melanesia, APFT, 153-164.

Brutti, L. and Boissière, M. 2002. Le donneur, le receveur et la sage femme. Echanges de porcs à Oksapmin (PNG). *Journal de la Société des Océanistes* 114/115: 141-157.

Connell, J. 1978. The death of taro: Local response to a change of subsistence crops in the Northern Solomon Islands, *Mankind* 11: 445-452.

Crook, T. 1999. Growing knowledge in Bolivip, Papua New Guinea. *Oceania* 69(4): 225-242.

Denham, T.P., Haberle, S.G., Lentfer, C., Fullagar, R., Field, J., Therin, M., Porch, N., and Winsborough, B. 2003. Origins of agriculture at Kuk swamp in the Highlands of New Guinea. *Science* 301: 189-193.

Golson, J., Denham, T., Hughes, P., Swadling, P., and Muke, J. (eds). 2017. *Ten thousand years of cultivation at Kuk Swamp in the highlands of Papua New Guinea*. Canberra: Terra Australis series 46, ANU Press.

Haudricourt, A.G. 1964. Nature et culture dans la civilisation de l'igname: l'origine des clones et des clans. *L'Homme,* 4: 93-104.

Jackson, G.V.H., and Wagih, M. E. 1996. *The second taro symposium: Proceeding of an international meeting* held at the Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23-24 November 1994.

Matthews, P.J. 1995. Aroids and the Austronesians. *Tropics* 4(2): 105-126.

Matthews, P.J. 1997. Field guide for wild-type taro, *Colocasia esculenta* (L.) Schott. Plant Genetic Resources Newsletter, No. 110. pp 41-48.

Matthews, P.J. 2004. Taro, *In* Krech III, S., McNeill, J.R., Merchant, C., eds, *Encyclopedia of World Environmental History*, vol 3 (O-Z), Routledge: New York, London.

Matthews, P.J. and Nguyen, D.V. 2018. Taro: origins and development, in *Encyclopedia of global archaeology*. C. Smith (ed.), 4p.

Morren, G.E.B.J. and Hyndman, D. C. 1987. The taro monoculture of central New Guinea, *in Human Ecology*, 15(3): 301-315.

Paiki, F. A. 1996. Symptoms of taro leaf blight disease (*Phytophtora colocasiae)* and relationship with yield components in Biak, Irian Jaya, *in Science in New Guinea*, 21(3): 153-157.

Panoff, F. 1972. Maenge taro and cordyline: elements of a melansian key, *Journal of Polynesian Society* 81: 375-390.

Perey, A. 1974. *Oksapmin society and world view,* thèse Ph. D., Columbia University, 386p.

Sillitoe, P. 1983. *Roots of earth. Crops in the highlands of Papua New Guinea.* Manchester University Press, Manchester, 283p.

Sillitoe, P. 1996. *A place against time. Land and environment in the Papua New Guinea highlands*. Harwood Academic publishers, Amsterdam, 438p.

Sillitoe, P. 2002. Archaic crop or awkward crop? Taro cultivation in the Southern Highlands province of Papua New Guinea. *In Vegeculture in eastern Asia and Oceania,* International Area Studies Conferences VII, Y. Shuji, P.J. Matthews eds., JCAS Symposium Series 16, Osaka, pp. 165-194.

Stewart J. P. and Strathern, A. 2002. The cultivation and use of taro and fruit Pandanus among the Duna of the Aluni Valley in the Southern Highlands of Papua New Guinea, with comparative notes *in Vegeculture in eastern Asia and Oceania,* International Area Studies Conferences VII, Y. Shuji, P.J. Matthews eds., JCAS Symposium Series 16, Osaka, pp.233-245

Wilson, J. E. and Siemonsma, J. S. 1996. *Colocasia esculenta* (L.) Schott., *in PROSEA* (*Plant Resources of South-East Asia*), No. 9, Plants yielding non-seed carbohydrates, pp.69-72.

P-ISSN 1693-6892
E-ISSN 2722-0257

Journal of Tropical Ethnobiology

VOLUME IV NUMBER 1 JANUARY 2021

CONTENTS