GEISHO
ITS USES, PRODUCTION POTENTIAL
AND PROBLEMS IN NORTHERN
TIGRAY, ETHIOPIA

Susanne Vetter
FARM Africa, CORDEP, Axum
Institute for Sustainable Development, Addis Ababa
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1997
# Contents

I. Introduction 1  
   Objectives of the study 1  
   Study areas 2  
   Methodology 3  

II. Geisho and Its Uses 6  

III. Existing Production Systems 9  
   Ecological distribution 9  
   The three main production systems in the area 9  
   Scale of production in the different systems 10  

IV. Production Methods, Labour and Resource Allocation 12  
   Raising and transplanting seedlings 12  
   Spacing and intercropping 12  
   Care 13  
   Harvesting 14  
   Replacement of old plants 15  
   Division of labour by gender 16  

V. Problems and Constraints in Geisho Production 17  
   Production problems 17  
   Relative importance of these problems in each system 19  
   Existing coping strategies 19  
   Factors currently limiting the scale of geisho production 20  

VI. Environmental and Genetic Variation 22  
   Environment-related variation 23  
   Variation within production systems 27  
   Genetic variation between production areas 33  
   Selection 34  

VII. The Marketing System of Geisho 36  
   How and where is geisho sold? 36  
   The market price of geisho and its fluctuations 37  

VIII. The Importance of Geisho to Farmers 40  

IX. Discussion and Conclusions 43  

References 47
### List of Tables & Figures

#### Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Average number of geisho plants per farmer</td>
<td>11</td>
</tr>
<tr>
<td>Table 2</td>
<td>Farmers’ estimates of maximum age before plants become senescent in their production area</td>
<td>15</td>
</tr>
<tr>
<td>Table 3</td>
<td>Pests mentioned by geisho farmers</td>
<td>18</td>
</tr>
<tr>
<td>Table 4</td>
<td>Statistical data for the relationships between measured variables</td>
<td>30</td>
</tr>
<tr>
<td>Table 5</td>
<td>Farmers’ estimates of geisho production</td>
<td>41</td>
</tr>
</tbody>
</table>

#### Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Map of the study area in Central Tigray</td>
<td>2</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Geisho (<em>Rhamnus prinoides</em>)</td>
<td>7</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Height of geisho plants at different ages</td>
<td>24</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Stem circumference of geisho plants at different ages</td>
<td>26</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Illustration of genetic variation within production areas: drawn from dried specimens</td>
<td>32</td>
</tr>
</tbody>
</table>
Preface

FARM Africa is a non-governmental organization registered as a charity in Britain. Since 1984 it has been working on projects in Ethiopia, Kenya, Tanzania and the Republic of South Africa. One of its projects in Ethiopia is the Community-Oriented Rural Development Project (CORDEP) in central Tigray. The aim of this project is to bring about increases in the income and welfare of poor peasant farmers in that area through community-oriented, self-reliant and sustainable approach to rural development.

One of the most common and important problems hindering agricultural extension and research in many rural areas in developing countries is a shortage of basic information on many of their important crops and other agricultural commodities. In Tigray, this situation was exacerbated by the many years of civil war in the region, which not only led to destruction and neglect, but possibly also to a loss of local knowledge, as much of the population was actively involved in the war. One of the activities of the agricultural component of the CORDEP is therefore to acquire and publish information on important agricultural commodities and other farming issues so that it is available to agricultural extension workers and other interested parties.

A baseline survey was conducted during the pilot phase of this project to gather basic information on the socio-economic background and the situation of the farming system in the area. From this survey, it emerged that geisho, which is used like hops to flavour locally brewed alcoholic drinks, is an important traditional cash crop in some parts of the project area. It was therefore decided to perform a study of its production system in order to assess the need and potential for development of geisho production in the area.

During the course of this study, the author received much appreciated help and support from a number of people. Alem Gebre Tsadik, her translator and research assistant, deserves special thanks for his unfailing help and
dedication. Stephen Sandford contributed his guidance and editorial assistance. Kiros Gebre Yohannes expertly organized the workshop held in May, to which Kebede Tesfay from the Ministry of Agriculture in Hahaile made important contributions. Staff of the Ministry of Agriculture and Bureau of Natural Resources, as well as the administration of Enticho, Adi Ahferom, Embasenaiti and Hahaile weredas are thanked for their interest and support, as are members of FARM Africa staff and Pippa Sandford who contributed their help, support and friendship. During the fieldwork, the author was received with warmth and hospitality by a large number of farmers in the study areas, to whom she is indebted for their knowledge and interest. These farmers are too numerous to acknowledge individually; they are all thanked sincerely.

Susanne Vetter
I. Introduction

Pilot studies in the CORDEP area (FARM Africa, 1994a) show that, due to extremely small plot sizes and low productivity, very few of the peasant farmers are able to produce enough food to support themselves and their families for the whole year by relying solely on subsistence agriculture. This situation is likely to become worse as a result of the continuing degradation of farmland and the increasing population pressures due to population growth as well as people returning to the area after the war. To increase the income of families, it is necessary to decrease the dependence on subsistence production, for which the plots in many cases are simply too small, and to diversify the sources of cash income. One possible solution is an increased move towards the production of crops with a higher cash value per hectare, and to use the income from these to purchase staple foods.

It emerged from the same pilot studies that geisho contributes significantly to some farmers’ incomes. Geisho production, unlike that of other cash crops, is well-established in the area, and it was therefore decided to study the existing production system to see the current importance of the income it generates for the farmers, and what can be done to make it more lucrative and reliable. About six weeks into the study, a workshop was held in which the preliminary findings and general issues were discussed with farmers from the study areas. The study itself is mostly a descriptive account of the production and marketing system of geisho and its constraints.

Objectives of the study were

- to know whether improving geisho production and marketing is a viable way to increase household income and the possible ways of achieving this;
- to gain an insight into the dynamics, problems and constraints of geisho production in order to obtain an understanding of the system, on which further
research and possible strategies for improvement can be based;
• to identify and describe different varieties of geisho, uses of geisho and different production systems; and
• to describe growth and productivity in different production systems and under different environmental conditions.

Study areas
Fieldwork was done in six tabias, between Adwa and Adigrat in central Tigray. The study areas are shown in Figure 1.

Enticho town, with an altitude of 2100 metres asl, falls into the weina-dega (mid-altitude) agro-ecological zone. Enticho lies on the road from Axum to Adigrat, about 65 km east of Axum.
Mishig is a highland tabia in Embasenaiti wereda, the areas studied lying around 2500 metres asl, in the ‘dega’ agro-ecological zone. Rainfall probably exceeds 1000 mm per annum (FARM Africa, 1994), and hailstorms are frequent. Mishig is reached via 22 km of dry weather road, which turns south from Enticho.

Mai Kotseli is a small village in Enda Maryam tabia in Enticho wereda. It is situated on a steep north-facing slope at an altitude of 2600 metres asl, and it is frequently windy. Like Mishig, the area experiences frequent hailstorms. This area is found along the road leading to Mishig, about 10 km from Enticho.

Edaga Arbi is the main town in Adi Ahferom wereda, which is a small wereda adjacent to Enticho and Embasenaiti weredas. Irrigated and rainfed areas, along two rivers that pass Edaga Arbi town on two sides, were visited. The altitudes of these areas are about 2000 metres asl. The road leading to this area is the same road which leads to Mishig, but continues straight another 8 km past the turn-off to Mishig.

Sefeo is found in highland Adi Ahferom, along the road to Edaga Arbi and Mishig. Its altitude is 2600 metres asl, and its rainfall is probably similar to that of Mishig. Hailstorm is a frequent occurrence. Only one day was spent here, but representatives from this area attended a workshop on geisho in Enticho.

Feres Mai is the capital town of Hahaile wereda, which lies to the west of the other weredas. The area has a weina-dega climate. The irrigated areas around Feres Mai river were visited for two days. Feres Mai is reached on 16 km of dry weather road, turning south from the main road at Gendebta.

Methodology
The research methodology comprised interviews, discussions, quantitative measurements and field observation. Additional information and feedback were gained from a farmers’ workshop held in Enticho.

Interviews
Most of the information was obtained through informal interviews with farmers in their houses or in their fields. Farmers were interviewed as they were encountered and it involved men and women of different ages, including older boys and girls who were busy harvesting or tending to
other crops in the same plot, as well as a number of priests and an old nun. The length and intensity of the interviews varied, depending on the interest, knowledge and enthusiasm displayed by the interviewee, as well as how much time he or she had to spare. For instance, many men were busy ploughing in April and May, during which most of the field work was done, and were therefore not always available for long interviews. Sometimes, small impromptu groups gathered during interviews, and the issues were then discussed with two to four people at the same time, which often proved constructive, as farmers added to each other's information and discussed issues between them. One such discussion with three farmers took place in Enticho nursery, where a number of people were engaged in off-farm employment.

To get an idea of how many geisho plants farmers own in different areas, groups of farmers from four different areas were approached, and each individual was asked how much geisho he grows in his farm. The following people were asked: 22 farmers from Feres Mai, 5 farmers from Mayshawa (highland Adi Abferom), 18 farmers as they were encountered during a walk through the irrigated area around Enticho, and 11 farmers as they passed through a small tea room in Mishig.

Five women who make sewa (local beer) and sell it in so-called sewa houses were asked how sewa was made, as well as what qualities they looked for when buying geisho. During these visits, geisho and related issues were also discussed with the proprietress and her almost exclusively male clientele in a more casual context.

One geisho merchant was interviewed in Enticho as part of an investigation into the marketing system of geisho. During two visits to Enticho market, which is the most important local market central to most of the study areas, the selling of geisho was observed, and questions concerning the different methods of selling geisho, the areas of origin, the price of geisho and other aspects of geisho marketing were asked.

Quantitative measurements
In order to illustrate variation of plant characteristics within and between production areas, measurements of leaf length, amount of fruit plus flowers, etc. were taken of individual plants. The measurements taken will be outlined in more detail in Chapter 6, which deals with variation. Note was taken of environmental factors such as altitude, water supply and soils in each area. Plants were measured in Mishig, Mai Kotseli and the
irrigated areas around Enticho and Edaga Arbi. Measurements were taken of plants from two to four different plots separated by no more than 500 m, reducing the variation of environmental conditions within the area's sample. Care was taken not to choose individual plants, but to measure the first ten or twenty plants growing next to each other in every plot.

Different measurements were plotted against one another (e.g. leaf length against internode length) to see typical relationships within the species, and to look at the range and pattern of variation within each area. Frequency distributions of leaf length, the amount of fruit plus flowers and the dry weight of 6 cm² of leaf material were also calculated. The data where individual plants were chosen is not included. Production methods and care may, however, account for differences between plots within the same area.

Field observation
General observations were made during visits to the farms, mostly with respect to intercropping and the number of geisho plants grown by the farmers. Notes were taken of things of interest such as people harvesting and transporting geisho and environmental features. Comments on the appearance and condition of plants that were measured were also noted.

Farmers' workshop
A workshop on geisho production attended by 25 peasant farmers and a few members of Bureau of Agriculture (BoA) and Bureau of Natural Resources (BNR) extension staff was held in Enticho in May 1995, organized by FARM Africa's training officer. Aims and preliminary findings of this study were briefly presented, as were the findings of a BoA member from Hahaile wereda, who had been studying geisho the preceding year. Both presentations were discussed at length by the farmers, chaired by a farmer nominated from among them. The different production systems, production methods and problems, and varieties of geisho were the most prominent among the issues discussed. Group discussions were then held to identify which problems should be addressed and what should be done to alleviate them. The workshop provided interesting and important information, feedback, and direction for the study. As all presentations and discussions were carried out in Tigrinya, it was, however, not always possible for the author to ask questions or to clarify issues at the time.
II. Geisho and Its Uses

Geisho, *Rhamnus prinoides* L'Hérit., belongs to the family Rhamnaceae. Geisho is a shrub or tree up to 6 m in height with glabrous, glossy and serrated leaves. The leaves are arranged alternately; longer and shorter leaves are found on the same branch, which alternate on either side in a distinctive arrangement. The longer leaves are 40–125 mm in length, while the shorter ones measure 10–80 mm. Leaves are ovate, oblong or elliptical in shape, with an acuminate to acute apex and a cuneate to rounded leaf base. The leaf base was observed to be more rounded in the shorter leaves compared to the longer leaves in the same plant.

Small flowers are light yellow-green, solitary or in 2–5-flowered axillary fascicles with pedicels 5–15 mm in length, up to 20 mm when in fruit. The flower consists of a puberulous receptacle, five acute sepals, 1 mm long petals (but these may be absent), 1 mm long filaments, 3 or 4 locular ovary and a 1 mm long style. The fruits are 5–8 mm in diameter, turning red to black-purple, with obconic stones (Vollesen, 1989). See Figure 2.

Geisho is mainly used to flavour traditional alcoholic drinks produced and consumed locally. The most important one of these is called SEWA in Tigrinya, better known outside the region by its Amharic name, TELLA. It is a kind of beer brewed from finger millet, sorghum or maize, using germinated barley as a fermentation starter. MIES, known as TEJ in Amharic, is brewed from honey and is more common in the eastern and southern parts of Tigray. Geisho is also used in home-brewed spirits known as KATIKALA or AREKI. Geisho is said by some people to add to the intoxicating effect of the drinks, but it is not known whether this is true or not.

Sewa and mies are brewed for home consumption, as well as for sale in sewa- or mies-houses. Sewa-houses are common even in small villages and are open for business when there is sewa to be sold. These establishments are very popular, especially since industrially produced alcoholic drinks like beer are not available in the smaller villages. Sewa is also considerably cheaper than beer (about 50 cents for sewa compared to...
Figure 2: Geisho (*Rhamnus prinoides*). A - branch x 2/3; B - flower with two sepals removed; C - fruit x 4.
birr 2.50 to 3.50 for beer). It is also considered an integral part of the local culture.

Apart from its main use in flavouring traditional drinks, geisho is also used as a pigment in dyes, according to farmers who took part in the workshop. One farmer in Edaga Arbi also mentioned a paint factory in Asmara which uses geisho for pigments, buying it in bulk from merchants. The extent to which geisho is used in this way is not known, and it may be worth investigating into the scale of present and potential use for this purpose.

Geisho is said by some sources to have medicinal value. One farmer and one woman who run a sewa-house in Mishig claim that it helps to prevent goiter, which is relatively common in that area.

The same view was expressed by someone from Adi Ahferom. However, the fact that goitre is relatively common in these areas is an indication that the soils are deficient in iodine. Whether geisho can contain significant amounts of this element is thus unlikely. Several farmers who participated in the workshop say that the geisho in sewa combats internal parasites. Other alleged uses are against fungal skin infections and to cure sore throats. The medicinal effects of geisho have not been studied, and it is not even known whether geisho is commonly used by people in these ways.
III. Existing Production Systems

Ecological distribution
Geisho is found in a number of African and Arabian countries, where it grows between altitudes of 1400 to 3200 metres asl. It occurs naturally in upland, riverine and secondary forest and scrub, and is also widely planted in hedges and gardens (Vollesen, 1989). It is grown as a crop in different parts of Ethiopia for use in brewing drinks. Within the study area in central Tigray, it is found predominantly in the highland and mid-altitude areas where there is enough water throughout the year. Geisho is sensitive to dry conditions, which is the main factor limiting the areas where it is grown as a crop.

The three main production systems in the study area

Highland rainfed areas system
These areas fall into the dega agro-ecological zone with altitudes roughly between 2300 and 2700 metres asl and a yearly rainfall probably in excess of 1000 mm (FARM Africa, 1994a). Geisho in these areas is generally grown relying on rainfall alone, but not all areas are considered suitable. Areas around streams are preferred, and in a few cases, water from these is used for small-scale irrigation. This was observed in Sefeo, but on the whole, it is comparatively rare. Usually good soil moisture retention is a prerequisite for geisho farming in rainfed areas, and soil and moisture management presumably play an important role. The study areas that fall under this production system are Mishig, Mai Kotseli and Sefeo.

Mid-altitude irrigated system
Most geisho in the weina-dega agro-ecological zone (around 2000 metres asl in the study areas) is grown under irrigation, as the annual rainfall, probably around 800 mm, is not sufficient in most areas. The study areas around Enticho, Edaga Arbi and Feres Mai are irrigated with water from nearby rivers, and thus receive water throughout the year.
**Mid-altitude rainfed system**

Some geisho is grown without irrigation in the weina-dega areas, but these areas are usually found near rivers, and often adjacent to irrigated land. In Edaga Arbi, one unirrigated area next to a river was studied as an example of this production system. In none of the mid-altitude areas that were studied was geisho found far from rivers, and farmers generally agree that such areas would be too dry to grow geisho.

Scale of production in different production systems

Our concept of scale of production includes the amount of geisho grown by each farmer, the production in the area, and the system as a whole. In both respects, production is said to be greatest in the high-altitude rainfed production system. The main reason for this is that the areas suitable for production are not limited to irrigated areas, which make up only a small proportion of farmland in the mid-altitude areas. During the reallocation of farmland which took place more than once in most places since the end of the Haile Selassie regime, every farmer eligible for land allocation (men and women over 18 years of age) received a share of irrigated land or land near streams and rivers as part of the total land allocated to them. As a result, the plots owned by individuals in such areas (i.e. plots suitable for geisho production) are extremely small. Figures of land holdings in the studied irrigated areas were not available, but many plots observed in Enticho were less than 10 square metres in size. Often, several farmers cultivate their land in common to use the areas more efficiently.

However, total landholding by individuals in the highland areas is very small. In Mishig the average landholding is 0.4 hectare (FARM Africa, 1994) and not all of this is suitable for growing geisho. So geisho production per farmer is still limited. Again, farmland with good water supply (e.g. near streams) was distributed among a large number of farmers, resulting in small plots.

In terms of total geisho production, the mid-altitude rainfed system is the least important due to the shortage of suitable land, with production per farmer also limited by the small size of plots near rivers.

A number of farmers were asked how many geisho plants they had on their farms. The results of these enquiries are listed in Table 1. These figures show that some farmers in the irrigated areas around Enticho have surprisingly many geisho plants, and therefore must have unusually large
plots. One explanation is that married couples commonly receive a piece of farmland and/or livestock from their parents with which to start their own families' farms. Land with geisho is apparently considered to be a valuable gift.

Another factor that could explain the large geisho plantations some farmers have is that during the land reallocations, farmers were allowed to keep land on which they had planted trees, including geisho, and farmers who already had large geisho plantations are now in possession of bigger plots of land. These land allocations can have important implications on farmers' attitudes towards growing geisho and other trees: the original plan of the Transitional Government was to carry out land allocations regularly every few years, during which every man and woman over 18 years of age receives a piece of land. If farmers are allowed to keep all the land on which they have planted trees, this would encourage growing trees and geisho, as plot sizes decrease every time land is reallocated due to the increasing size of the population. If farmers are not allowed to keep land on which trees have been planted, it would have the opposite effect, as farmers would probably consider planting trees and looking after them a waste of effort and of farmland. No information on current policies was available.

Table 1: Average number of geisho plants per farmer

<table>
<thead>
<tr>
<th>areas</th>
<th>Production system</th>
<th>Average no. of geisho plants</th>
<th>Range</th>
<th>n</th>
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<tbody>
<tr>
<td>Feres Mai</td>
<td>*w/d irrigated</td>
<td>40</td>
<td>15-100</td>
<td>22</td>
</tr>
<tr>
<td>Mai shawa</td>
<td>dega rainfed</td>
<td>78</td>
<td>60-90</td>
<td>5</td>
</tr>
<tr>
<td>Enticho</td>
<td>w/d irrigated</td>
<td>77</td>
<td>15-200</td>
<td>18</td>
</tr>
<tr>
<td>Mishig</td>
<td>dega rainfed</td>
<td>57</td>
<td>30-100</td>
<td>11</td>
</tr>
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</table>

*w/d = weina dega
n = number of farmers
Raising and transplanting seedlings

Farmers either raise their own seedlings, buy them from farmers who grow them in their own plots, or, in recent years, obtain them from community or state nurseries in some areas. The community nurseries in Enticho, Feres Mai, Edaga Arbi and Mishig grow geisho seedlings; farmers in Mai Kotseli do not have access to a nursery nearby, and Sefeo may be in the same position.

Seeds are collected, sometimes rubbed in ash, and sown in seedbeds. From seedbeds, or from underneath mature plants where seeds have germinated naturally, the seedlings are transplanted into holes with loose soil at the beginning of the rainy season (around July). Farmers at the workshop said that good soil (not specified what type) should be brought and put into these holes. This was not mentioned by any of the other farmers interviewed, and it is not sure how common or effective this practice is.

Spacing and intercropping

The distance between geisho plants depends on whether a pure stand or intercropping is desired. Pure stands of geisho are comparatively rare and are found in some of the irrigated plots, or where the geisho plants are very old and completely shade the area where they grow. In the irrigated areas, intercropping with maize and/or vegetables is the more common arrangement, especially between younger geisho plants. In the highland areas, geisho is usually found in rows across fields where maize and other grains are grown. Spacing allows ploughing in-between even when the plants are mature, but there is much variation in spacing; distances of two to three metres between plants are common. Because the plant is stripped of all leaves except the growing tips at every harvest and growth continues from the tips outwards, geisho bushes with their mostly bare branches cast relatively little shade and are therefore suitable for this kind of intercropping.
Care
Mature geisho needs little care, but the young plants need to be well looked after to avoid high mortality. They are particularly sensitive to drying out during the first year, and may need watering if rains are insufficient. In the rainfed areas, the young plants have to be watered regularly during the dry season. In some areas, this involves hour-long trips to the nearest water source. The difficulty is arduous, especially in the dry season when the need for watering and the increasing scarcity of water coincide, it often limits the number of seedlings that can be grown each year.

After the first year, plants should ‘fend for themselves’ as far as water is concerned, as watering of whole plantations is too labour-demanding to be a realistic option. But in cases of extreme drought, farmers may water some of the plants (especially younger ones) to save part of the harvest and/or the plants themselves.

The general care of mature plants consists of digging (loosening) the soil for aeration and better water penetration, weeding, removing dead branches (which are used as firewood), and applying manure.

Digging the soil is considered by most farmers to be important for the well-being of the plant. Several farmers, when addressed on the cause for variation among plants in the same area, accredited good growth, bigger leaves and overall good condition of the plant to digging the soil regularly and at the right times of the year, especially at the beginning of the rainy season to ensure good water penetration and drainage.

Weeding is also considered an important part of geisho care. One of the adverse effects of weeds, according to many farmers, is that they act as a habitat for insect pests and it is therefore important to weed especially at the beginning of the rainy season when pests are most prolific.

The effects and benefits of using manure are disputed by farmers. During the workshop, some farmers said they used goat manure to improve the fertility and texture of the soil. Some farmers push manure into cracks in dry soil to improve water penetration once it rains. The use of manure, ash and straw was observed during the fieldwork. Whether geisho responds to the use of manure in terms of improved growth and productivity is, however, disputed. Many farmers do not use manure to fertilize geisho,
and reasons for this vary. Some farmers have simply never tried it, some consider it unnecessary or ineffective, and others say it has an adverse effect. One farmer at the workshop described it as ‘burning’ the plants where there is little water, while other farmers say it increases the effect of certain unspecified pests, possibly termites. One woman in Hahaile also claimed that the use of manure causes premature senescence.

Dead branches are removed from the plants, but no farmer who was asked pruned his or her geisho. It is not known whether this has been tried or what the effects would be. The usual effect of pruning is to reduce apical growth and to increase the number of growing tips. Both would probably be desirable in geisho, as reduced height makes harvesting easier while an increased number of growing tips would most likely increase yields, as growth of new leaves takes place from the tips onwards. However, a denser bush may cast too much shade for intercropping, and possibly reduce the production per area. If an increased number of leaves resulted in the growth of smaller leaves, the positive effect may also be nullified. This is something which would have to be tried to see the effects.

**Harvesting**

The plant is considered mature, i.e. ready for harvesting three years after transplanting. Every farmer agreed on this time period adding that premature harvesting could damage the plant or decrease its life span, as could too frequent harvesting. The whole plant, except for the growing tips of the branches, is stripped of its leaves, which are then air-dried. The produce is usually sold within a few days, but it is possible to store geisho for several months if it can be kept dry. This is often a problem in the rainy season, especially in houses with traditional stone-and-mud roof.

When asked about the timing of harvesting, the immediate answer was always that harvests took place three times a year, in Meskerem (September), Sene (June) and Ter (January). During the study period, most harvesting was observed from the last two weeks of May onwards (by early June, many geisho trees had stripped branches). Some farmers said that harvesting is done before the start of the rainy season to avoid pest attacks, the frequency of which is said to be highest during the rains. However, farmers were also observed harvesting, drying, transporting or selling throughout the study period (late March to early July), but most farmers would still insist on the above harvesting times until directly challenged. Alterations to the conventional harvesting calendar were
explained by the fact that when a harvest is damaged or destroyed, the farmer will often harvest as early as possible thereafter in order to compensate for the financial loss. Many farmers harvest and sell geisho when food and money reserves run out. Where geisho is intercropped with grains, the farmer may also decide to harvest before ploughing or sowing.

The three yearly theoretical harvests are only rarely achieved in the high-altitude areas, where generally at least one of the harvests is badly damaged or destroyed by hail, usually in the rainy season. Damage by drought also claims harvests in some of the rainfed areas. In the irrigated areas, both these factors are much less of a problem, and three harvests a year is a more realistic estimate. Some farmers in the highland areas say that in a good year, farmers in irrigated areas can even harvest a fourth time.

Replacement of old plants
When the geisho plants become senescent, their productivity decreases, parts of the plants die, and they become more vulnerable to the effects of waterlogging and rotting (in the irrigated areas), and possibly to drought. They are then removed and usually replaced with new seedlings. The maximum age reached varies according to environmental conditions. Plants in the highland areas live longer than those in irrigated areas (Table 2). Apart from these differences which are a direct result of the irrigation itself, good soils, protection from drought and good care can increase the lifespan of the plants. For instance, while most geisho plants in Enticho are said to be replaced between 10 and 15 years, several very old and very big geisho trees were observed in this area.

<table>
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<tr>
<th>Area</th>
<th>Max. age before senescence (years)</th>
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<tbody>
<tr>
<td>Enticho</td>
<td>10-15</td>
</tr>
<tr>
<td>Mai Kotseli</td>
<td>60-80</td>
</tr>
<tr>
<td>Mishig</td>
<td>up to 100</td>
</tr>
<tr>
<td>Edaga Arbi</td>
<td>20-30; as little as 5 if in bad soil</td>
</tr>
</tbody>
</table>
Division of labour by gender

Farmers were asked who did which part of the work in planting, rearing, harvesting and selling of geisho. The general opinion is that men are responsible for planting geisho, while women harvest it; both men and women sell the produce at the local markets but men are said to do the trading in areas further away. Caring for the geisho plants was said by the majority of interviewees to be done by men, but carrying water is mainly done by women, as well as by girls and boys.

In the absence of a male household head, the woman plants geisho, and her son takes over when he is old enough. Two old women said they had not planted any geisho since their husbands died, but one of them had grown the existing trees together with her husband; her married son is now responsible for the farm. Another woman stated that there was no difference in the kind and amount of work she and her husband did.

During the fieldwork, many women, girls and some boys were seen harvesting. Most men at that time (from April to the beginning of June) were busy ploughing and sowing. Planting was not observed, as it takes place at the beginning of the rainy season. During the market surveys, both men and women were seen selling large bags of geisho; the large scales used to weigh these bags were operated by men.
V. Problems and Constraints in Geisho Production

Production problems

*Water shortage*
Lack of water was described as the most pressing problem in some of the rainfed areas, notably Mishig, Mai Kotseli and in the non-irrigated areas around Edaga Arbi. To prevent geisho plants from dying during long dry periods, water often has to be carried from far away, and it is difficult to save large plantations that way due to the great amount of time and effort it requires. More often, the leaves dry out, destroying the harvest, and sometimes parts of the plant die and are then used for firewood. This decreases the total size of the tree and therefore affects future harvests. Water shortage is not usually a problem in the irrigated areas, and the farmers in Sefeo say lack of water is never a serious problem for them.

*Hail*
In all the highland areas, hail is a great problem that claims whole harvests every rainy season. This means that one of the three harvests each year is almost always badly damaged or destroyed altogether. Even in the mid-altitude areas, hail damage occurs at times, but far less frequently. In the highland areas, frost is also a problem at times.

*Waterlogging*
Waterlogging sometimes occurs in irrigated areas after heavy or persistent rains, when the water does not drain away properly. The resulting poor oxygenation of the roots leads to reduced root respiration, and active uptake of water and solutes is thus impaired. This can cause the plant’s leaves to die, and leads to rotting of the roots in more extreme cases. Some farmers also pointed out that plants that are receiving too much water are more prone to pest attacks and premature ageing.

*Pests*
A variety of pests that damage geisho were described by the farmers. The general view is that they are more of a problem in the irrigated areas than
Problems and Constraints

In the highlands, and young plants are said to be the worst affected. Pest attacks are concentrated in the late rainy season (August and September, especially in years of poor rainfall), and it was thus not possible to collect and identify samples of pest species at the time this study was carried out. Table 3 lists the pests described by the farmers, their Tigrinya names and the English translation or interpretation. Some farmers were not able to name the pests that attacked their geisho, and we are neither certain if pests were identified and named correctly in each case, nor if the English translation correctly represents the animal in question. The pest anchoy is mentioned but no details on the type of pest or damage was found.

Table 3: Pests mentioned by geisho farmers

<table>
<thead>
<tr>
<th>Tigrinya name</th>
<th>English interpretation</th>
<th>Effect of the pest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulho</td>
<td>Termite</td>
<td>Damages roots, especially of young plants</td>
</tr>
<tr>
<td>(Tsada)</td>
<td>(White) Caterpillar</td>
<td>Eats the leaves</td>
</tr>
<tr>
<td>Tchagora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habi</td>
<td>Worm in soil</td>
<td>Eats the roots and damages whole plant</td>
</tr>
<tr>
<td>Tsatse</td>
<td>Ant</td>
<td>Cause young leaves to shrivel as they walk over them</td>
</tr>
<tr>
<td>Agora</td>
<td>Worm that lives in manure</td>
<td>Damages roots</td>
</tr>
<tr>
<td>Fanta</td>
<td>Grasshopper</td>
<td>Eats leaves</td>
</tr>
<tr>
<td>Barnos</td>
<td>Army worm</td>
<td>Eats leaves</td>
</tr>
<tr>
<td>Djandja</td>
<td>probably lives in manure</td>
<td>not given</td>
</tr>
<tr>
<td>Tantu</td>
<td>Mosquito</td>
<td>not given</td>
</tr>
</tbody>
</table>

In the absence of pest animals for inspection, it was also impossible to tell whether the names of the pests were used consistently. The names ‘habi’ and ‘agora’ may both have been used to describe the same worm that lives in the soil and attacks the roots of the plant. A number of farmers mentioned army worm which, however, does not attack broad-leafed plants. The farmers are most probably referring to milsha worm, which is
similar in appearance and is commonly confused with army worm. A proper study of the pests including sampling and identification should be carried out if ways of combating them are to be devised.

Of the pests mentioned, the caterpillar that eats the leaves and termites that damage the roots of (especially young) plants were the most frequently mentioned ones.

**Relative importance and severity of these problems in each system**
Hail was considered to be the greatest problem in all highland areas, together with water shortage in Mishig and Mai Kotseli. In the highland areas, pests were generally considered to be less severe but they are most active when damage occurs due to hail.

In the irrigated areas, pests are more common, and are probably the biggest problem. Drought and hail play a minor role. Waterlogging occurs, but the overall extent and severity of this is not known.

Lack of water is the most crucial problem in the non-irrigated mid-altitude production system, followed by pests. Hail plays a minor role at these altitudes.

**Existing coping strategies**
There are no ways of dealing with hail other than harvesting before the damage is done. However, hail often occurs unpredictably, although most common in the rainy season. Also, harvesting can only be done if the plant is ‘ready’, about four months after the last harvest, and premature harvesting is considered harmful to the plant.

Giving the plants water (carried from the nearest water source) is often necessary to deal with insufficient rainfall. This, as was described previously, often involves a great amount of work and is only a practical solution if it is limited to emergencies, or if the farmer’s plot is close to a reliable source of water. Soil moisture management is also important. Most farmers believe in digging the soil before or during the rains to ensure good drainage, and some farmers use manure to improve soil drainage and water retention. How farmers cope effectively with water shortage varies; while some farmers complain of losing harvests frequently due to droughts, others in similar circumstances claim that with good management one can grow geisho almost anywhere.
The problem of waterlogging, according to farmers at the workshop, can be solved with correct soil management, and should therefore not stand in the way of geisho production. Although this was generally agreed on during the workshop, it did not become clear exactly what is done to improve water drainage and thus alleviate waterlogging.

Ways of dealing with pests were described by some of the farmers, but many did not know how to control them or did not consider them as a big problem to intervene. The latter view was especially common among farmers in the highland areas. The use of pesticides seems to be rare; no farmer who was interviewed had used them for geisho. Several farmers said they can control the effects of 'habi' by digging the worms out at the first signs of its effect, which include discolouration and wilting of the leaves. Other farmers said that they do nothing, and that the worm disappears at the end of the rainy season.

Since different insect pests (which the farmers did not specify) are said to live in weeds, weeding (especially at the beginning of the rainy season) is considered by many farmers to be an effective way of reducing their impact. Some farmers also said that they managed to pre-empt pest damage successfully by harvesting before the rainy season.

**Factors currently limiting the scale of geisho production**

**Land shortage**
The most commonly cited factor preventing farmers from expanding their geisho production is the small size of suitable land. The shortage of land was described earlier and needs no further discussion here.

**Lack of seeds and seedlings**
A shortage of seeds and especially seedlings was also sometimes given as a reason why farmers did not grow more geisho. However, many farmers are growing and even selling their own seedlings, and geisho plants produce many berries. Thus, this should be a problem only for farmers with only immature plants. Most nurseries are now growing geisho seedlings due to the high demand, so a lack of planting material should not be a serious problem to expand geisho production.
Problems and Constraints

Production problems
There are problems limiting production. Shortage of water seems to discourage many farmers from growing geisho or increasing the size of their plantations. While the mortality of grown plants does not seem to be very high, seedling mortality was described by several farmers as hindering the expansion of their plantations. One farmer in Mishig said that he planted as many seedlings as he could every year, but only about 40 per cent survived due to drought, and because of the great amount of work involved in trying to water them all. In Feres Mai, a group of farmers said that termites were their biggest problem, causing high seedling mortality, and this problem was mentioned by farmers in other areas as well.

Other crops
Since geisho is grown in farmland with the best supply of water, it competes for this land with other crops. In the irrigated areas, most farmers prefer to intercrop geisho with vegetables and maize, as this arrangement is considered to be more profitable than pure stands of geisho. The same is the case with geisho and grain crops in the highlands.

Some farmers prefer to grow different crops instead of geisho in the land available. They consider crops to be a more profitable, and usually a safer option. Many farmers are uncomfortable with the idea of growing only a cash crop, as this puts them at the mercy of the geisho market with its price fluctuations. The fact that geisho takes three years to mature (and thus before bringing in any returns) also makes some farmers reluctant to grow it. On the other hand, there are farmers who consider geisho to be their most lucrative and important crop, and who feel that they can buy more grain by selling geisho than they could grow on their land.

Lack of experience
Lastly, there are farmers who feel that they lack the experience to grow geisho altogether, or successfully on a larger scale. How many farmers were actually discouraged by this is not known, but many farmers said they felt they do not possess as much knowledge and experience as they would like to have in order to deal with problems or to make production more efficient.
VI. Environmental and Genetic Variation

One of the aims of this study is to find out if genetic varieties of geisho exist, and what environmental conditions affect its growth and productivity.

Farmers were asked whether they recognized variation between different geisho plants within and between production areas, and to describe which plant characteristics are concerned. This topic was also extensively discussed at the workshop.

In order to look at variation more precisely, a number of measurements were taken that were then plotted against one another to see what relationships exist within the species, what the pattern of variation is (continuous or discontinuous), and the differences between areas. Measurements were taken in four areas (Enticho, Edaga Arbi, Mishig and Mai Kotseli) with a sample size of about 50 trees in each area.

Farmers were asked for the age of the plants and the following parameters were measured:

- The total height of the plant;
- The circumference of the stem;
- The length and width of the longer leaves: three measurements of each on the same branch were averaged;
- The length and width of the shorter leaves as was done above;
- The number of leaves in the last 10 cm from the tip of the branch;
- The number of fruit plus flowers which was categorized as 0-none, 1-very few, 2-few, 3-medium, 4-many, 5-very many; and
- The dry weight of 6 cm² of leaf material.
Environmental and Genetic Variation

The following ratios were calculated and used in the analysis:

- Length : width of the longer leaves;
- Length of the longer leaf : length of the shorter leaf (hereafter referred to as the long : short leaf ratio').

Environment-related variation

Growth and productivity

Farmers agree that geisho in the irrigated areas grows faster, is more productive (in terms of volume of leaves per harvest) and ages earlier. All these factors are considered to be a direct result of the water supply.

The total height of geisho plants was measured and plotted against their age (for Enticho, Mishig and Mai Kotseli). A number of factors are responsible for the relatively poor data. Because many men were ploughing during the study period, there was not always someone who was able to give the age of the plants. Often, the women who were in the field at the time measurements were taken did not know the age of the plants and suggested asking their husbands. On many plots where farmers were spoken to, the geisho plants were old and their age not precisely known, and branches had often been removed, reducing their size. Most of the older plants were also too big to measure their height accurately with a tape measure. For these reasons, only plants under ten years of age were measured. It was assumed that differences in growth rates would be reflected within this age range. In irrigated areas, a geisho plant of ten years is considered old, and often replaced. Sometimes, a number of height measurements were taken, but all plants on the plot were of the same age. This accounts for the abundance of data for some age classes, while there are none for others. Total plant height was also not found to be a wholly satisfactory reflection of growth and productivity, as plants of the same height often differ considerably in appearance: while some are dense and bushy, others are more sparse and obviously yield less per harvest.

Plots of height against age for Enticho, Mishig and Mai Kotseli can be seen in Figure 3. There is great variation of height in every age class, and clear curves cannot be distinguished. From what can be seen in the graphs, there is no apparent difference in growth rates between Enticho and Mishig, contrary to the common view that highland geisho grows more slowly. The Mai Kotseli curve will be discussed in a later section.
Figure 3: Height of geisho plants at different ages
Stem circumference was measured and plotted against age (see Figure 4). A direct relationship was found to exist between the two variables, as would be expected. Stem circumference data for Mai Kotseli was available only for two age classes, and correlation was thus poor. The plots for Enticho and Mishig show good correlation, with \( r^2 \) values of 0.74 and 0.76 respectively. The slope of the plot for Enticho is 2.8 (std error: 0.19), that for Mishig 4.4 (std error: 0.22). This implied that the stems of geisho plants in Mishig increased in girth at a greater rate than in Enticho, which again, was opposite to what was expected from farmers' views, as well as to what one would predict given the considerably greater water supply in Enticho.

Observations made during the fieldwork suggest that geisho in the highland areas does grow more slowly, although this may be due to an overall smaller appearance of plants even when total height at the same age is similar. A larger sample size of growth data (and data from more different areas) would be necessary to get better information on growth and productivity in different areas and production systems.

**Leaf characteristics**

All farmers who were asked, agreed that geisho grown in highland areas is different from that grown in mid-altitude irrigated areas. Geisho from mid-altitude rainfed areas was not considered in this discussion, probably because this production system accounts for a relatively small proportion of the total geisho production. Highland geisho is said to have 'heavier' leaves with a stronger flavour. 'Heavy' presumably refers to the weight per unit of leaf area (i.e. density rather than just the weight of individual leaves), as was stated by the farmers that a bag of highland geisho weighs more than a bag of the same size filled with geisho from irrigated areas. Samples of 6cm\(^2\) of leaf material from Enticho, Mai Kotseli and Edaga Arbi were dried and weighed using the facilities of ILCA in Addis Ababa. The leaves from Mai Kotseli surprisingly emerged as the lightest per leaf area, while those in Edaga Arbi were the heaviest. The leaves from Enticho, which were generally considered to be 'light' by farmers and traders at the market, were heavier than those from the highland area of Mai Kotseli. Again, it would be desirable to obtain more data of this kind from other production areas, especially from the highland areas of Adi Ahferom and Hahaile, both areas being famous for their high-quality geisho which is said to have heavy leaves. No tests were performed to
Figure 4: Stem circumference (in centimeters) of geisha plants at different ages
assess the strength of flavour of geisho from different areas objectively. Women who brew sewa said they use less highland geisho than geisho from irrigated areas for the same amount of sewa. While there may be a bias towards highland geisho among buyers, these women’s judgement is probably well-founded.

It is apparent that leaf weight per unit area is not determined solely by the water supply, since the leaves from the two rainfed areas differ greatly in weight, while those from Enticho, which receive by far the most water, are intermediate. Other factors that could play a role in determining leaf density are soils and genetic differences. Where farmers were present, they were asked what they thought the soil type was; their description often differs significantly from that given by the agriculturalist who has extensive experience in Tigray. Soils in all the areas are either clay or clay loam, i.e. they all have fine particles. In none of the areas sampled were the soils coarse or sandy. A better study of soils and their effect on plant characteristics such as leaf weight and strength of flavour, as well as growth and productivity, would be useful.

Variation within production areas

Farmers’ views

Farmers were asked whether they recognized differences between geisho plants within the same production areas. If they did, they were then asked to describe which plant characteristics are implicated and what the causes for the differences are - whether there are different varieties, or whether external factors are responsible.

Many farmers said they were unaware of differences other than between production areas. Among those that recognized differences within production areas, several farmers said that these were a result of management practices, especially digging the soil: plants growing in well-dug soil are thought to grow bigger and have larger leaves.

Some farmers did, however, recognize differences which they explained as being the result of genetic variation. One variety generally known as Shewa variety’ was the most commonly recognized one. Some farmers said that there were differences in other geisho as well. There were two additional varieties: Lemlem and Bordid. While farmers present at the workshop generally agreed with this division and proceeded to discuss all
three varieties in detail, most of the farmers that were interviewed in the field were much less clear about the varieties issue. After the workshop, the information on the varieties had spread among the farmers in the areas from where delegates had visited the workshop, and a number of farmers (including some who, in previous interviews, had not mentioned genetic variation) subsequently pointed out the different varieties when their fields were visited.

‘Shewa’ geisho has very small, dark leaves which are said to have strong flavour. Branching is very dense, and the plant bears a large amount of fruits. Farmers say that at harvest, the weight of the berries often exceeds that of the leaves, which makes geisho of this variety unpopular despite its strong flavour. Because the berries are useless for making sewa, buyers avoid geisho with too many berries, as they add weight (and therefore a higher price) but no value to their purchase. To make the geisho marketable, the farmer thus has to sort the harvest. According to farmers, ‘Shewa’ geisho is also less productive than the other varieties. Two nine-year-old geisho bushes, one ‘Shewa’ and one ‘Lemlem’ that were planted next to each other on the same day, were seen in Mishig. Although the heights of the plants were the same, the ‘Shewa’ geisho had fewer main branches and had an overall smaller appearance. Most farmers claim that they do not choose to grow this variety, but it is usually planted by mistake. Some farmers at the workshop said that many farmers remove ‘Shewa’ geisho from their farms and replace it with plants of the more productive varieties.

‘Lemlem’ geisho is the extreme opposite of ‘Shewa’ variety in appearance: its leaves are large and it branches less dense and at wider angles, making the bush look less ‘cramped’. It bears few berries. Farmers consider this to be the best variety because it is the most productive and its leaves are the most popular on the market.

‘Bordid’ has smaller leaves, denser branches and more berries than ‘Lemlem’ geisho, and in these respect, it is intermediate in appearance between ‘Shewa’ and ‘Lemlem’ varieties.

Farmers say that there is no difference in the strength of flavour and weight’ of the leaves between ‘Lemlem’ and ‘Bordid’ geisho, and that their resistance to drought and pests is the same.
**Data analysis**

The $r^2$ value, slope coefficient, standard error of this coefficient and the ratio of the slope coefficient to its standard error for each graph are listed in Table 4.

Although correlations between some plant characteristics can be discerned, the $r^2$ values were generally small. Apart from $r^2$ the ratio of the slope to its standard error indicates how precisely the x-coefficient describes the relationship between the two variables. When the ratio exceeds 2, the relationship is precise enough to be considered statistically significant.

The closest correlation can be found between the lengths of the long and the short leaves. While the slopes in Enticho, Edaga Arbi and Mai Kotseli are almost the same (around 0.6), the slope of the Mishig plot is greater at 0.75. This suggests that the shorter leaves of geisho plants in Mishig are bigger relative to the longer leaves than in the other areas.

There is some correlation between the length of the longer leaf and the ratio between its length and its width, and the slopes for Enticho, Edaga Arbi and Mishig are similar, around 0.01. The correlation is poor or nonexistent for the Mai Kotseli data. Many farmers say that longer leaves are ‘wider’. In terms of absolute width, this is usually true, but the correlations show that the longer leaves tend to be relatively narrower, and shorter leaves more rounded.

The negative slope implies that where the longer leaves are shorter, the size difference between the longer and shorter leaves is greater, which implies that the ratio between the length of longer and shorter leaves is relatively constant. Moreover, plants with longer leaves tend to have longer internodes.

The number of fruit plus flowers shows a weak negative correlation with the length of the longer leaves. A somewhat better (though still weak) negative correlation can be seen between the amount of fruit plus flowers and the length of the shorter leaves, which suggests that plants where the shorter leaves are smaller bear more fruit. Whether there is a causal relationship is not clear.
<table>
<thead>
<tr>
<th>Character</th>
<th>Area</th>
<th>sample n</th>
<th>R²</th>
<th>x-coeff.</th>
<th>std error of x-coeff.</th>
<th>x-coeff: std error</th>
</tr>
</thead>
<tbody>
<tr>
<td>length of shorter leaf vs. length of longer leaf</td>
<td>Enticho</td>
<td>70</td>
<td>0.53</td>
<td>0.580</td>
<td>0.0665</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>Edaga Arbi</td>
<td>48</td>
<td>0.55</td>
<td>0.588</td>
<td>0.0784</td>
<td>7.6</td>
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<tr>
<td></td>
<td>Mishig</td>
<td>30</td>
<td>0.82</td>
<td>0.752</td>
<td>0.6570</td>
<td>11.4</td>
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<td>Mai Kotseli</td>
<td>60</td>
<td>0.69</td>
<td>0.613</td>
<td>0.0542</td>
<td>11.3</td>
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<td>length: width (long leaf) vs. length of longer leaf</td>
<td>Enticho</td>
<td>70</td>
<td>0.36</td>
<td>0.010</td>
<td>0.0017</td>
<td>5.9</td>
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<td>Edaga Arbi</td>
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<td>0.43</td>
<td>0.013</td>
<td>0.0022</td>
<td>5.9</td>
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<td>Mishig</td>
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<td>0.011</td>
<td>0.0026</td>
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<td>Mai Kotseli</td>
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<td>0.24</td>
<td>0.007</td>
<td>0.0016</td>
<td>4.3</td>
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<td>longer: shorter leaf length vs. length of longer leaf</td>
<td>Enticho</td>
<td>70</td>
<td>0.11</td>
<td>-0.017</td>
<td>0.0059</td>
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<td>Edaga Arbi</td>
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<td>&lt;0.10</td>
<td>0.008</td>
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<td>Mishig</td>
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<td>0.34</td>
<td>-0.017</td>
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<td>&lt;0.10</td>
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<td>0.0039</td>
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<td>leaves in 10 cm of branch vs. length of longer leaf</td>
<td>Enticho</td>
<td>68</td>
<td>0.45</td>
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<td>Edaga Arbi</td>
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<td>0.27</td>
<td>-0.114</td>
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<td>Mishig</td>
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<td>0.38</td>
<td>-0.139</td>
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<td>-0.079</td>
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<td>fruit + flowers vs. length of longer leaf</td>
<td>Enticho</td>
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<td>0.25</td>
<td>-0.042</td>
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<td>fruit + flowers vs. length of shorter leaf</td>
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<td>0.26</td>
<td>-0.054</td>
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<td>0.31</td>
<td>-0.046</td>
<td>0.0091</td>
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<td>Enticho</td>
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<td>0.561</td>
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<td>Edaga Arbi</td>
<td>48</td>
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<td>1.132</td>
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<td></td>
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<td>0.4469</td>
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<td>0.2427</td>
<td>2.6</td>
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<tr>
<td>leaf weight (6 cm²) vs. length of longer leaf</td>
<td>Enticho</td>
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<td>0.000</td>
<td>0.0001</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Edaga Arbi</td>
<td>47</td>
<td>&lt;0.10</td>
<td>0.000</td>
<td>0.0001</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Mishig</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mai Kotseli</td>
<td>49</td>
<td>&lt;0.10</td>
<td>0.000</td>
<td>0.0001</td>
<td>1.2</td>
</tr>
<tr>
<td>leaf weight (6 cm²) vs. fruit/flowers</td>
<td>Enticho</td>
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<td>255.6158</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Mai Kotseli</td>
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<td>&lt;0.10</td>
<td>6.674</td>
<td>16.7916</td>
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</tbody>
</table>

N/A = not available
Leaf weight distributions for each of the three areas seem to be normal. Leaf weight, while it differs between areas, thus seems to be unaffected by variation in other plant traits.

According to farmers, leaf length is the main factor by which the different varieties can be distinguished. If there were discrete genetic varieties of geisho, one would expect a bimodal distribution, each peak representing the most common leaf length of one of the varieties (because of its relative rarity, no 'Shewa' geisho was included in the sample).

The relative influence of genetics and environmental factors is possibly different between plant traits: while leaf weight may be predominantly a function of water supply or soils, leaf size and shape may be more strongly determined by genetic differences.

**Varieties or just variation?**

In the field, all three ‘varieties’ can be recognized visually if one is familiar with the appearance and anatomy of geisho and the characteristics of the varieties. However, the data suggests that between the plants which seem to be perfect examples of any one of the varieties, there is a continuum of genetic variation with a range of intermediate forms. Figure 5 illustrates the extent of genetic variation within production areas.

Variation would be expected to be continuous, unless plants of different varieties were reproductively isolated, as the differences described (such as the shape and size of the leaves) are not determined by single genes. Different gene combinations can lead to a range of intermediate forms. There are different ways in which reproductive isolation can be achieved, and the following are some of the better known mechanisms.

**Chromosomal differences** (e.g. different numbers of chromosomes) can prevent interbreeding. Grasses, for instance, commonly speciate by so-called polyploidy (doubling or multiplying of chromosomes), and the resulting new species or varieties are immediately prevented from interbreeding, as only cells with the same number and structure of chromosomes can fertilize each other. This explains why there is such a large variety of grain landraces which remain separate even if several of them are grown in the same area. This is not likely to be the case with
Figure 5: Illustration of genetic variation within production areas, all x 1/4. Drawn from dried specimens. A & B from Enticho; C & D from Mai Kotseli
geisho as it is a relatively rare phenomenon; grasses and some other plant
groups being unusual in this way.

Physiological and anatomical differences (which would be the result of
genetic differences that do not usually involve chromosomal differences),
can prevent cross-fertilization. For instance, if the position, shape or size
of male and female reproductive structures differ, pollination may not be
successful. As cross-fertilization with other species is prevented by a
sensitive chemical ‘recognition system’ in the stigma, differences in the
biochemical make-up of the pollen can also form a reproductive barrier.
Whether any such reproductive barriers exist in geisho, is not known.

Self-fertilization is the predominant mode of reproduction in some plant
species, but this is rare. Some genetic recombination takes place during
self-fertilization, but only involving the plant’s own two sets of
chromosomes. Asexual reproduction, e.g. from runners or cuttings, results
in genetically identical offspring. In crops like enset (false banana), where
propagation is primarily vegetative, numerous genetic varieties can be
kept separate this way. Geisho does not reproduce asexually; its tendency
to self-fertilize is not known.

Reproductive isolation among plants of the same species that inhabit the
same areas is rare, as it arises by mutation in an individual that
consequently cannot interbreed with any of its conspecifics. Thus, while
there is much evidence for genetic variation among geisho, there is no
evidence for the existence of reproductively isolated varieties. Whether
one prefers to think of geisho simply as a species which displays genetic
variation, or as different varieties that interbreed, giving rise to
intermediate forms, is essentially a matter of description.

Genetic variation between production areas
There is considerable variation in plant characteristics between the
different areas where these were looked at. This is likely to be determined
to a great degree by environmental factors such as altitude, water supply,
soils, etc. It may also be due to differences in the gene pools between
different areas. Since geisho production is relatively localized, it may well
be the case that individual populations are reproductively isolated from
each other by geographical barriers like mountain ridges or gorges.
Population genetic studies and studies on pollination suggest that insect-pollinated plants do not have long cross-fertilization distances, especially if the stretches with few or no representatives of the species in question are long in-between populations. This can be explained by the foraging behaviour of insects, which seek nearby sources of pollen or nectar, as flight is very energy-consuming. There would still be some genetic exchange between areas, e.g. when farmers obtain planting material from different areas, but breeding populations do not have to be completely isolated from each other for differences in gene frequencies to develop between them.

Some farmers mentioned that they had tried to plant seeds or seedlings from other areas (e.g. seeds from Maryam Shewito, an irrigated area between Adwa and Enticho), but that the plants were poorly adapted to their new environment. The farmer in Hahaile said that while the seeds from Maryam Shewito were a disappointment, seeds from other areas in Hahaile and Adi Ahferom were well-adapted. This further suggests that different areas have their own gene pools with their particular environmental adaptations. Because of whatever selection farmers apply, as well as badly adapted geisho not having a good chance of survival under the relatively harsh conditions in these production areas, selection of better adapted genes and purging of the gene pool of 'weak' genes can happen over relatively few generations.

Selection
Because the differences in a number of plant characteristics are genetic, selective breeding (e.g. choosing seeds from the preferred variety) can, in the long run, result in a predominance of better varieties. The fact that geisho with big leaves is common, while by far most seeds are produced by the smaller-leaved 'Shewa' plants, suggests that farmers have been selecting their seeds in the past and are presumably doing so today. If reproduction were random, one would expect the varieties which produce many seeds to predominate, but 'Shewa' geisho, for instance, is comparatively rare.

It may be worthwhile doing a more rigorous genetic and taxonomic study of geisho. More importantly, making farmers aware of genetic variation and its implication for plant breeding would enable them to choose their
seeds and seedlings more carefully if they were interested in particular characteristics (such as large leaves), or if they wanted to avoid certain types of geisho. Farmers seem to be aware that there is variation among geisho, and during and after the workshop, it became clear that this issue was of particular interest to farmers.
How and where is geisho sold?

By the farmers Most farmers sell their harvest at local markets, Enticho, Nebelet, and Feres Mai being the most important ones in the study area. In these markets, farmers sell their whole harvest at one time by weight, the main buyers of such large quantities (up to 30 kg or possibly more) being merchants. Sometimes the farmer may sell the harvest in two or more smaller portions, e.g. to women who run sewa-houses. In some cases, the price for a bag of geisho is agreed upon without weighing it. Another option is selling geisho by volume: some women were seen selling geisho (whole leaves) by small basketfuls, which is said to be more profitable when selling the lighter geisho from the irrigated areas.

Farmers may also move further afield to markets where the price for geisho is higher. Axum and Shire have markets where prices are higher. When the market survey was performed in June, prices in Axum were said to be about one birr higher per kilogram than in Enticho (five birr compared to four birr in Enticho). The highest prices for geisho are obtained in Asmara, and some farmers go that far to sell their geisho, crossing the border on small tracks with their donkeys. However, because of the long distance and the amount of time involved in such a venture, it is not worth it for most farmers going with just their own farm’s harvest.

Merchants sometimes go to the production areas (especially the highland areas known to produce high quality geisho), and farmers sell their geisho directly from the farm. The merchant is probably able to buy geisho at a lower price that way, as the farmer does not have to carry the load the long way to the market. Merchants may also do this in times of high demand in order to avoid the competition at the market.

Several farmers take their harvest to the lowland areas, where no geisho is grown. These areas are important producers of grain, and direct bartering of geisho for grain takes place there.
Merchants and ‘retailers’ Merchants buy several farmers’ harvests and sell the geisho at markets where the prices are higher, such as Axum, Shire and Asmara. A merchant who was interviewed said that merchants have to pay taxes when crossing the border into Eritrea. He does not have his own vehicle and thus uses lorries and trucks who transport paying passengers and their loads, and this is probably the case for most geisho traders who, although trading in geisho is considered very profitable, are hardly rich men.

At Enticho market, many women who live in the town buy a large bag of geisho from a farmer, crush the geisho to small pieces and sell geisho in this form by the Menelik, a volumetric measure equivalent to around 900 ml. At the time of the survey, one Menelik was being sold for 1 birr, or traded directly for grain. This way of retailing geisho is probably an important source of income for a number of women who live in the towns. It would be interesting to know how regularly this is done by any individual, and to obtain an estimate of how many women are involved in this kind of trading and how much income can be generated this way.

The market price of geisho and its fluctuations

Seasonal price changes There are marked annual fluctuations in the price of geisho, prices being highest between October/November and January, and lowest between May and September. For example, in Tigray farmers gave the low price as 3-5 birr/kg and the high price as 6-8 birr/kg. Prices for the same seasons in Asmara are almost double the Tigray prices. Prices on Enticho market were 5.00-5.50 birr/kg in the first week of April, and 3.50-4.00 birr/kg in mid-June, when the market was visited again.

Most farmers were aware of factors causing seasonal price fluctuations. Prices are high during and after harvest time, since much sewa is consumed during harvesting, often provided by farmers for their helpers. At this time, farmers’ food reserves are also replenished, which means increased demand for sewa, and the farmers who sell geisho are in a more powerful bargaining position as they are not desperate for money. January sees the highest geisho prices, being the month most traditional weddings take place. In the following months, geisho prices start to drop, and the
following factors may play a contributing role in this: 55 days’ fasting during March and April (during which, however, alcohol is allowed), Gunbot (May) being traditionally an unlucky month for weddings, and dwindling food resources. Farmers also say this is a time of hard work, especially ploughing. Thus, seasonal price changes are essentially demand-driven. Since seasonal price fluctuations are predictable and geisho can be stored, farmers who are in a financial position to do so can store geisho and sell it when prices are highest.

**Interannual price changes** It is a generally acknowledged fact among farmers and buyers that geisho prices are high in years of good grain harvests. This can again be explained by the fact that when farmers have good food resources, the demand for geisho increases, and farmers are in a position where they are able to demand high prices for their geisho.

The geisho merchants and some farmers said that in years of poor geisho harvests, geisho prices increase due to low supply. It has not been mentioned that prices drop in times of high geisho supply. It would be important to get an idea of this if geisho production is to be significantly increased, as it would be undesirable to ‘flood the market’, causing geisho prices to drop, and thus reducing farmers’ income. Many people seem to be of the opinion that the market is growing since the defeat of the Derg regime, before which normal life was impossible in Tigray.

**Effect of quality on price** Desirable qualities, according to all people asked, are heavy leaves with a strong flavour, attributes associated with geisho grown in the rainfed highland areas. Not only is highland geisho preferred, the demand is greatest for geisho from Adi Ahferom and Hahaile. Both areas are well-known even outside the region for their high-quality geisho. This is reflected in the price: geisho from Adi Ahferom has the highest market value of 4.00 birr/kg in mid-June 1995, while that from the irrigated areas, especially Enticho, has the lowest price of 3.50 birr/kg. This was found at Enticho market, where no geisho from Hahaile was sold. Given the great popularity of geisho from Hahaile, many merchants probably go to this market, and there would be no need for geisho farmers to sell their produce in Enticho. Geisho from Mai Kotseli, which is grown at the same altitude as the sought-after highland geisho from Adi Ahferom
and Hahaile, is less popular and cheaper, costing around 3.75 birr/kg at the time of the survey. People at the market explained that its flavour is less strong. Geisho from Gondar, which is available in Axum and Shire according to women who brew sewa, is also unpopular. Like geisho from irrigated areas, it is said to have light leaves with a weak flavour.

Apart from the above differences, there are also less predictable factors affecting the quality of geisho. Geisho which is damaged, e.g. by hail or pests, has a very low market value, as it is torn and discoloured.

It seems as if buyers are fairly discerning about the quality of the geisho they purchase, and most people claim to recognize superior and low-quality geisho. Considering that merchants and women who own sewa-houses are the main customers who buy directly from the farmers, this is likely to be true. On the other hand, one farmer, when asked how quality affected prices, said that farmers would sell lower quality geisho at the highest possible price if their customers were unable to recognize its value. When crushed geisho is sold by the Menelik, the women selling it sometimes mix ‘good’ and ‘bad’ geisho, and one woman said that some even mix leaves of other plants.

It would be interesting to find out how well and how objectively buyers choose their geisho, especially what the rationale is for the high popularity of geisho from Adi Ahferom and Hahaile as compared to that of other highland areas. It would be desirable to find ways of improving the quality of the geisho grown by farmers, e.g. by looking at growing better varieties, but if buyers are not judging quality objectively, and farmers are locked into a price category simply by the area they live in, there may not be any advantage in improving only the quality of the geisho, and development should focus on increasing yields per area.
Since geisho is used almost purely as a cash crop (some may be used for making sewa in their own home), the importance of geisho to the farmer is measured in terms of the income it generates, which is determined by the amount and quality of geisho produced by the farmer and the market prices at the time of selling.

The question arises whether farmers are able to sell geisho at times when prices are high, either by harvesting at such times or by storing geisho until prices rise. Harvesting takes place three times a year, about four months apart. Harvesting at shorter intervals, especially if there is not enough water, is said to damage the plant, and harvesting at longer intervals has the disadvantage that the leaves are shed after a time, and it is thus not possible to store the leaves on the plant. Storage of the dried leaves is possible if they can be kept dry, but it seems that farmers are seldom in a financial position to wait for higher prices, usually having to sell their geisho immediately after harvesting.

The amount of geisho produced differs between farmers and between production systems. The most obvious factor determining this is the number of geisho plants grown by each farmer. The age of the plants also plays a role, as young plants produce small or no harvests. The productivity of mature plants is also important, and this is affected by the area where the geisho is grown, the plants' genetics and the condition of the plants as a result of good or bad production methods. The size and condition of these plants is most likely to be a result of a combination of the production system, care and management, the age of the plants, and possibly genes. Hail, drought and pests reduce harvests and thus income, the former two being much greater risks in the highland rainfed areas. In the irrigated areas, the risk of harvests being damaged is lower, and good harvests are thus more frequent. However, although the irrigated areas are said to be more productive, the general opinion is that farmers in the highland areas make more money from geisho production. If this is true,
this may be due to larger plantations, heavier leaves or the higher quality of highland geisho.

Table 5 shows some farmers' estimates of their yields. Estimates of yields range from 1 to 15 kg per tree per harvest. The farmers from the irrigated areas around Enticho gave the highest estimates, while those of the highland areas and the areas around Edaga Arbi are lower.

Table 5: Farmers' estimates of geisho production

<table>
<thead>
<tr>
<th>Farmer no.</th>
<th>Yield/plant/harvest</th>
<th>Production area</th>
<th>Age of plants</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>10 kg</td>
<td>Enticho</td>
<td>10 yrs</td>
</tr>
<tr>
<td>2</td>
<td>10-15 kg</td>
<td>Mai Kotseli</td>
<td>50 yrs</td>
</tr>
<tr>
<td>3</td>
<td>2-3 kg</td>
<td>Mai Kotseli</td>
<td>4-5 yrs</td>
</tr>
<tr>
<td>4</td>
<td>1 kg</td>
<td>Edaga Arbi</td>
<td>40 yrs</td>
</tr>
<tr>
<td>5</td>
<td>1-5 kg</td>
<td>Edaga Arbi</td>
<td>----</td>
</tr>
<tr>
<td>6</td>
<td>4 kg</td>
<td>Sefeo</td>
<td>old</td>
</tr>
<tr>
<td>7</td>
<td>1 kg</td>
<td>Sefeo</td>
<td>old</td>
</tr>
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</table>

In the baseline survey, 17 farmers in Mishig were reported to have earned a total of 1100 birr in one year from sales of geisho, i.e. each farmer made on average about 65 birr a year from geisho production.

There is much variation in the estimates. Reasons for this are the variation in production, the fact that estimates are rough and possibly inaccurate and lastly, some people may feel sensitive about discussing their income, or underestimate their income, as people often worry that they will not get any help or support if they appear to have a good income.

On the other hand, there are numerous farmers who grow no geisho at all. The small survey done during this study of how many geisho plants farmers have did not reveal any farmers without geisho, but another study
(FARM Africa 1994b) states that in Mishig, 24 per cent of farmers obtain income from sales of geisho, i.e. a minority of farmers grow geisho to generate income. A more comprehensive survey of how much geisho is grown and how much money earned by farmers in different areas is necessary to get a better overall estimate of the income from geisho production.

Farmers were asked during interviews how important they felt geisho farming was for their income, and this was also discussed at the workshop. Most agreed that geisho is a very important crop for them, which was underlined by their enthusiasm and support for the study and the workshop. A farmer in Edaga Arbi with a plantation of about 30 geisho trees said that sales of geisho made up about a quarter to half of his total yearly income, and he thought that this was a representative figure for farmers with irrigated plots in that area.

In a survey carried out in Mishig in mid-1995 about the fate of seedlings from nurseries, practically all farmers expressed a wish for geisho seedlings. While many farmers are still reluctant to give up other crops in favour of geisho, some farmers consider geisho to be their most important crop because of its high value per area and are keen to improve their production.
IX. Discussion and Conclusions

Investigating geisho production has been the first step in looking at cash crop production in central Tigray. The ultimate aim of the project is to improve the income of farmers through more efficient and productive use of their land, as well as diversification of cash income sources. We need, therefore, to consider the production of geisho in the context of the farming system in order to assess its present and potential value to the farmer, as well as in which areas research and development would be most fruitful. Geisho is not the only cash crop that interests farmers, although it is the best known and established one in the area. Cash crop diversification would be desirable, as it makes the farmer not only less vulnerable to production hazards (such as pests or diseases) that affect any one crop, but also to market fluctuations.

The overall impression gained from interviews and observation is that geisho is considered by most farmers to be an important and valuable crop, and there is general interest in developing and improving its production. Many farmers who do not grow geisho because they feel their land is not suitable, or that they lack sufficient knowledge, said they wished they were able to grow geisho.

A number of characteristics of the crop and its production explain why it is so highly valued, and why improvements of this crop may be a viable move towards improving income.

Geisho seems from farmers’ accounts to be a relatively uncomplicated and reliable crop compared to many others. Being perennial, there is no need for high labour input every planting season, except for planting new geisho. The level of care seems to be quite moderate; digging, weeding, etc, are said to be done only twice or a little more frequently every year. Harvesting and processing are also relatively simple compared to many other crops. Since geisho is not very labour-intensive, farmers are able to devote more time to other crops or off-farm employment to supplement their incomes. Geisho is harvested three times per year, so damage or destruction of one harvest affects only a third of the year’s harvest at any
Discussion and Conclusions

one time. Although farmers mentioned pests as one of the major production problems, the general view is that geisho is less severely affected by them than most other crops. Not only does geisho itself have a high per-hectare value, the fact that it is suited to intercropping allows for even more lucrative land-use. According to farmers at the workshop, geisho has been grown and marketed in the region for several generations, and there is considerable local expertise and experience on which further development can be built.

The following are areas that need more research, and suggestions for possible directions in research and development.

1. Better data is needed on the distribution of geisho production areas, on how much geisho is grown in each area and per household, and on the income from geisho in different areas. If the same data can be obtained for other crops, comparisons can be drawn between the income that can be generated by the production of each.

2. There is also a lack of growth and productivity data under different growing conditions. This is needed to find out how environmental conditions affect growth and productivity, for instance, which soils are the best for growing geisho.

3. More research into the different markets and their existing and potential importance to farmers in the region would also be useful, especially to get an idea of what the possible effects of greatly increased geisho production would be. A study of market preferences, focusing on how buyers choose the geisho they purchase, could be useful.

4. A more thorough study of the genetics of geisho, with bigger samples from more different areas, may be of value. To obtain more conclusive results, some transplant experiments, where geisho from different areas is grown together under the same conditions, should be carried out. In the same studies, it should be observed how closely the offspring resembles the parent. This would be a long-term study because of the long time involved in observing the growth and development of geisho plants, and therefore is not suitable for the more short-term on-farm trials. However, this issue could be discussed with interested parties such as farmers,
Bureau of Agriculture staff or the nurseries, as the principles are simple enough to enable anyone interested to experiment with this on a small scale. This may be more practical and affordable than a study using sophisticated genetic techniques. As was demonstrated by farmers’ response to the discussions about varieties at the workshop, the concept of genetic varieties is a readily understood and accepted one to farmers, and discussions and dissemination of existing knowledge regarding this would be useful in aiding farmers to exercise better choice over what geisho they plant.

5. A study of the existing production and management showed that, while some farmers seem to be geisho experts, many others feel they lack sufficient experience and knowledge to deal with production problems effectively.

Pest control emerged as one of the areas where farmers want or need research, information and technical support from government and non-governmental organizations. A thorough study of pests and methods of combatting them, using both local and scientific knowledge, would be desirable.

Soil moisture management seems to be poorly developed. As shortage of water is the most commonly cited factor preventing farmers from growing geisho or expanding their geisho production, ways of alleviating this need to be investigated, especially how to overcome this problem with improved soil management.

Other practices that could be tried and their success monitored, are the use of manure, pruning and possibly propagation from cuttings, which would enable farmers to grow genetically identical offspring from bushes that produce good harvests of a high quality.

Because of the small sizes of the farms, it is important to emphasize productivity per area when developing agricultural production. Thus, it would be worthwhile to investigate the possibility of more efficient and profitable land use, especially with respect to intercropping.
With farmers’ co-operation, studying existing ways of production and experimenting with different combinations and arrangements of crops can show how land is utilized most profitably. The detail in which such studies are carried out, will depend on the time and resources available, as well as farmers’ interest.

Although geisho grows and matures over a period of several years, and is therefore in many ways unsuitable for year-to-year experiments involving farmers, there is still considerable scope for farmers’ participatory research. Farmers should, for instance, be involved in pooling and disseminating existing knowledge about geisho production, especially with respect to better production methods. Pest control can be experimented with on a short-term basis, as could pruning of the branches, which could be tried out on a few plants, and at different times of the year. In the long run, if farmers can be encouraged to adopt an experimental approach to geisho farming, and if support and advice can be provided where they are needed, ongoing and sustainable research and development could be achieved.
References


The Institute for Sustainable Development is working for awareness of the central role played by biodiversity in the survival of traditional agricultural systems and the communities dependent on them. The systematic study and publishing of the traditional knowledge in these communities is an essential first step in introducing sustainable development strategies.

FARM (Food and Agricultural Research Management) Africa is a non-governmental organization registered in Britain which works at a grassroots level to assist peasant farmers, both men and women, and rural communities improve their production capacity and also their ability to conserve and manage the natural resources around them. All projects aim at full participation of the beneficiaries. Since 1994, FARM Africa has been running the Community-Oriented Rural Development Project (CORDEP) in northern Tigray. The study on geisho presented in this booklet is one of the studies undertaken by the project.