PN-AAW-843

TECHNICAL AND ECONOMIC FEASIBILITY STUDY ON THE IMPLEMENTATION OF BLACK PEPPER (PIPER NIGRUM) IN THE DEMOCRATIC REPUBLIC OF S. TOMÉ E PRÍNCIPE

November 1985

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I INTRODUCTION

This study results from a contract awarded to Sociedade Comercial Francisco Mantero SARL in September 1985 in accordance with the conditions laid down in the Trilateral Agreement Portugal/United States of America/Democratic Republic of S. Tomé e Príncipe.

The team formed for the purposes of this work (i.e., Dr. Pedro Mantero, Mr. Jaime Borges, Mr. Mário Pais Ramos, Mr. Daniel Nunes and Dr. Francisco Mantero) is pluridisciplinary and the aim hereof consists in studying the implementation of black pepper culture in the Democratic Republic of São Tomé e Príncipe as required under the terms of the Tripartide Cooperation.

In accordance with the specifications required for contract purposes, we shall describe the ecological characteristics of the selected areas, the findings resulting from 8 years' experiments, the technical and economic feasibility as well as the need for this black pepper alternative.

Pepper cultivation is feasible in S. Tomé. Conditions are such that 1,500 ha of black pepper shrubs on marginal areas will place cocoa in the second place even if this latter crop will reach the level of 12,000 tons which existed at the end of the colonial era.

It will be shown that crops can be diversified in S. Tomé and that five years will be quite sufficient for projects to develop into actual results.

By using more than one type of farm, family firms (small agriculture) will have a market crop with a revenue of more than 500% of that of cocoa but the so-called breadwinning production will still not decrease.

We have considered the most pessimistic figures and have not stressed certain points which could be used for psychological motivation since results speak for themselves.

Revenues will only be achieved if an effective aid is provided and if there is proper management.

Unsuccess (if any) as in all projects will be related only to human resources, options regarding cropping systems or the shortage of financial means.

The implementation of areas shall have to be limited only by technical and economic problems since the survey was based on economic and social assumptions.

We were the first to introduce Piper Nigrum in the islands of S.Tomé e Príncipe in 1967; we were also the first to plant it and the first to export it. This makes us highly honoured by the fact that we were now chosen to carry out the feasibility study on this crop at the Democratic Republic of São Tomé e Príncipe.

We hope it will be quite complete and that we may have given ample information covering all we know about the world of Pepper to the future pepper growers of São Tomé e Príncipe. Those going into this business will be aware of the problems they may have to face, how to prevent them and how to overcome them. In addition to our suggestions and information, creativity and experience gained by the new growers may lead to new solutions in the cropping and technology fields and thus enrich the existing knowledge and enhance whatever they may imagine for the solution of the complexity in the cropping of Piper Nigrum.

We feel sure that all this will happen. This reason alone made this work fascinating. Our aim was to be able to achieve a cultural, technological, commercial and economic model for the pepper growers at S.Tomé e Príncipe. If we do succeed, we will then feel very proud and that we were truly useful.

II BRIEF HISTORICAL REVIEW ON THE KINGDOM'S PEPPER (PIPER NIGRUM L)

1 - Black pepper is one of the oldest known spices which has always been associated to India, where it is assumed to have originated. The Greek word péperi as well as the Latin piper and Arab filfil originated in Sanskrit pipalli, a creeping bush, Piper Nigrum L, which was traded between the coast of Malabar and the Mediterranean in very ancient times as reported by Theofratus in 372-387 BC; he mentioned two species and the second one is probably the one corresponding to "tail pepper". Later on, Discordius and Plinius mention the same.

The first short known description is claimed to have been made by Cosmas Indicopleustes after his visit to the coast of Malabar in 540. He mentioned the plant's characteristic. Marco Polo later mentions the production of pepper at Java around the year 1280.

2 - It originated in Southeast India and was then taken to the east and Java probably by Hindu immigrants early in the Christian era.

It then expanded to other regions subsequent to enhanced value resulting from a highly unequal consumption which was practically reserved to the noble class and to the upper bourgeoisie. This restriction was especially due to the very small quantities on the market and to the prices reached. Its generalized use was later imposed in view of the conditions for preservation of food; the coming autumn season and the lack of pasture land led to the slaughter of a large part of cattle and meat was either smoked or salted for preservation purposes. Nevertheless, it would easily rotten and the same would happen to salted fish when exported to a far distance. The disgusting smell and taste often had to be compensated by using strong aromatic and hot products.

Trading of drugs ans spices in Portugal started early after independence. This is confirmed in the Orders issued by the Municipality of Coimbra in 1145 and certified through the Town's charter in 1179.

In 1266, the Silves, Loulé and Tavira charter established the king's entitlement to a moravedi (old gothic iberian gold coin) per load of indigo or pipere.

The Aljezur charter of 1280 mentions black pepper. The charters of the House of King Diniz, 1278/1282, include one dated 1287 where the rights on pepper and saffron are reserved to the Crown.

According to Portuguese Historians, the Portuguese Market was supplied by Flandres between 1319 and 1330, through Castilla, which means by land, as described in "Descrição de Terreno em Roda de Lamego".

Curiously, up until the first half of the 15th Century, no reference is made on direct contacts between Portugal and markets where this and other spices are produced.

The direct interest for these spices is first shown by Usidemore and Ca da Mosto who, together with a Portuguese and the Venetian Patrício di Conti visited the Venetian galleys which had to anchor at Cape St. Vicente in 1454 due to bad weather.

Documents published at that time show that the aim of the voyage proposed by Usidemore and Ca da Mosto to Prince Henry was probably to find spices in the African coasts since Usidemore's arrival at the mouth of River Gambia had the aim of marketing gold and malagueta pepper.

Diogo Gomes, in 1456, bought not only the usual products, such as cotton cloth and elephant teeth but also "unam quantim mensuram de malagueta in grano ..." from the negroes of Rio Grande (Geba).

Trade starts to expand and the Portuguese dominate: Afromomum Malagueta and Afromomum Granum-paradisi and other products called Amomum granum-paradiso and tail pepper or Guinea pepper, so named because its stalk was attached to the fruit: this was Piper Clusi. We, therefore, have to consider two different times: one, in 1454, when malagueta pepper first arrived by sea; and the second one, in 1485, a time when the first pepper from Guinea reached the golden period at the end of the 16th century when Cá Masser estimates the quantity of black pepper and malagueta yearly disembarked in Portugal to be about 2,000 quintals.

By mid 16th century, difficulties in India made it necessary for the cultivation of spices to be extended to S.Tomé and Brazil. The description of S. Tomé by the sailor Gonçalo Pires to Valentim Fernandes (manuscript pages 197-210) does not mention any attempt in introducing spices on the island. Nevertheless, the cultivation of spices is mentioned in 1578/9 in "Relatione del Reame di Congo" dated 1579 which states ... "ginger and spices at S.Tomé yielded copiously". (The word was underlined by us). Scattered documents found in box 1, Dec. 61 of A.H.U. mention the following: ... "There is a lot of ginger in Lisbon coming from S. Tomé, India and Brazil ..." (the word was underlined by us).

Nevertheless, spices at S. Tomé last for a very short time. Traders interested in the Cape route reacted in such a way that the plantation of spices was banned in 1593 because this caused losses to India. This piece of news is reported in "Rendas de Portugal", 1593, Page 64.

Trade was then extended to the world in 1700 when the Europeans arrived at the Eastern and African countries. The brief report then goes on to the 19th century. The Dutch developed their own plantations at Java, Sumatra and Borneo where they introduced cropping methods which were adapated by the Chinese and the Dutch Eastern India obtains the pepper monopoly.

It is uncontroversial that it was under the Portuguese that black pepper was expanded to Malaca and to the Islands of the Malayan archipelago but they were not able to maintain the monopoly after the 18th century and the Dutch were not able to maintain it after the 19th century.

III PIPER NIGRUM L

A - Bothanical Study

1 - The genus Piper belongs to the Dictolidonea class, piperales order and piperacea family and includes more than six hundred species, a dozen of which bears more or less useable fruits for medicinal purposes or as spices.

Piper Nigrum L has a cromossomatic name of 2N = 52 and is under the form of a persistent foliage creeping liana which may reach a height of ten or more meters.

1.1 - The root system is formed of three to six main deep roots which may go down to a four meter depth, and these are responsible for the fixation of the plant to the ground and for the absorption of water from deep layers at the time of droughts; the system also consists of an important network of fascicular routes concentrated on a 0 to 2 meter diameter (scattering of the foliage in the soil) and situated at a depth of 30 to 60 cm, for the nutrition of the plant.

1.2 - The part above ground is divided into three different parts: the stolons, on the base of the plant, spreading over the ground and acting, in certain cases, for propagation purposes; the orthopropic branches, formed between knots, 7 to 10 cm long, 1 to 3 cm thick and developing vertically, forming the base for the fixation of the plant through casual routes coming out of the knots and, finally, plagiotropic branches.

The plagiotropic branches alternate with the orthotropic ones. They have a 2 to 3 mm diameter, shorter internodes and a herbaceous consistency but no casual roots; they have alternate leaves with shoots which originate fructification branches.

1.3 - Leaves are inserted alternately, they are pectolated and simple. The 2 to 3 cm long pectol is formed of a sheath and has two lateral 10 to 15 cm long and 5 to 10 cm wide stipules, it is complete, oval or elyptical, pointed at the top and cordiform at the base. Leaves are dark green; there is a regular and dark dimorphism between the leaves of the orthotropic trunks and a lighter colour and assymetric dimorphism in relation to the main vein for the plagiotropic branches.

1.4 - Only the plagiotropic branches have alternate inserted inflorescences opposite the leaves. They consist of 7 to 12 cm long hanging ears formed of a series of pearly flowers, each one placed inside the hollow part of each bract. There are sometimes as many as 150 flowers per ear and they may either be hermaphrodites or unisex. Plants may, therefore, be monoic or dioic hermaphrodites or even polygamous.

The greenish-yellow flowers are, as said, pearly. The pistil is formed of a simple unilocular ovary, under a very short style which branches off into a star shaped stigma with 3 to 5 1 mm long branches containing papillas of about 10 microns in diameter. The ovary contains an orthotropic ovule with a lower micropyle.

The androceum is formed of two short 1 cm long stamens (sometimes four) set on each side of the ovary. Each stamen is formed of a short flat filament over the ovary and of an anther with two cells. Pollen is formed of very small round grains with a diameter of no more than 10 microns (Please see Fig. 1).

1.5 - The pepper fruit is a sessile, acaulous, monospermic, spherical berry with a diameter of 4 to 8 microns and its colour is firstly green, then yellow and finally, when mature, it is red. The seed testa have a floury endodermis with an albumen on top envelloping a small embryo.

B - Flower Biology

The study of the flower biology explains the pollination of flowers and, therefore, the formation of fruits. This is extremely important in the case of the pepper shrub since some varieties tend to have very few grains. On the other hand, knowledge on the pollination forms is extremely useful for the creation of new varieties through cross-breeding or hybridation and for the selection of methods to be used in the fight against certain diseases (please see Fig. 2).

There are few studies on the flower biology of pepper shrubs and one of the reasons is claimed to be the fact that there are difficulties resulting from the very small size of the flowers. Hasa-Iljas studied the development of the flower branches and buds until full opening of the flowers. A study on eleven cultivated varieties and one wild variety of pepper shrubs at the Agricultural Research Station of Bogor, Indonesia, showed that the shoots on each knot of the more or less horizontal plagiotropic branches are found on the upper part of the trunks. As time approaches for blossoming, the buds form new shoots, generally starting with those closer to the "distale" end of the trunk. As the shoot develops, the different layers of bracts fall one by one until there is only one left. This is the time when the flower bud is formed under the sheath of the new leaf which is also formed on the shoot. The flower bud is, at a particular time, impelled by the blossoming bud in the first bud but it is still protected by the bract Later on, the flower ear develops through the two halves of the pleated blade of the young leaf. The latter unfolds following an epinastic movement, breaks through the covering bract and releases the young flower ear; the ear still remains inside the bract and only gets away from this shield when it is about 1 cm long as this is when it is able to stand the air conditions. The flower branch will dry and will not develop if deprived of such protection at a very early stage. This often happens, for example, with the Piper Betle species where fruits are seldomly found because flower branches are usually destroyed prematurely due to the fall of the protecting bract. This justifies the very important role played by the leaf sheath, the blade and the bract in the development of the flower branch. On the other hand, an additional flower bud is formed inside the young bud and the shoot then has two flower buds (please see Fig. 3, 4 and 5).

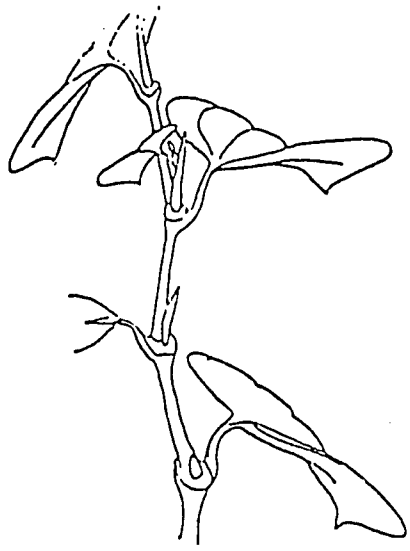


Fig. 1 - Branch producing flower ears, as seen from the top. Buds developed into shoots. The buds are located on the upper part of the horizontal branch supporting them. The shoots closer to the distal end of the branch usually develop first. The base end bud is just starting to be unattached.

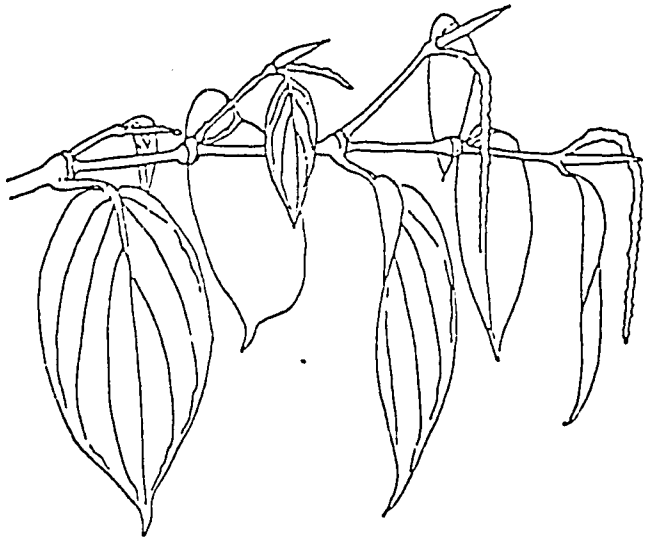


Fig. 2 - The same branch as in Fig. 1 but at a later stage. The four shoots develop into young trunks with one flower ear each.

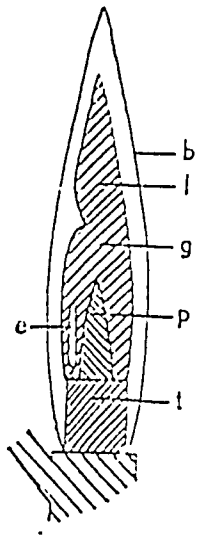


Fig. 3 - Schematic representation showing a bud with a flower outline.

b = bract
l = leaf blade
g = leaf sheath
p = young bud
e = flower outline
t = branch internode

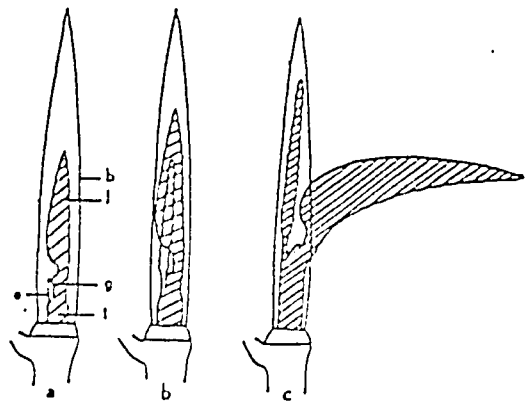


Fig. 4 - Schematic representation of the development of the flower outline.

a) The flower outline (e) came out of the sheath enveloping it as it was pushed by the developing lower bud (p in fig. 3);

b) The young flower ear is inside the blade of the new leaf.

c) The new leaf unfolds epinastically, cracks the enveloping bract and releases the flower ear which, nevertheless, remains in the bract.

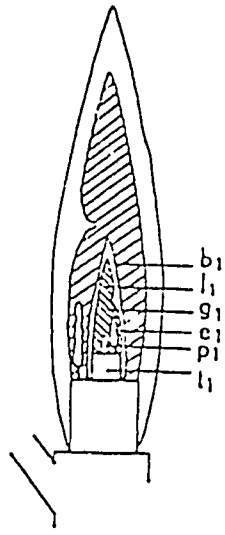


Fig. 5 - A second flower outline (e_1) is about to develop inside the new bud (p) in such a way that there are two flower outlines developing inside the same shoot.

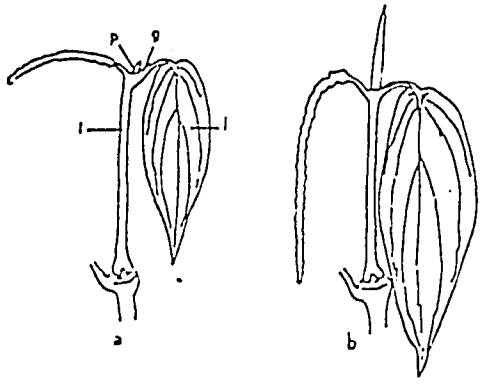


Fig. 6 - a) The bract has fallen. The new young bud comes out of the sheath cavity (g). The positive geotropic bending of the ear starts.

b) The positive geotropic bending of the ear is completed. The new bud has reached its maximum size and the same events take place inside it.

A few days after the ear sprouts, it has a positive geotropic reaction and it then bends progressively towards the ground. This bending starts from the top and gradually reaches the base of the ear. The flowers are not yet visible since they are covered by the squamous bract (please see fig. 7).

Flowers start to bloom from the base of the ear and then continue towards the top. In the "Bangka" variety, for example, the stigmas of the base flowers start coming out of the bract two weeks after ears appear. Five or six days later, this reaches all the flowers and the ear then has the female nature since the stamens have not yet snapped (please see fig. 7). This condition lasts for about five days; the first stamen then appears on the ear base and other stamens start to appear during the four to five following days and the ear becomes hermaphrodite (please see figure 8).

29 to 30 days elapse between the time when the ear appears and flowers fully blossom. The period between the time when the female and the male organs of one flower are formed is 10 to 11 days for the flowers of the ear base and nine to ten days for those of the distal end (see fig. 7).

Three to five days after the male flowers sprout, the stigma is covered by a viscous liquid which means that it is ready. The anther of the stamen starts to open up two days after its formation. These are protogenic plants, i.e., the female organ matures before the male one. Please note that the two stamens of one same flower do not develop at the same time and that they mature at different times; this means that the two pollen bags of one stamen do not open at the same time and, therefore, the distribution of the pollen grains of one same flower lasts for quite some time. This procedure is not the same for all varieties. In the case of the "Belantoeng" variety, for example, the first stamens appear on the base of the ear before the stigmas of the ear appear. There is, therefore, no female stage for the ear but blossoming is still protogenic.

The wild variety "Bukit Kemuning" is quite different. The ears grow at a reasonable pace but they have few grains which always form close to the base. The study of the ear showed that flowers start to develop on the base and that stamens appear before the stigmas. In the "Bangka" or "Belantoeng" varieties, flowers are protandric, i.e., the male organ matures first. Generally, it

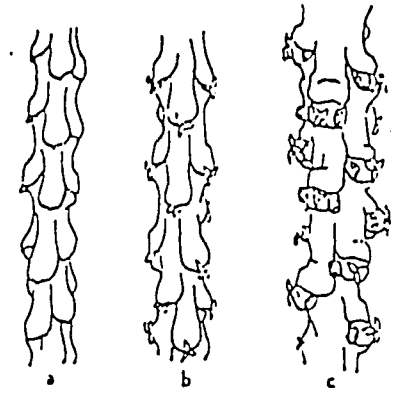


Fig. 7 - a) Part of a flower ear soon after completion of the geotropic bending. Flowers are still covered by squamous bracts.

b) Part of a flower ear in the female condition. The star stigmas left the bract protection.

c) Part of a flower ear in the hermaphrodite condition. Each flower has one stamen on each side of the ovaries.

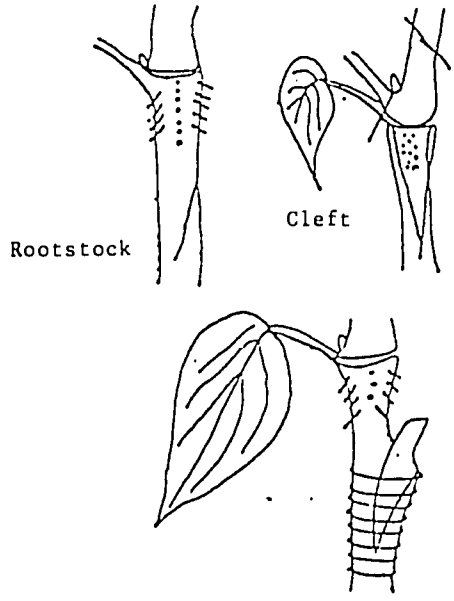


Fig. 8 - Grafting as designed by Carré.

even disappears before the stigma appears and becomes pollen receptive; however, the period between the maturity of the organs of the two sexes is shorter for the flowers on the ear base and there is, sometimes, a possibility for direct pollination and the formation of one or two grains. This is why these varieties with such a low productivity are not used.

Flower pollination is a controversial matter. Some authors, such as Barber, Cramer and others, believe that pollen is carried by rain. This belief is highly spread throughout India since fecundation usually takes place during the rain season. Other authors, such as Govinda and Venkateswaran, concluded that very heavy and long lasting rainfall harms fecundation just as much as a very long exposure to the sun. Based on these two theories, Hasan-Iljas decided to isolate flower ears of the pepper shrub before the genital organs of the flowers developed. After careful examination to check the absence of insects or mites, the ears were placed into spacious polythene bags for free development.

A comparison with a same number of randomised ears (which were not isolated) showed a similar fecundation. This proved that the fecundation of the flowers of the pepper shrub does indeed not depend on the rainfall, insects or wind conditions. However, it is found that, in the majority of cases and with the usual varieties, pollination takes place between the flowers of the same ear.

Pollination of the stigma with pollen from the same flower (autogamy) is not impossible but it is seldom due to the usual protogeny of flowers; the usual method is that of "geitonogamy", i.e., pollination between flowers of the same ear. This is easily explained by the positive geotropism of the ear: as soon as the stigma of a flower becomes receptive, the stamens are not yet ripe but, on the other hand, the flowers closer to the end by the ear base are, due to the positive geotropism of the ear, placed over the flower and issue a functional pollen which will fecundate the ready stigma by gravity. Other researchers, such as Martin and Gregory came more or less to the same conclusions as Hasan-Iljas. However, Barber and his disciples were not totally wrong. Rain may indeed not be vital for the fecundation of the pepper shrub flowers but moisture is really important. It favours the separation of the more or less aglutinated masses forming the pollen grains outside the pollen bags. Furthermore, a high moisture content maintains the turgescence of the

stigmatic branches and, therefore, extends the receptivity period of the stigma to some ten days, thus increasing the pollination capabilities.

The absence of flower pollination may be strongly due to a stigma lesion, resulting from its fragile nature. Insects seem to play an important role here, not as pollination agents, as would be assumed, but rather as stigma destroying agents.

Tests are being continued for new strains but they take too long because of technical and scientific difficulties, such as for example the behaviour of the plant.

C - Ecology

The natural habitat of the pepper shrub is the dense leave forest covering the western side of the Western Gates in the Malabar Coast. This is an equatorial climate plant and its culture will only yield interesting results in the hot countries with a high and well distributed rainfall.

Pepper shrubs in the Western Coast of India develop in hot and well irrigated regions along the coast. At less than 600 m heights, considerable rainfall of more than 2,600 mm per annum is required and 3 to 5,000 mm per annum are reached in the large production centers. Estates are found in countries with hot equatorial climates but they are also found in countries with tropical climates will a clear cut dry season provided however it is not a very long one. A dry season under the described conditions is a factor for a good production since the crops will mature and be grouped.

The ideal or optimum climate for black pepper will have a rainfall between 2,500 and 3,000 mm with a relative humidity of more than 80%.

The following table shows the figures for three pepper producing regions where maximum values are obtained:

TABLE I

Average Rainfall at several Pepper producing Stations

INDIA AND MADAGASCAR

MONTHS	INDIA Negumangad	INDIA Todopuzha	MONTHS	MADAGASCAR Tamatave
May	241	300	February	385
June	447	778	March	458
July	274	767	April	406
August	165	549	May	287
September	180	328	June	275
October	363	432	July	293
November	246	218	August	203
December	74	51	September	135
January	25	20	October	98
February	26	33	November	135
March	59	71	December	257
April	186	208	January	365
TOTAL	2,286	3,749		3,291

Table I shows the average rainfall figures of three pepper producing regions, two of which in India, Negumangad and Todupuzha at Kerale and one at Malgache: Tamatave. Adjustments were made to have coinciding rainfall epochs since Madagascar is in the South Hemisphere.

Please note that rainfall at Todupuzha in June to August usually corresponds to 55.6% of the annual rainfall. Just for curiosity sake, please note that annual rainfall at certain pepper production stations, such as Peermade, reaches 5,210 mm, of which 1,197 in June and 1,293 in July, but this does not damage the plantations since most of them are on slopes and are also subject to drainage works.

Please note that a dry season can be beneficial if it is not too long and that it can be subject to corrections. These are carried out not only through irrigations but also through adequate and easily controllable shading.

To summarize: the pepper shrub is a hot climate plant requiring quite considerable average temperatures and a high rainfall rate.

Table no. II shows the climate figures at the pepper production station of Patambi:

TABLE II

Climate Data

Patambi Station

Months	Maximum Temperatures -°C	Minimum Temperatures -°C	Humidity
July	28.3	23.4	93.5
August	29.0	24.2	92.2
September	29.2	23.3	92.8
October	30.9	23.4	88.1
November	33.6	22.3	80.8
December	34.6	21.1	64.4
January	34.9	20.6	60.7
February	35.3	22.2	80.2
March	35.9	24.3	82.8
April	35.1	25.0	84.3
May	34.1	26.0	76.0
June	27.4	25.2	88.1

Please note that the pepper shrub will not tolerate strong wind. This will dry the trunk and separate it from the stake.

D. Soils

Pepper shrubs can be formed on several types of soil. Nevertheless, special attention should be paid to the extremely sensitive root system and to excessive moisture as this will asphyxiate the plant. The soil must have a texture and physical structure suitable for aeration and drainage. This is one of the reasons why there is a need for a richness in humus and mineral elements. Soil fertility is indeed an important factor for abundant crops and pepper shrubs require quite a considerable amount of nitrogen and potassium. However, a very rich soil would not be extremely convenient if it were flooded.

Generally, the pepper shrub will prefer deep clay-siliceous or silica-clayish, permeable, fresh soils with their surface at a distance of more than 2 m from the water table layer. When there is surplus water, the best soils are those of slopes on hills since water will flow more easily than from flat soils. Highly clayish, heavy and impermeable soils should be avoided.

Pepper shrubs will take a high soil acidity and some are on soils with a pH of no more than 5.5.

Table III shows the result of tests made on soils at Madagascar, tests at the Laboratory of Sociedade Açucareira de Nossi-Bé and at the Chemistry Laboratory of the Agricultural Station of Lake Alaotra.

TABLE III

Tests on soils for pepper shrubs at Madagascar

	1 Genesi Plantation		2 Milloto Plantation		3 Baboto Plantation		4 Plantat. S.de Açucarel
	Soil	Sub-soil	Soil	Sub-soil	Soil	Sub-soil	
Sand %	5.00	4.80	24.80	42.40	25.80	38.30	17.20
Slime %	48.30	41.50	39.60	31.90	38.80	36.60	53.60
Clay %	31.30	38.40	29.50	19.10	26.30	21.60	22.60
Total Nitrogen %	1.43	1.23	1.03	0.87	1.06	0.88	1.50
Organic Carbon %	2.31	1.87	2.89	1.30	1.87	1.01	2.89
C/N ratio	16.15	15.20	28.00	14.90	17.50	11.40	19.26
Total organic matter %	3.98	3.22	4.98	2.24	3.22	1.74	4.98
Humus %o	1.08	0.84	1.63	0.71	0.37	0.21	1.63
Assimilable H_2O_3 %o ..	0.834	0.728	0.430	0.306	0.541	0.417	0.333
Exchange Capacity %o .	28.8	28.5	29.80	17.82	30.42	22.35	34.60
Exchange K_2O %o	0.359	0.325	0.237	0.134	0.191	0.191	0.319
Exchange CaO %o	7.66	1.82	2.10	1.34	2.24	1.21	2.18
Exchange Mn %o	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Exchange Na %o	0.016	0.015	0.071	0.053	0.045	0.061	0.061
Exchange HgO %o	0.174	0.174	0.314	0.295	0.241	0.295	0.954
Free Iron %	5.15	4.75	0.71	0.85	1.32	1.43	7.15
pH	5.74	5.29	5.83	5.87	5.78	5.50	6.51

These slime-clayish soils are well supplied with nitrogen; their contents in organic carbon, total organic matter and humus are average and even high in samples 2 and 4; their exchange capacity is considerable. They are quite rich in assimilable phosphoric acid and their contents in exchangeable bases

are good, especially potassium in samples 1 and 4 and magnesium in sample 4. Acidity is average; it is weak for sample 4. These data may be compared to those of the Western Coast of India where the soil composition is concerned; one of the tests concerns the soils of the Agricultural Research Station of Pattambi and the other the soils of the Trivandrum region.

TABLE IV

	TRIVANDRUM	PATTAMBI
Physical Tests		
Humidity	3.06	2.07
Coarse sand	33,79	48.40
Fine sand	19.97	16.22
Slime	8.65	8.77
Clay	33.35	26.61
Chemical Tests		
Fire loss	9.63	7.84
Insoluble	67.83	62.86
$Fe_2O_3 + Al_2O_3$	-	28.64
N.	0.10	0.084
Total P_2O_5	0.04	0.293
Total K_2O	0.05	0.191
Assimilable P_2O_5	0.0004	0.0058
Assimilable K_2O	0.002	0.02
CaO	0.04	0.129
MgO	-	0.146
Na_2O	-	0.126
pH	7.00	5.75

The lateritic soils are poor in nutritional elements but they are good supports for the pepper shrubs as they are located on hilly slopes and are well drained.

E. Cultivated Area

This shrub originated in India and, therefore, it is only natural that it should have been developed around the original nucleus: in India, on the west side of the Western Gates and, especially, in the States of Kerala, Mysore and Madras.

The area taken up by pepper cannot be easily assessed since it is found everywhere both under the form of single crop and in association with other crops.

However, in the sixties, it was considered that, on the basis of an average density of 740 plants/hectare, there would be 78,000 ha of soil occupied by pepper shrubs, 70,000 of which in the State of Kerale and the remaining at Mysore and to a lesser extent at Madras. According to Marinet, the 78,000 ha were distributed into three different zones depending on the type of cultivation: extensive, family or in association with other crops. The first one is found at South Kamara in the State of Mysore at the sub-district of Chirakkal and Kottoavam with live stakes (usually erytrine) at an average density of 750 plants/ha; the majority of farms is found in the north side of valleys, expanding to the Pala-Kottayan region.

The second zone, the family type, lies in the coastal region of Tellichery and extends to the north and to the south of Trivandrum where it ends. The stakes here are still live ones but of different species and the plantation density varies with the soil nature and with the rainfall volume. This is the main cultivation zone and it is divided into three main centers: in the north the Tellichery region at Calicut, with about 6,000 ha, to the south Kottayan with about 15,000 ha and further to the south at Nedumangad with about 7,500.

The third zone, which is occupied with tea and coffee plantations as well as tangerine tree orchards, has pepper shrubs planted under the protection of the main crops; this is found in the district of Nilgiri and shading is provided essentially by Grevillea robusta which is also used as the support stake for the pepper shrubs.

The pepper shrubs extended from the Malabar coast to the Far East : Indonesia, Malaysia, Thailand, Ceylon and Cambodia.

The Dutch developed a new technique in the XIXth Century at Java, Sumatra and Borneo and were able to maintain a share of 80% in the world exports.

However, the whole situation changes after the second world war: production in Indonesia decreases because of Japanese occupation, pepper production is replaced by textile plants and some farms are abandoned; on the other hand, products from Sarawak and India increased and reached 2/3 of the world share after the 2nd world war (1952).

Following the decrease of production in Indonesia, Brazil becomes the third largest producer in the world in 1969.

With regard to Africa, this crop starts being planted in the Central African Republic and is also developed in Gabon where it has a very high quality.

F. Geographical Evolution

Indonesia: According to historians, pepper shrubs were introduced in Indonesia between year 100 B.C and year 600 of our era. This country known in the old days as Dutch Indies, was the main producer with a tonnage between 70,000 and 80,000 and covered 85% of the world requirements. Production in this archipelago was essentially found in Java (10%), Banka (20%) and Sumatra (70%). This situation deteriorated under Japanese occupation, as mentioned above and only started to improve in 1954. Nevertheless, there are some limiting factors:

1 - The area at the Banka Island, producer of a white pepper with good reputation in the world market and known under the name of Muntok, decreased from 6,000 ha to about 2,000 ha. This decrease was due to a disease known as "yellowness" which this variety is very sensitive to and which makes it essential for plantations to be reconverted or renewed every six to ten years.

2 - At Sumatra, the variety Lampong occupied an area of about 16,000 ha in the southern part of the district of Lampongs before the war but it was then replaced and increased and now the pepper shrubs occupy an area of more than 20,000 ha. The Lampong variety was very sensitive to the Muller disease and was replaced by a highly resistant variety known as Belantoeng.

3 - Pepper has been produced at Sarawak for a very long time. The date when these plants were introduced is not known but data show that a considerable amount was exported in 1809. Diseases which periodically would destroy the crops were fatal for many plantations during the times of Japanese occupation.

4 - Production in Thailand nowadays is quite irrelevant.

5 - Tradition in Ceylon is quite ancient. Around 200 tons were exported in 1739. Production decreased under Dutch occupation. After the second World War, prices reached a very high figure and Ceylon went back to its tradition; production in 1964 reached a figure of 8,000 tons, most of which was traded and consumed in the domestic market.

7 - Production went beyond the boundaries of Asia and pepper started being produced in Africa and Brazil.

7.1 - Pepper was introduced in Madagascar early in the XXth Century. Incentives provided by the high prices led to a rise in production from 100 tons produced in a very limited area in 1945 to approximately 1,000 tons in an area of app. 4,500 ha in 1960.

7.2 - Nigeria, Zaire and Gabon started producing for the domestic needs and Gabon then started exporting.

7.3 - Brazil - Production in Brazil dates back to the XVIIth century at Baía where plantations were of a family type. It was then extended to Paraíba, Pará and Maranhão but the situation was somewhat at a standstill. The crop did not develop considerably because of the climate conditions and of the varieties existing during the colonial era and known as caiena or common soil pepper.

The Singapore variety was introduced in 1933 at the Municipality of Tomé-Açu in the State of Pará and this was quite decisive for Brazil which is now the third largest producer in the world.

G - Cultivation

1 - Multiplication

Propagation of pepper is carried out through three different methods: seminally (seeding) and through layering or staking.

2 - Seeding

This method is seldomly used in pepper culture due to the slow development of plants, to an undesirable cover and a late and irregular production. The greatest problem results from the extensive polymorfism of the issue. Nevertheless, this is the method chosen in countries where stakes cannot be easily received by plane or where new varieties have to be obtained.

2.1 - Choice of seeds and preparation of nurseries: seeds to be used for multiplication purposes must originate from branches producing the fruits which will be more similar to the type which is to be multiplied and they should be completely ripe. Fruits are then hulled in fresh water, dried under the shade and seeding can then take place.

Harvesting, hulling and seeding should be carried out within the shortest possible period of time since:

a) Late hulling is an excellent means for multiplication of more or less dangerous cryptoma, such as Screlotiu and Phitophora which deteriorate or attack the plantules.

b) The choice of grains is extremely important since the germination coefficient depends on that. It is known that seeds with a diameter between 2.5 mm and 4 mm yield a germination percentage of 0 to 25%; from 3.5 mm to 4 mm a percentage of 55% and more than 4 mm 100%.

c) Please also note that the germination capability of pepper lasts a very short time and that ripe seeds which are prepared and seeded in due time contain a germination capability around 75%.

3 - Preparation and management of nurseries

Plantules are so fragile that seeding should be made on vegetal soil trays or beds.

The same method used for horticultural products should be used for the preparation of the bed; nevertheless, the pepper shrub bed should be placed at a high level in order to compensate for the surplus water and moisture content.

The bed should be prepared and then covered with a 2 cm thick layer of pure sand.

Seed spacing should be such that there will be 400 per m^2. They have to be spread evenly.

A 1.20m x 0.85m galvanized plate, with 6 mm bores made every 5 cm on both directions should be used for the distribution of the seeds.

The grid is placed over the bed and the seeds are then spread at a rate of one seed per bore, pushed into the ground by means of a slight pressure with a finger. The grid is then removed and the seed is covered with a light 2 cm layer of fine sand.

Fine sand mixed with coarse sand is used to prevent the formation of rinds on the surface.

Top and side shading and irrigation are vital since this is an umbrophillic plant.

Germination takes about a month and it is helped if coarse sand is used. Fungicidal treatment is vital at this stage.

Shading is regulated in accordance with the development of the plants so that they will get used to the normal environment; this usually takes about four months.

Transplant should be made as and when plants have issued 6 to 8 leaves and this usually happens when they reach about 20 cm.

4 - Transplant

Transplant may be made with a naked or other root but irrigation and shading have to follow.

Staking is essential.

5 - Layering

This consists in burying a branch on the soil, with it still attached to the plant so that the knots in contact with the soil will issue roots.

Layering is seldomly done with an orthotropic branch in the case of the pepper shrub. However, multiplication in India is carried out with base (orthotropic) stolons running along the soil. Roots will not be formed with this technique and the branches should be wound around the stakes so that they will form branches and then the roots. At Sumatra, farmers let the stolons form roots and they used these as the basis for the multiplication procedure.

6 - Grafting

Grafting is not much used but has advantages when the aim is to prevent certain diseases which frequently arise in the pepper shrubs. Some wild varieties resisting such diseases would be used as rootstocks and good varieties were used for clefting purposes.

Pepper shrubs will accept shoot grafts. However, the method which is mostly used is that of the cleft. The cleft is chosen from branches which are at least two years old and will be found in the vegetation.

Grafting: The shoot, which should be at least two years old, is cut below the rizogenous zone at the top of the middle part of an internode. The incision in the mid part of the trunk should be as long as the cleft bevel.

Cleft: it is chosen from among branches aged one or more years and should be cut above a knot; the longer length shall be maintained where the double bevel is made over the whole internode. The upper segment may be dormant or not but shall never be more than 1 cm long. Both the petiole over the dormant segment and the adventitious roots should be cut. The cleft is inserted with the shoot facing the outside, it is connected and the cuts are protected. (Please see fig 8).

This type of grafting is quite common in Sumatra, Cambodia and Sarawak but not in India. Grafting in this latter country is done as follows: the branches of two stakes with roots in the same vase are linked one to the other some 5 cm above the incision. One month later, the graft is partially released and the operation is completed during the second month by cutting the cleft branch below the prop. (See Fig. no. 9 on page 25).

Stakes: The usual system for propagation of the pepper shrub consists in using stakes. Preparation varies from country to country.

In India, as already said, stolons are used as the material to be reproduced through stake grafting. These shoots are suppressed every year at the time when the rain season starts but they are maintained if a need is felt for further material to be planted. The stolons are left in contact with the soil and they will generate roots on every knot just as in the case of the layering

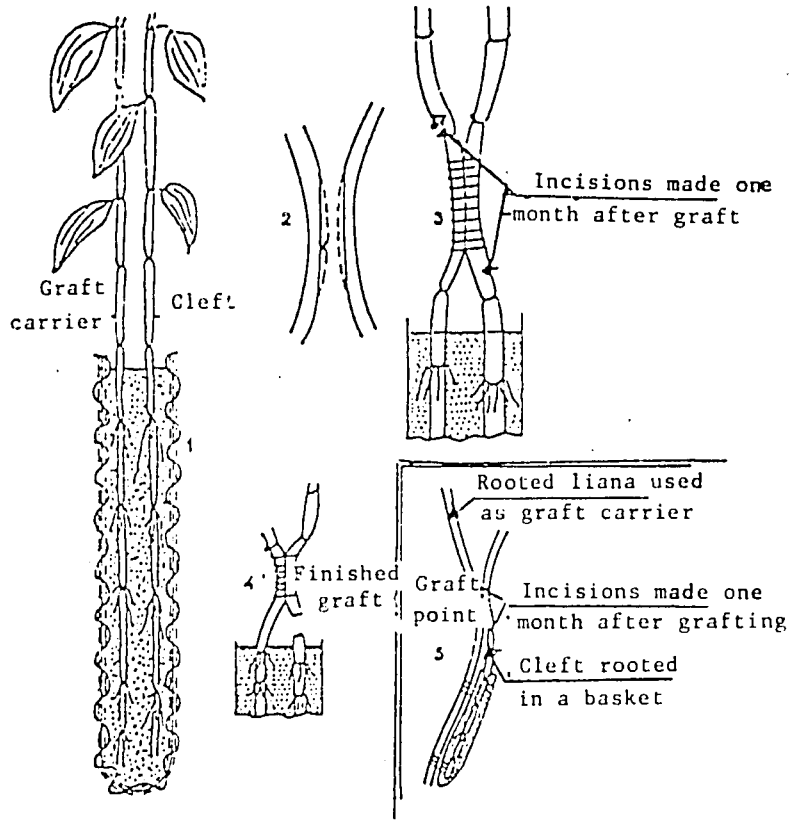


Fig. 9 - Graft method used in India

1 - Graft carrier - cleft

3 - Incision made one month after graft

4 - Finished graft

5 - Liana used as graft carrier

Graft point

Incisions made one month after grafting

Cleft rooted in a basket

system used at Lampongs. These roots usually are avoided as they may be harmful; three stakes are burried in the soil lose to the base of the liana and the stolons form a crown coil over the stakes at a certain distance from the ground. These shoots have a very small diameter but they may reach a length of 2 to 3 meters and supply 4 to 6 50 cm stakes each. Each stolon may supply about 20 stakes. These stakes produce plants which will reproduce the characteristics of the mother shoot but they are naked on the base and late in producing fruits. Reproduction is not always good and, therefore, rooted stakes are used.

In Bangka, Sarawak, Malaysia and Indochina only stakes formed of two orthotropic branches (direct plantation) are used. These stakes either come from one year old branches which are pruned (direct plantation) or from stake nurseries formed of lianas which are cut every year. They are one year old and formed of orthotropic trunks growing along a support with bud roots on each knot. However, different methods are used for the propagation of stakes in Malaysia and Indochina (See Fig. 10 on page 27).

In Sarawak and Malaysia, branches resulting from the pruning of 1 or 2 year old plants are used. Stakes should be 60 cm long and should have at least five knots and seven at the most. Preparation takes place when they are still fixed to the mother plant. The terminal shoot of the chosen branch is tightened. Then, the lateral trunks and the leaves found between the third and the seventh knots are selected. (Please see fig. 14). A new terminal shoot develops seven to ten days later and the wounds left by the leaves and the lateral trunks start to heal; this is the time when the stake is withdrawn from the mother plant by cutting it below the seventh knot but care should be taken so as not to harm the adventitious roots. These stakes are generally planted in their final site and only seldomly in nurseries. Plantation is carried out in an oblique position on the side facing the east of the prop at a depth of 10 to 15 cm with 3 or 4 knots buried (please see fig. 10). The soil should be tightened and irrigated.

Stakes used by the Chinese pepper shrub growers in Indochina are prepared after separation from the mother base. The 3 to 5 orthotropic branches forming the main branch are pruned at 15 to 20 cm from the ground; the adventitious roots are carefully withdrawn from the prop. The branches are then separated and

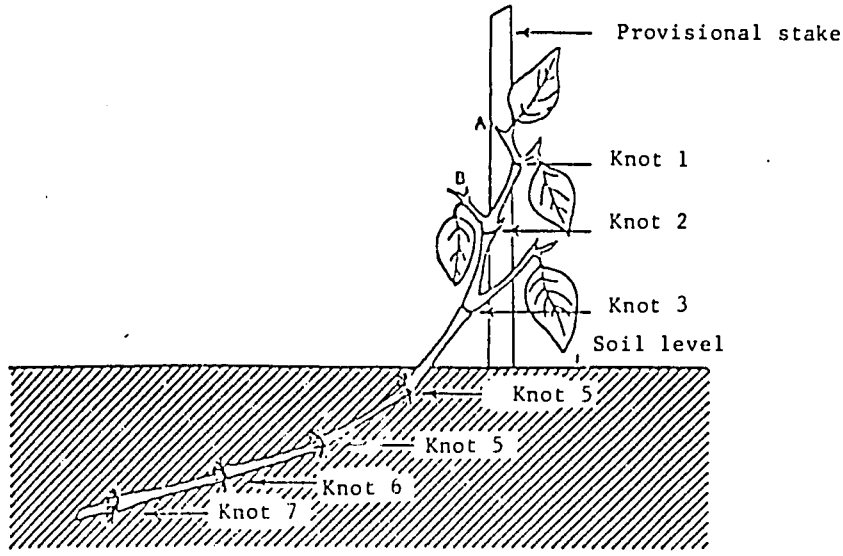


Fig. 10 - Stake reproduction at Sarawak. A seven knot prop placed but not staked. Four knots are buried at a short depth and three others are still above ground. A, B and C are the future main branches to be carried by the stake. The stake will be shaded by fern leaves.

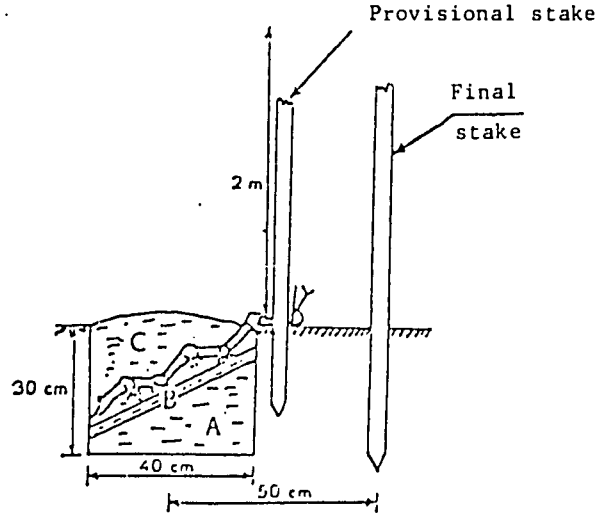


Fig. 11 - Placing stakes as designed by M. Carré.

the tender part or the part without bud roots is removed; the remainder is cut into pieces with a length of 60 cm and include five to seven knots. The leaves and lateral trunks, except for those of the two upper knots, are cut from each piece. Plantation should take place immediately but only at the end of the day or under shady weather. This is done in ditches with the same width as the spade handle at a depth of about 40 cm and at a distance of 5 cm from the prop. Stakes are carried into the fields in a bucket full of water so as to be kept fresh. There will be two per hole and they will be placed vertically against the nearest face of the prop but the stake buds should be placed on the side opposite the prop. Care should be taken to leave the two upper knots outside the soil and to have a provisional shading coverage. This is a definitive plantation and the results usually reach 70%. Each one of the four knots of the two stakes produces one orthotropic branch (see Fig. 11).

According to some authors, the adequate technique for the propagation with the stake system is the one used in Indochina. The stake is removed from the upper part of the one year old stalk, it should have 50 to 60 cm, be totally green, have a width of at least that of a thick pencil and should have strong adventitious roots. The plantation system is similar to that of Sarawak: stakes are placed at 45°, at a rate of two per hole (see fig. 11), they are buried in a layer of enriched soil (B) (mixture of soil and manure) (A) and then irrigated. Each one of the stakes has about 5 knots, three of which under ground and two above ground. In plantations with live props, the placing of stakes is quite a controversial matter. Some authors say that the stakes should be placed away from the base of the tree to avoid competition between roots of two plants. Others believe the opposite and claim that this would cause a closer contact between the rootage of two plants and would needlessly complicate the subsequent growth of the plant.

All parts (stalk and branches) of the pepper shrub may produce the stakes and the same applies to the fruit branches. However, the stakes of a purely pagiotropic nature develop dwarf peduncles. Although they produce fruit at an earlier stage and do not require props, their yield does not seem to be of any interest. Tests are being carried out at the Agricultural Research Center of Boukoko in the Central African Republic on the behaviour, life and productivity of such peduncles as compared to those obtained from orthotropic branches. Experts, such as Gilot and Van Digenen have tested several types

of short orthotropic and plagiotropic stakes at Yangambi. They claim that the best multiplication material is that of the plagiotropic stakes with an orthotropic sprig (Fig. 11 and 12). The results consisted in normal plants with the advantage of having fruit trunks on the base. However, the superiority of these peduncles vis-a-vis those of long stakes from orthotropic branches has not yet been proved (see Fig. 12).

Extremely short stakes formed of one leaf and a shoot on the base can be used in multiplication. This is the last resource used for multiplication of a material which is highly interesting but with not too great a quality (please see fig. 13).

Conclusions: Advantages and disadvantages of gamic and asexual propagation:

Gamic originated Plants:

Advantages:

- Introduction of a crop into a country which cannot receive stakes from the producing region;
- Obtaining new varieties.

Disadvantages:

- Greater polymorphism;
- Plants without ramification on the bases;
- Weak production starting only after a height of one and a half meters;
- Late production;
- Doubts as to their duration.

Asexual Multiplication:

Disadvantages:

- Sometimes the quantity is not sufficient;

Advantages:

- Precise reproduction of the mother plant;
- Well shaped and easily manageable plants;
- Early production
- Longer duration.

Fig. 12 - Piper Nigrum branch

1 - Primary branch

2 - Secondary branch

3 - Terciary branch

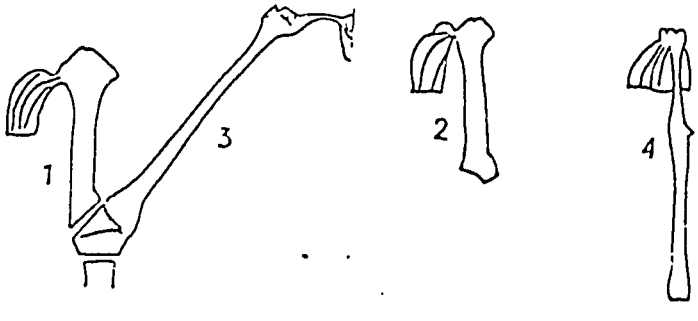


Fig. 13 - Different types of piper nigrum stakes

1 - Orthotropic stake with upper knot

2 - Orthotropic stake with two knots

3 - Plagiotropic stake with orthotropic sprig

4 - Plagiotropic stake with plagiotropic sprig

A wild and seminated propagation by birds resulted into a considerable number of varieties due to the natural polymorphism of the pepper plant.

We believe that the first characteristic considered and selected by man as the most important one was the distribution of the sex of the flowers. No attention was paid to plants with a large number of unisex flowers and a larger number of hermaphrodite plants were selected and multiplied asexually. Out of some 600 known species of Piper Nigrum, man promoted some dozens which showed the best characteristics for adaptation to the environment, a higher resistance to diseases, rusticity, earliness and size of the fruit. Some twenty will be found in India and Indonesia and then there are the varieties from Thailand, Cambodia, Sarawak, etc.. Nevertheless, this number of varieties can be divided into two main classes which may be more or less described specifically in view of their cultivation forms: there is a class formed of plants with large leaves and long internodes and another class with small leaves and shorter internodes. The Indonesian varieties "Lampong" or "Kawur" belong to one class and "Bangka" or "Muntol to the other. Bregmar established the following comparison between these two types in his study on the Cultivation and Trade of pepper at Bangka":

"Lampong" (or "Kawur") Variety	"Bangka" (or "Muntok") Variety
- vigorous growth of all the parts of the plant and abundant branches extending horizontally;	- closer and finer poise, short and hanging branches;
- large but comparatively thin leaves specially in small plants;	- small leaves sometimes with mosaic dots and very thick;
- quite thick but very fragile trunk;	- coriatious trunk;
- first flower blossoms at two years of age; economical maintenance;	- early blossoming, requiring the picking of inflorescences in young plants; expensive maintenance;
- considerable seasonal blossoming;	- also flourishes comparatively well out of season;
- large cluster of fruits;	- small and short ears, sometimes with abnormally thick berries;

"Lampong" (or "Kavur") Variety	"Bangka" (or "Muntok") Variety
- small pepper grains, of a very light colour and highly regular thickness;	- large greyish white irregular pepper grains;
- long life, extending some time over 20 years;	- long life, extending to thirty or more years;
- production starting after three years; very strong in the first years and then gradual decrease;	- production starts after 3 or 4 years (due to the picking of inflorescences) and more evenly distributed throughout the different years;
- period between blossoming and maturity of berry of about 9 months, i.e., early harvest;	- period between blossoming and maturity of about ten months; late harvest;
- short harvest period (five to six picking passages);	- longer picking time (six or more picking passages per harvest);
- young plants have a vigorous vegetation; plants over ten years comparatively bad;	- less vigorous vegetation but comparatively better in old plants;
- new plants grow comparatively well on bad soils;	- poor growth on poor soils;
- sensitive to "yellowing" and peduncle rottening.	- somewhat less sensitiv to yellowing; not very sensitive to peduncle rottening.

There is a third less important class which is known for a variety used in Indonesia under the name of "Merapin"; its leaves are even smaller than those of the "Muntok" type and it is very rarely used since it is not a yielding one.

The "Belatoeng" variety does indeed belong to the "Lampong" class. Its resistance to the peduncle rottening disease led to its export from Indonesia to Madagascar in 1938. It was then exported to Indochina in 1947 and to the Central African Republic in 1954. The above comparison is also applicable to the varieties used in the producing countries with the exception of Indonesia. There is a close variety in India to that of the "Lampong" class. The Indian type

is the "Balamkotta" variety which also includes the varieties "Kumbhakodi", "Karivalli", "Chumala", "Kaniakandan", "Kuthiravali" and "Thulakodi of Travancore" (State of Kerala). The "Muntok" class is found in India under the variety "Kalluvally" which may also include the varieties: "Karuvilanchy", "Perumkodi", "Mundy", "Munda", "Kottanadam" and "Karimkotta". Finally, the four varieties "Balamkotta", "Kalluvally", "Krinkotta" and "Nadanvally" represent about 83% of the Indian production.

The existence of two wide types of varieties can also be found at Sarawak. This may also be said with regard to Cambodia where the large leaf type ("Lampong") is represented by the variety "Phnom-Pon" and the small leaf "Muntok" type is found in the variety "Kamchay".

Please note that income resulting from the processing of green pepper into dry pepper is very important for India and, depending on the varieties, varies between 30 and 43%. The Indian producer usually sells the green pepper after some peeling which takes place straight after harvest; the traders prefer the varieties which will yield a greater dry pepper/green pepper ratio.

A high pepper yield in the processing from green to dry also means that the variety produces few hollow grains and this is quite frequent in Indian production.

H - Plantation and Maintenance

1 - Pepper shrubs may be cultivated in accordance with two main methods, which will lead to either an intensive system or an extensive or associated one. These two classifications which are somewhat theoretical cover all the stages between the two extremes.

Intensive cultivation is usually characterized by using dead props, a high density per hectar (2,500 plants), very detailed care (management of plants and fertilization) and a high average yield (five to six tons/hectar of black pepper). The choice of plants in this particular case does not follow very rigid rules. For example, in Cambodia and Sarawak, stakes come from long orthotropic branches which are taken from the above described one year old branches.

Extensive cultivation is characterized by the use of live props which are taken from trees which are of no interest for production purposes or which are to be used for industrial purposes. Cultivation in this case does not require a lot of care and some authors define this as a catch crop system since its characteristics are neither those of a cash crop nor those of a food crop.

2 - Location - Choice of the land - Propping and plantation: Characteristics vary from country to country and we shall now look into what happens in certain regions:

2.1 - Cambodia: Plantations in Cambodia are almost always found in the lower part of forested hills with slopes which are more convenient for drainage purposes. The soil is prepared during the dry season, i.e., in December/January. When trees are felled, timber is chosen for the props and fences. The remaining vegetation that cannot be used is burnt and ashes are spread out. The soil is worked by digging to a 30 m depth, it is then arranged in straight seeding soil layers with a 50 cm height and spread out in single 2 meter lines perpendicular to the highest slope line. The average yield per worker is about 200 m. The plantation is usually surrounded by a service zone and a fence. The soil is then marked and a provisional 2 m high prop is buried into the soil to a depth of app. 0.50 m. Props are placed on the top part of the seeding soil layer at a distance of 2 m from each other. A density of 2,500 plants is obtained.

Holes (40 cm x 40 cm x 40 cm) are dug at a distance of twenty cm from each prop and on the east or north side. Then they are covered initially with improved soil (mixed with manure or a fertilizer) and then arable or other soil. Seeding is carried out at the beginning of the rain season in accordance with the technique described above.

2.2 - Sarawak: Pepper shrubs used to be planted at Sarawak together with "Gambir" (Uncaria Gambir Roxb.) a taniferous rubiacea used to extract a product known in the trade under the name of yellow or cubic "catechu". The leaves obtained from this crop were treated and then used as straw or even as a fertilizer. However, Gambi production decreased and disappeared around 1924 and pepper growers started to use greater and greater quantities of burnt soil;

however, this technique is no longer used as 4 ha were required for the production of the soil and timber to maintain one sole hectar of pepper shrubs for some ten years. This technique exhausted the soil and led to the fast attack of the soil by a tropic weed known as Imperata Cylindrica which makes the soils acid and degradable. The majority of the new crops have now taken the place of the pepper shrubs which are no longer produced in those soils which are actually covered with Imperata.

Pepper plantations are of a family nature at Sarawak and their average area varies between 200 and 400 m^2 depending on what can be maintained by each owner. Considering the importance of rainfall, these crops are usually found in considerably sloped areas so that there will be adequate drainage. This also favours erosion and, therefore, the land has to be terraced. However, more often than not, three or four weedings are carried out during the three driest months of the year, March and August, for elimination of Imperata and the soil becomes ridged. The ridges in a perpendicular position to the slope are placed at a distance of 2.10 to 2.40 m and are formed by a mixture of burnt land and ashes. Provisional props are placed at equal distances to those of the seeding soil layers and this corresponds to a density of 1,689 to 2,210 plants per ha. The stakes for the pepper shrubs are planted during the rain season following the above mentioned method.

2.3 - India: Various extensive cropping types are found in this country. Pepper plantations are associated to the plantation of shading trees or to bushes. The most developed cropping method consists of the use of live props.

The preparation operations and the installation procedure for the plantation of pepper shrubs will depend on the cropping option.

Cultivation with live props in the district of South Kanara follows more or less the same system as in the case of dead props. After clearing the area, the land is terraced if the slope is too high. Otherwise seeding soil layers are formed. In land where there is a sun exposure trees are planted for shading purposes. Spacing is greater than in the case of dead prop plantations and varies between 2.40 and 3.60 m. A density of about 730 to 1,680 plants is obtained.

Props are placed on the seeding soil layers by opening ditches during the rain season in April and May; five to six pepper shrubs stakes are planted by the base of each prop (direct plantation with no provisional props).

Preparation of soil in the case of association of crops, such as for example, with coffee and tea plants as well as with citrines, as in the case of the Districts of Nilgiri, Coorg and Wyanad and States of Madras, Mysore and Kerala, is usually carried out in view of the main crop and not in view of the pepper shrubs which are just a complementary activity. There will only be about four or five stakes and sometimes more close to the trees which are the main product and they will be used as props. Density of pepper shrubs is limited to the number of trees.

In the case of family properties, the method is more or less similar to the one described above. The pepper shrub density will depend on the number of fruit trees around the farmer's house since these are used as the props.

3 - Shading: Pepper shrubs under their wild condition are surrounded by forests. This is a plant requiring shade specially when young. As said, plants resulting from grains cannot take direct sun influence. Stakes, as also said, should be protected as soon as they are placed so as to provide for preservation of the new originated shoots. Adult pepper shrubs also need shade and they will be stronger if they are kept under shade than if they are exposed to the sun. Seeding should also be carried out under shade. If the dead prop is placed under the sun, this will harm the plant and will cause an abundant fructification but the plant will become more fragile and will require special care thus making it acquire the characteristics of an intensive crop.

4 - Propping

4.1 - Dead Props: Dead props are the ones of vegetal origin. The choice of the dead props will depend on the flora of the region and should have a diameter of about 10 to 15 cm and a height of about 3 to 5 m depending on the customs of each country.

The types of timber more commonly used are: Vatica Astrotricha, Xylia rolabriformis and Shorea obtusa in Cambodia; Uranda Sp, Ochnanostachys amentacea and Kackia Ornata in Bagka; Eusideroxylon zwageri, etc. in Sarawak.

The above mentioned varieties are limited in time since they will not resist for more than 12 years. The disadvantages are clear. It was then thought that perhaps wired trellis should be used. Nevertheless, this system was found to bring about physiological disadvantages and concrete was tried out. The reinforced triangular prop with three irons for reinforced concrete use was then started in Bagka. This is an expensive system but the maintenance costs are low.

4.2 - Live props: Live props have a double fold advantage; on the one hand they sustain the pepper shrub and on the other they provide shade. Robust species should be used with the characteristics which are usually required for a good live prop. They should be chosen essencially with the following characteristics:

- Easy multiplication and plantation
- Good rooting. The root should be straight and deep so as to avoid competition with the root system of the pepper shrub.
- They should have a hull in such a way that shoots can be solidly fixed and will not cause peeling.
- They should grow at a considerably fast rate but this usually contradicts their solidity.
- They should withstand pruning which is severe but required for the pepper shrub to grow and have an abundant fructification.
- They should be able to stand straight and in as vertical a position as possible although pruning will also help this.

Although there is quite a considerable number of convenient species, they should preferably belong to the leguminous family because of the nitrogen they supply to their roots and of the vegetal material which is obtained from pruning. The use of these species varies from country to country:

The most commonly used essences in India are two erythrines: Erythrina indica or "murukhu" and Erythrina lithosperma or "dadap". The first one is thorny and is usually preferable when compared to the latter since it is unarmed. Both are multiplied by stakes or by seeding in nurseries. Plants resulting from the seeding are usually cut as soon as they reach a height of 3 m; the stakes are at least 2 m long and their thickness corresponds to that of a fist. They are maintained upside down for two or three months so that they can then be rooted because, it is said, of the migration of the carbon hydrates from the top to the bottom. They are turned around and planted over the soil layers during the rain season.

The best essences used in India as live props are said to be Autocarpus integrifolia, Hevea brasiliensis and Grevillia robusta. Teck (tectona grandis) could also be adequately used but it is said that its leaves are very rich in aluminium and that this would accumulate in the soil and would not have the adequate conditions for the development of vegetables. However, tests would still have to be carried out on this question.

The best essences used in Cambodia seem to be Wrightia annamitensis and Leguminous plants such as Leucaena glauca, Cassia siamea, etc.

A Pterocarpus sp., known as "Sandragon" has given excellent results in Madagascar and Comores; Michelia champaca also had good results in Nossy-Bé. Leucaena glauca also had good results. Other essences are being tested such as Cassia and other leguminous plants such as L'ylang-ylang (Canaga odorata), etc.

Species which may be used as live props for the pepper shrubs are quite considerable and, when pepper shrubs are introduced into one region, an appropriate essence is found; for example, in Gabon, pepper growers found an African leguminous sp. in the forest, Pentaclethra macrophylea, usually known as "ovala". This is a very good prop but its stake multiplication is difficult.

One of the essential problems in a property using live props is shading. This should be quite considerable during the earlier times but should be reduced as soon as the pepper shrub starts to blossom and fructify. Otherwise, yield

will decrease considerably and maturity will be heterogeneous. Therefore, there is an absolute need to use live props which may be considerably pruned and very special attention should be given to this very delicate condition. During the first year, we usually just suppress the side branches so as to facilitate the growth of the prop. Branches are no longer suppressed when the plant reaches a height of 4.5 to 5 m. The work should be done at the beginning of the rain season so that the plant will form a crown at the top so as to provide sufficient shade. Shading should then be regulated every year.

The density of a plantation with live props is lower than that with dead props. The square system varies at least between 2.90 m and 3.60 m and thus there will be a density of 730 to 1,680 plants/ha.

Finally, family cultivation of pepper shrubs around houses is a completely different case where propping and shading are concerned since the props often consist in fruit trees and, therefore, they cannot be precisely pruned.

5 - Support of the pepper shrub, dimensions and blossoming: the support given to the pepper shrub is an extremely important point. We even believe this is a vital question if a good profitability is to be achieved. Double stakes planted with three or four knots above ground will supply an equal number of fragile branches during the months following plantation. As soon as these branches reach some 20 cm of length, they are tied to a provisional or definitive prop. Fixation is done on every knot with a material which will not harm the pepper shrub (which is very tender during the first times) and will not prevent further development.

An orthotropic branch knot will only originate a fruit branch if it is solidly fixed to the prop with good adventicious roots; adventicious roots will only be developed over the orthotropic knot if this is duly secure against the prop. Each one of the knots will have to be adequately tied so that the pepper shrub will supply fruit branches on every orthotropic knot. This kind of operations will prevent the frequent naking of the base of the pepper shrub at a height of 1 m to 1.50 m. Another useful measure consists in driving the three or four orthotropic branches vertically and in parallel so that they will not overlap each other. Special attention should be given so that the

threads will not tie the fruit branches because this will mean that they will be fixed to the prop and will lose their blossoming power. Strings will be chosen in accordance with the vegetation species in the country.

The free and indefinite growth over the props will weaken the branches and will cause the base of the plant to become naked. Some branches which may be considered to be surplus will be cut so as to cover the base of the plant. The cutting operations should be made whenever required by the ecological conditions of each country.

Cambodia: The first branch cut should be carried out around the seventeenth or twenty fourth month of plantation. Pepper shrubs are cut to the same height between 15 and 30 cm from the ground in July-August and the removed part will be used for the production of stakes; when these branches are cut, the final dead props are replaced but this is a very delicate operation. The top of the pepper shrub is then pruned every year so that it will reach the top of the prop, 4 m, only in the fourth year. Later on it is regularly cut whenever it goes above the height of the prop.

Sarawak: Stakes used from the pepper shrubs themselves are malleable and fine due to the system of plantation; they lie in an oblique position, at a very short depth (10 to 15 cm) and the terminal end is placed against the prop. Shoots are fine and, therefore, they provide very few branches. Several pruning operations should be carried out to avoid the naking of the base. The first pruning operation should be carried out as soon as the main branch achieves 8 to 9 knots and it is cut at a distance of 15 cm from the soil. The other branches will be later on treated in the same way. The second pruning operation is carried out as soon as the three branches have produced a dozen knots. They are pruned as follows: three or four knots are cut above the previous pruned part and there will be six or seven knots left. This operation is carried out seven or eight times before the pepper shrub reaches the top of the prop, at the height of 3 to 4 m. Maintenance consists in periodical clearing of all that goes above the height of the prop.

The principle of constant pruning in pepper shrubs applies both to the extensive culture with live props and with dead props. Sometimes, plants are not protected

on the base of the time of multiplication into stakes. Correction by pruning is not possible. Nevertheless, the bad shape of these pepper shrubs can be compensated by using the "omleggen" method which was fashionable in Indonesia at a time when it was still the Dutch Indies.

6 - Omleggen Method: This is a method used to correct plants produced through seeds, at an age of 8 to 10 months and with a height of 1 m to 1.50 m. The aim is to develop the roots and the branches. The fruit branches and leaves all over its length are removed from the pepper shrub.

6.1 - Implementation: A 50 cm dia. and deep ditch is opened around the prop at a distance of some 30 cm. About 10 days later, the pepper shrub is carefully untied from its prop and the branches are arranged in such a way as to form a circle around the ditch and only the top will be tied to the prop. The ditch is then covered with earth, in many cases burnt earth. This is a delicate method but roots will form in the buried part of the branches and it is not used very much nowadays because of the preparation and selection of plants before plantation. Nevertheless, it may be used to correct badly formed plants and may also be used to carry a pepper shrub from a provisional prop to a final one, provided the distance between the two of them is small. The operation may also be carried out on line as a means to increase the length of the branch to be buried.

Removal of the stolons which are formed over the soil but are useless is a good procedure.

7 - Fructification pruning: Fructification pruning operations may also be carried out to a certain extent and this consists in suppressing all or part of the inflorescences of the pepper shrub and they are classified into two categories: those of the period of formation of the pepper shrub and those which are to be used later on to avoid an excessively long cropping period.

The pepper shrub does indeed flourish sometimes already in the first year but a very early production will harm the plant which is not yet properly rooted and decreases its life considerably. A good technique requires the following:

- Suppression of all inflorescences arising during at least the first two years of cropping.

- During the third year, only the flowers of the inner third of the pepper shrub should be maintained. During the fourth year those of the two lower thirds may be maintained and they will only be fully kept after the fifth year.

We should actually mention that this technique is only used up to the third year and even then this is not always so.

The second pruning method is specially useful for countries which are not extremely dry and where, therefore, vegetation does not stop. These climatic conditions are harmful for a proper profitability because pepper shrubs which produce flowers and fruit at the same time will provide an abundant production. In Gabon, for example, blossoming is quite continuous with two peak periods; this means that there are two harvesting times: one and a half month in January/February and three months from July to September. Considering that the dry season coincides with this latter period, this is the most favourable time for a good preparation of the pepper and therefore fructification should be grouped during the period of July/September. In order to achieve this, blossomings appearing between November and January should be the only ones to be kept and the others should be suppressed (See Fig. 14).

A third means of pruning consists in selective defoliation used in certain countries with intensive cropping, particularly at Sarawak. During the first two years, defoliation aims at providing for the development of fruit branches and, therefore, at increasing the fructification potential. The auxiliary leaves characterized by long and thick petioles which originate the branches and the terminal leaves of the orthotropic or plagiotropic branches are maintained. (Please see Fig. 15).

At Sarawak, plants are considered to have achieved their adult age in the third year. They are subject to a considerable defoliation and the old leaves are eliminated straight after harvesting. All leaves are then eliminated with the exception of those found above the sixty centimeters of the terminal branches as well as the auxiliary leaves and the terminal leaves of each plagiotropic branch.

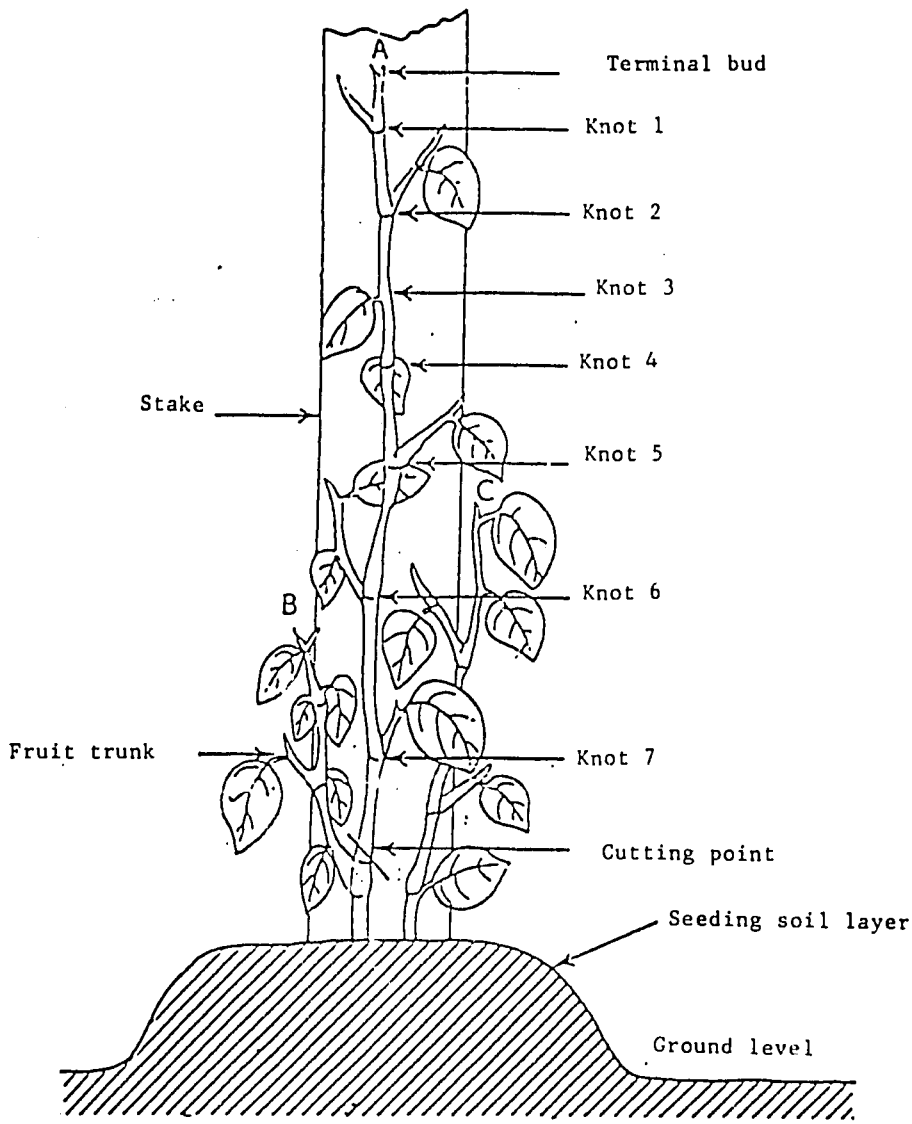


Fig. 14 - Six month pepper liana. A, B and C are the three main branches which should be cut. The terminal bud is held and the leaves and trunks are placed over knots 3 to 7 of branch A. Seven to ten days later, the branch may be cut where shown. One seven knot stake is obtained.

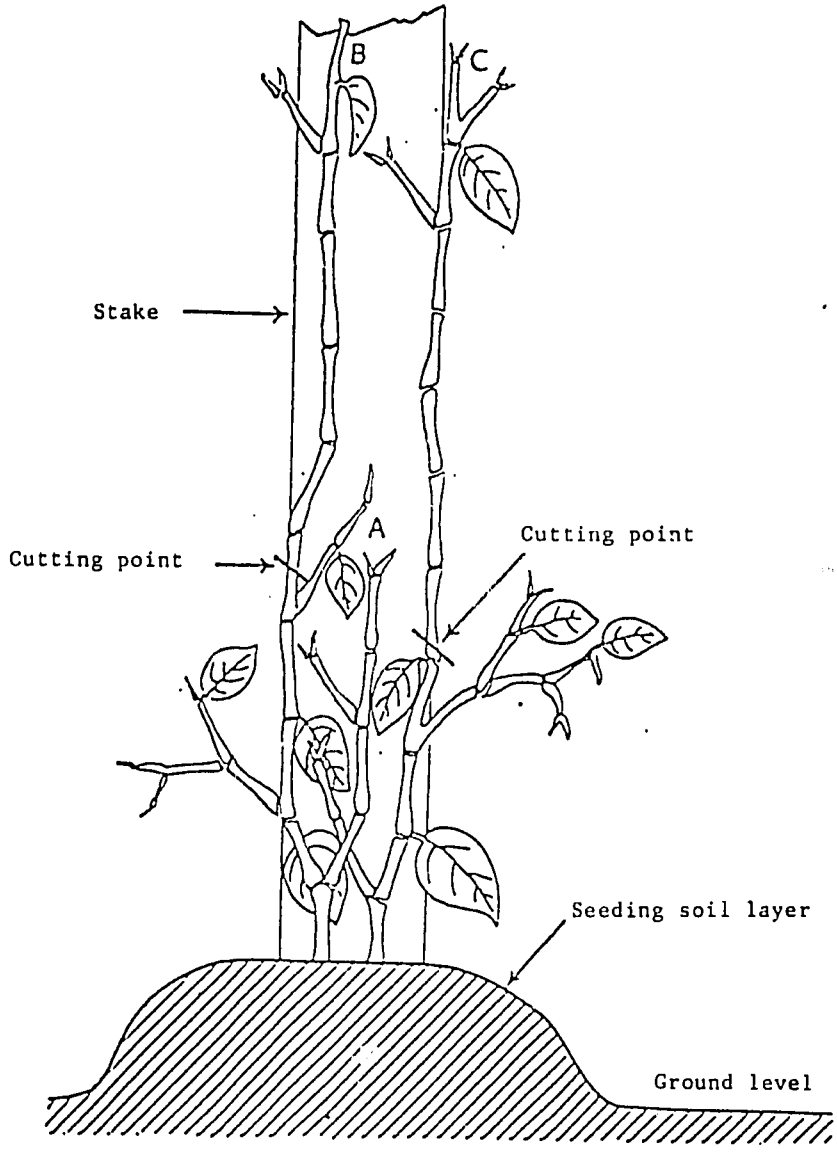


Fig. 15 - The same liana as in Fig. 14 but some time later. Branches B and C undergo the same treatment as applied to branch A.

Finally, defoliation is very moderate in the case of five to six year old pepper shrubs and only the leaves of the terciary branches are eliminated.

Pepper shrubs which are defoliated in this or in any other manner should be considerably fertilized.

8 - Cropping Care: Usually in intensive croppings, such as in Cambodia and Sarawak, soil is usually kept very clean and aired and therefore it is frequently dug. This is a wrong procedure since the soil will be considerably subject to erosion and, in addition, the nutrient elements go into deeper distances due to strong rainfall and an impermeable crust which is harmful for the develoment of the root system is formed.

In regions where there is a long lasting drought, potholes are built around each pepper shrub at the end of the rain season so as to provide for irrigation during the dry season. Irrigation is carried out every two or three days, two of which should consist in a dozen liters per pepper shrub. At the beginning of the rain season, the potholes are covered to prevent water stagnation close to the pepper shrub.

Generally the soil is covered with mulch or a live coverage to prevent the serious disadvantages of cropping on an open soil.

The use of live crops provides for shading not only as a result of the crops themselves but also because of leaves falling and pruning. However, this coverage is usually completed by using "green fertilizers" such as: Pueraria javanica, Canavalia ensiformis, Calopogonium, Stylosanthes, Indigofera endecaphylla, Minosa invisa inermis, etc.

Some of the above mentioned plants may be competing with the pepper shrub with regard to the availability of water and nutrients and these disadvantages may more or less be avoided. Some experts say that the importance of green fertilizers during the dry season should be reduced so that the harvest products will then be used as that coverage or by using plants such as Calopogonium mucunoides which forms a thick carpet during the rain season but dies during the dry season.

In some countries, for example, in the case of extreme culture of pepper shrubs,

live coverage is just formed by spontaneous vegetation which is harvested at the end of the rain season.

In some producing regions, a dead cover is added under the form of a more or less abundant covering with straw. This is an excellent practice since this will mean that the soil will be rich in organic matter and will be kept fresh, humid and protected against erosion and no digging will be required. It is an expensive operation because of the quantity of added material which is around 20 kg per pepper shrub and this means about 75 tons/ha in the case of extensive cropping at distances of 2 m x 2 m; tests carried out in Cambodia with Tithonia diversifolia provided excellent results and supplied 150 to 200 tons of green matter/hectar. More recent tests carried out in the same country confirm the value of using Eupatorium odoratum and this is absolutely required to fight nematodes and also in treating a pathological complex which Barat called the "decadence of pepper shrubs".

9 - Fertilization: This is a plant from a forestry habitat and therefore requires soils rich in humus; the best fertilizer, therefore, consists in organic matter which it is strongly poor in. This accounts for their habit of adding forest earth but this is not feasible nowadays.

"Burnt earth" is also used and it is prepared through the slow combustion (for some fifteen days) of a portion formed of alternate wood and vegetation earth layers. This mixture is extremely difficult to achieve because of the price and because it is difficult to have wood and vegetation earth close to the plantation.

These difficulties led to the use of the so called green fertilizers and the use of straw to supply the pepper shrub soil with a certain quantity of organic matter but this is not sufficient for an interesting yield to be obtained. Fertilizers were then used to meet the mentioned needs. A good and profitable operation will require the use of manure which is quite easy to be obtained in certain countries if we consider a yearly production of 10 to 20 tons per cattle head. The manure is incorporated in the soil early in the rain season at a rate of 15 to 20 kilos per base, i.e. 40 to 50 tons per hectar.

10 - Nutrient consumption: Tests show that the pepper shrub consumes 39 g of nitrogen, 9 g of phosphoric acid (P_2O_5) and 20.6 g of potassium (K_2O) per kilo of black pepper. This means an annual consumption of about 200 kg of nitrogen, 50 kg of P_2O_5 and 100 kg of K_2O, i.e., a formula 4-1-2, in the case of intensive culture, with a production of 5 tons per ha. This shows the extent in which pepper shrub needs nitrogen which should also, if possible, be applied under the organic form.

Organic manure is useful not only for fructification but also strengthens resistance to diseases and extends the life of plantations. Unfortunately, they are not always applied, especially in extensive cropping regions; in some regions, they are even seldomly applied.

Some authors believe that the high content of nitrogen and, especially, sodium chloride from shrimp waste are factors leading to sudden death in Sarawak.

Organic fertilizers are always insufficient and should be completed by using mineral fertilizers. Some authors establish the following rules and recommendations:

- Mineral fertilizers should be started one month to six weeks after plantation of the stakes and the doses shall depend on the growth of the plant.

- Fertilization should be carried out at a distance of 20 or 30 cm from the plants, there should be operations every six to eight weeks and coverage should be applied at those same intervals.

- The fertilizing unit of mineral fertilizers is not as expensive as that for organic fertilizers.

- It is better to have repeated doses of fertilizers by using small quantities at each time, twice or three times per year.

- Phosphated fertilizers should be used specially if the location method in association with lime is used; located applications of monocalcic phosphate every two or three months on the basis of 100 g per pepper shrub will give good results.

- Pig manure, in a dose of about 1 kg every two months, also provides a good result, but it should be well mixed in the soil around each pepper shrub.

- Small applications of potassium chloride, on the basis of 50 g per dose, every two or three months, will strengthen the pepper shrubs.

The adequate and quick reaction of the pepper shrub to fertilization lead some experts to recommend that fertilization should not be repeated too often because, they claim, this would cause a time blossoming. They recommend an organical and mineral application at the beginning of the rain season and they also advise the following:

- Should there be strawing and manuring, they shall be buried around the plant at a ratio of 15 kg/peduncle.

- Manuring should be completed with the use of located fertilizers buried slightly in the soil.

- The quantity of fertilizers to be used per peduncle is about 300 g of amonium sulphate and 200 g of tricalcium phosphate or superphosphate.

I - Diseases and Plagues

1 - Cryptogamic Diseases

Whenever Man changes the environment, imbalances are caused normally pro rata with the change. In the case of intensive crops, plagues and diseases appeared with different severity but not in all regions and only related to the ecological environment. The following is found:

1.1 - One of the most well known diseases in Indonesia and Sumatra is the disease caused by Phytophthora palmívora, var piperis, known as "Muller's disease":

- Symptomatology: The first symptoms appear on the hull, on the peduncle base (close to the soil). The colour goes from normal to dark green and then black and progresses from the base to the top and this is known as "Die

back". Leaves lose their turgidity, they go yellow, get darker or are covered by brown spots which start at the edges and finally they fall.

- Treatment: Soil disinfection through irrigation with the application of bordeaux mixture and preventive sprays on the base of the branches and leaves are advisable.

The most efficient and safe treatment consists in using resistant varieties, such as "belatoeng" as introduced in Madagascar, Indonesia and Africa.

1.2 - The stalk rottening appeared in India in 1895 due to the Rosellina bunodes which, according to literature, was limited only to the State of Mysore. Then there was Scleratim Rilfit in the region of Assan, the Wilt disease which was caused by a nectria and which has the following symptoms: the leaves are yellowish and the edges look burnt and this develops gradually all over the leaf blade. The new shoots which may develop will also be attacked.

Stalk rottening - Symptomatology: yellowing of the leaves after the fall and death of the plant. The disease has a propagation through located spots.

Treatment: aeration and liming of the soil.

1.3 - In Malaysia: Fomes lignosus, Corticium salmonicolor and Ganoderma lucidum were found to attack the roots causing rottening; this may be dangerous if not detected in due time.

Treatment: use of copper sulphate.

1.4 - Sarawak: Cephaleuros mycoidea, an alga causing early fall of fruits (black fruit). Treatment with copper syrup.

1.5 - In Brazil: burnt leaf filaments caused by a fungus Pellicularia Koleroga. It is one of the most serious leaf diseases and attacks both leaves and fruits.

Symptoms: dusky and dark spots on the leaves, rapidly spreading with a rise in relative moisture, causing the total burning of leaves and younger branches and also possibly extending to flowers and fruits.

Treatment: use of copper syrups as soon as the first symptom appears. Two to three applications are usually sufficient.

Anthrecosis: caused by a fungus Collectotrichum Glocosporioides. Black rottening of the fruit caused by Cephaleuros Verescens, rubelosis caused by Corticium Salmonicolor and Fumagina caused by Meliolacena fungi.

These diseases are not very serious and can be controlled by using copper fungicides.

2 - Plagues

Nematodes: Identified in Cambodia, Indonesia, Malasya and Sarawak, it is often confused with Muller's disease and frequently called the decay illness or sudden death; it is one of the diseases which has caused greater losses until it was identified.

It results from a number of factors and it is nowadays known that it is caused by Anguilulas Heterodere Radicola or Heterodera Maroni and the initial agents attack the roots which become exhausted and are then fully destroyed by the action of Pythium Complectens or Pythium Spendens mushrooms.

Symptons: similar to those of Phytophtora.

Actions to be taken: Covering of the soil since dead coverage is one of the means for development of the predator mushrooms of the anguilulas. Detailed reference was made when we described the cropping care.

The disease which seems to cause greater losses in India is called "pollu" or disease of the hollow grains of pepper. The word "pollu" initially concerned grains attacked by some insects (berry borers) and they became hollow for that same reason; the "pollu" disease in actual fact groups several diseases with similar results and, in some years, the losses may reach up to 50% of production. Studies carried out to assess the reasons leading to these diseases led to their division into three categories: attacks by insects, physiological factors and attack by a mushroom.

3 - Insects: There are two kinds causing losses in India, the first one being irrelevant and known under the name of gall fly. The second one causes considerable losses and is known as Longitarsus negripennis or flea beeth.

The female lays the eggs in small bores opened in the fruit pulp and covered with excrement. Five days later, larvae are born and they destroy the grain contents and then attack the neighbouring berries. Each larva destroys about three or four fruits and sometimes it will destroy the fruits on one whole bunch thus producing great damage. This insect alone can cause 5 to 20% of losses in production.

Fruit fall: The fruit fall is another kind of "pollu" which is considered to be caused by physiological factors. Some clusters which look sound fall before they mature and the grains are more or less hollow depending on the development condition of the fruits.

There is another "pollu" resulting from the attack of a mushroom, Colletotrichum necator. This mushroom develops its stromas on the upper part of the leaf and there are some small black spots forming on more or less concentrical rows. Resulting "conidiae" are carried by water and will germinate on the site where it accumulates, inter alia on the point where the cluster and the fruit branch are inserted; the cluster falls as it is attacked and its grains will obviously be malformed. Losses may reach 4 to 13% of production.

Treatment: Spraying with bordeaux mixture or another adequate fungicide. Bordeaux mixture seems to be very efficient when treatment is carried out during the dry season and not early in the rain season.

A hemipter of the Tinginides family in Cambodia causes considerable damage: it is the Elasmognathus nepalensis, commonly known as the "pepper shrub tiger".

There is a similar species in Sarawak, Elasmognathus hewitti (sucking bug) which lives on the leaves in the adult stage but does not cause considerable losses. The greyish 1 to 2 mm long larva living on new ears is really dangerous and causes the abortion of flowers and frequently the fall of the whole inflorescence and may, if not fought in due time, harm the whole crop.

Treatment: Spraying with tobacco juice or maceration for 5 to 6 days of the Stemona tuberosa tubercles at a rate of 1 kg per 5 liters of water; treatment has to be carried out during the blossoming season.

In Cambodia, a small night beetle, Apogania Ranea, in the adult condition gnaws the leaves and causes indirect damage.

Treatment: use of snares or insectices.

In Bangka: the pepper shrub bug, Dasynus piperi, is considered to be responsible for the greatest damage in the crop quality.

Treatment: Use of insecticides of the dialdrium type.

Sarawak: the lophobaris serratipes, known as "pepper weevil" attacks fruits and causes damage similar to those of the "pollu".

Brazil: The plant lices of the Aphos gossypiiglov species cause one of the greatest types of damage in the pepper shrub since they are responsible for a virus known as the "pepper shrub mosaic" which destroys the new shoots and causes bad development and fall in production.

Control: Spraying every two weeks or one month with Metassistox kind of insecticides.

In the seventies an epidemic in the State of Tomé-Açu, in Brazil, spread over more than 80,000 plants in a very short time. Research carried out at the time identified the virus as the "cucumber mosaic" which is also caused by the Aphis gossypgi louse.

Characteristics of the disease: the plants are not well developed, the leaves are speckled, the veins are necrosed. The leaves are deformed, there is an excessive number of shoots and the fruit is necrosed.

Treatment: the affected plants are taken out and burned.

Insects: The coleopteran Litostykus juvencus may cause significant damage as it gets its feed from the leaves.

Treatment: Insecticides of the azodrine type.

Cochineal insects are normal of occurrences but they cause no damage. Specific insecticides should be used for treatment purposes.

4 - Physiological disturbances: Frequent disturbances in new plants at the time of fructification when this takes place before a long drought period.

Symptoms: Withering and sudden death.

J - Blossoming - Production - Harvesting and Yield

1 - Blossoming: The period between blossoming and harvesting is, according to the countries, between 6 and 9 months. In regions with a strong rainfall throughout the year, there will be two blossoming periods and, therefore, two harvests during the year. This is the case in India where the main blossoming takes place in May/June and the corresponding harvest takes place in December/February.

In Malasya: Two blossomings in January/April and August/September and the harvesting is in July/September and in March/April although the latter is less importance.

In Cambodia, the dry season is quite well marked and blossoming takes place in May and harvesting between January and April.

There are two different conditions in Madagascar in view of the ecological conditions: in the north west coast, blossoming takes place in October/November and harvesting in July/September and in the east coast there are two blossoming periods (December/February and July/August) and two harvests (July/August and January/February). Deflowering of inflorescences arising in July/August should preferably take place so as to abolish the small harvest in January/February which exhausts the pepper shrub.

The first harvest takes place at an age varying in accordance with the country: It is early in Sarawak where plants can be first harvested in the third year and sometimes in the second year. In India, production will only take place during the fifth or the sixth year of plantation.

Frequently, plantations last partly in accordance with the age when they start producing. We find that Indian plantations will last 20 to 25 years whereas the Sarawak ones do not last more than 10 to 15 years. The reason for the long lasting plantations in India is that they are shaded with live stakes whereas in Sarawak there are intensive operations.

2 - Harvesting time: this will depend on the commercial quality since this is what determines and lays the conditions for the ideal time when picking should take place.

White pepper: When white pepper is required, the berries should be picked when they are absolutely mature, i.e., when they are red or, at least, yellow.

Black pepper: In order to have black pepper, clusters are usually harvested when they are complete and only contain one or more ripe grains.

If blossoming is done on a gradual basis, harvesting should also take place on different times. For economic reasons, harvesting operations should be done as quickly as possible and production should be grouped in short periods by using the technique of deflowering inflorescences.

Considering the height of the pepper shrub which will easily reach four or more meters, pickers should have ladders, step-ladders or tripode ladders which are very useful for certain cares such as fastening, pruning and deflowering.

3 - Yield varies from country to country, in accordance with the type of farms and the age of the plantations. The following figures have been obtained in Sarawak:

Age of the liana	Yield in Kilos of fresh pepper
1 to 2 years	Nil
3 years	1 to 2 kilos
4 to 7 years	from 3.5 to 9 kilos
8 to 15 years	from 2 to 2.5 kilos
More than 15 years	almost nil

In India, depending on the State, the average yield does not amount to more than 1 kg to 1.5 kg of green pepper per pepper shrub and the dry pepper produced at Kerala is estimated at 650 g and at Mysore 480 gr.

The following table results from a study made by Marinet and establishes the yield in accordance with the two forms of extensive cropping in India and intensive cropping in Vietnam.

TABLE V

Comparison between extensive cropping in India and intensive cropping in Vietnam

INDIA	SOUTH INDOCHINA
Usually associated to other crops over live props.	Always intensive cropping with dead props.
Plantation Density: 750 peduncles per ha.	Plantation Density: 2,500 peduncles/ha.
Multiplication through plant base stake.	Multiplication through raised stakes on peduncles with one year pruning.
Filiform stakes, branching off at 1 m - 1.50 m.	1-2 cm stakes branching off close to the soil.
Slight linkage of the plant to the prop to avoid falling.	Very careful linkage on each knot to develop roots and shoots.
Blossoming at the third or fourth year.	Total or partial blossoming since the first year, deflowering in the first 3 to 5 years.
Normally no earth is added.	50 to 70 kg of forest or burnt earth are added per peduncle and per year.
Weak or no fertilization.	

INDIA	SOUTH INDOCHINA
No insecticide treatment.	Considerable fertilization.
One single harvest before maturity.	Many insecticide sprays.
Pepper is peeled before drying.	Several harvesting operations when ripe.
Average yield: 450 grs per peduncle.	Pepper is peeled after drying.
	Average yield: 1.500 kgs per peduncle, i.e, 3.750 kg per ha.

L - Technology

Technological preparation will depend on the quality of product to be obtained, i.e., white or black pepper. A sound and adequate preparation will only be obtained if the characteristics and composition of the fruit are known.

Let us consider the botanical characterization of pepper according to Jacques Maistre: sessile berry containing one single grain. The group of teguments of the fruit, or the pericarp (P), is decomposed into three parts, as usual: the epicarp, the mesocarp and the endocarp.

The epicarp is formed of a group of very dark cells, the epiderm, which has a thick extensive part.There are two parts in the mesocarp: one is the external mesocarp formed under a set of cell rows with thick walls, and a parenchyma which is very loose and the cells of which have thin walls. The other part is the internal mesocarp formed of a tighter parechyma with flat cells. Between the two there is a net of fibro-vascular beams corresponding to the carpel nervures. The mesocarp is rich in cells containing essential oils (please see fig. 16).

The endocarp is formed of one single row of cells with thick and dark walls. The grain inside the fruit is formed of terminal teguments represented by three cell layers. A double albumen is found over these teguments. The external

albumen, the perisperm, fills the large part of the grain and it is formed of cells full of starch. The albumen itself or endosperm is quite small and is situated close to the microphyl; it contains a very small straight embryo with a conical radicule and a cutiledone turned directly in the direction of the fruit base.

The important factor from a technological point of view is that the internal mesocarp and the fibro-vascular beams which separate it from the external mesocarp adhere to the endocarp and form a kind of protection envelope for the grain.

The preparation of the two commercial types of pepper, i.e., black and white pepper, is based on this particular anatomical constitution of the pepper fruit. Black pepper is obtained from a whole dry fruit. White pepper is obtained by removing the pericarp part with the epiderm and the external part of the mesocarp from the fruit; the white pepper grain is, thus, formed of the grain enveloped in the endocarp, the internal mesocarp and the group of fibro-vascular beams of the internal mesocarp.

a) Black pepper corresponds to the whole dry fruit where all anatomical elements are inserted (please see fig. 16).

When preparing black pepper, the clusters are picked when some grains start becoming yellowish or red. This is done before the due time but losses caused by birds if one waits for the ideal time do account for this fact.

The picked clusters are carried in baskets to sun exposed driers.

As they dry, berries will darken and the fruit pericarp will shrink. Should sun exposure bee too strong, three days will be sufficient for drying but sometimes one week will go by until good results are obtained. As soon as this is achieved, husks are removed by trampling and sieving takes place for choice of the fruits.

Then, the grains are again placed under the sun for full drying and for the moisture content to go down to 10 to 12%. Sizing is carried out as required for marketing purposes.

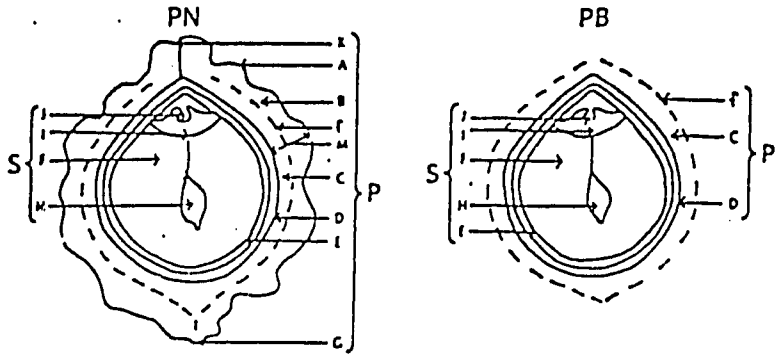


Fig. 16 - Anatomical composition of Black Pepper (PN) and White Pepper (PB) grains

P - Pericarp
- A - epicarp
- M - mesocarp
  - B - external mesocarp
  - C - internal mesocarp
  - f - libero-ligneous beam
- D - endocarp
- G - pseudo-peduncle
- K - microphyl

S - Grain
- E - seminal teguments
- F - perisperm
- H - more or less developed seminal cavity
- I - albumen itself
- J - embryo with two cutiledones

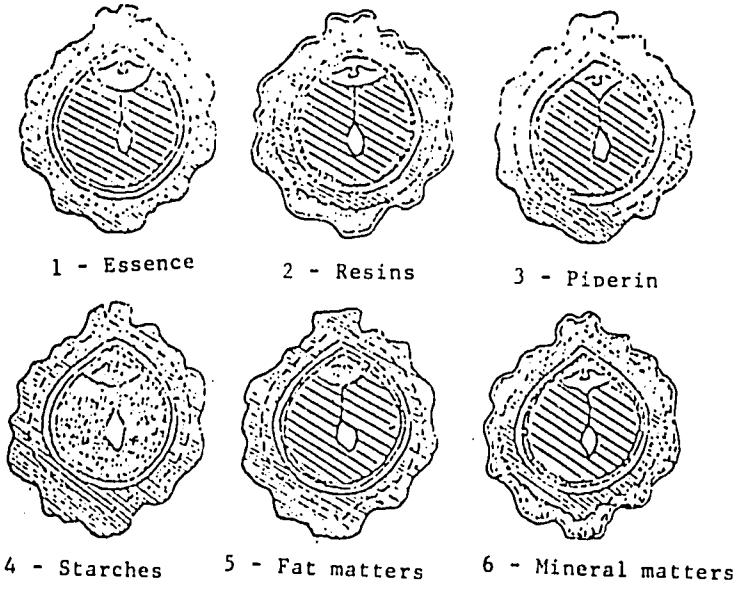


Fig. 17 - Location of the main chemical components of pepper in the different fruit tissues. (Line intensity pro rata with content).

When green pepper is processed into commercial pepper, the quantity is reduced down by about one third. 100 kg of fresh pepper in clusters correspond to 35 kg of black commercial dry pepper.

The preparation procedure varies from country to country. Sometimes, the clusters are dipped into boiling water for some ten minutes before they are placed under the sun; this will make the grain get darker more quickly and will activate drying.

Some other times, grains are peeled when they are still fresh. This is the case in India.

Artificial drying is seldomly used. Several mechanical means may be used for peeling before drying.

b) White Pepper

b) a. - Current white pepper: when preparing white pepper, treatment (maceration - grinding) will remove the parts outside the vascular network, i.e., the epicarp and the external part of the mesocarp. The vascular beams under treatment will then form striped light spools which can easily be seen on the surface of the white pepper. The main difficulty in preparing white pepper lies in the definition of the moment when treatment should be stopped so as not to destroy the vascular beams and the internal mesocarp which is very rich from a scent point of view and has a darker colour. When this condition is not found, pepper will be too dark and will have a low quality.

Operations used in the preparation of white pepper vary from country to country. In the Island of Bangka, which supplies Muntok pepper, the following is done: harvest takes place when the shrub is under the most mature condition. Clusters are placed in bags which are tightly closed and dipped into lakes or into tanks with slow flowing water so that a product with a nice colour will be obtained. As soon as the pulp, formed of the external part of the mesocarp, is sufficiently soft and easily removable (this takes about 7 to 10 days), bags are removed from the water, emptied and the pepper is washed with current or renewed water and the petioles and the grain pulp as well as waste are eliminated because of the difference in gravity. After these operations, white

pepper is placed under the sun in thin layers, in dryers or in clean spaces and drying is activated as well as made uniform because of stiring. Drying will take 2 or 3 days depending on the sun intensity. Pepper, which is grey at the time of washing, will gradually become cream white if it is well dried. The moisture content should be between 11 and 15% and the commercial yield will be 21 to 26% when compared to the pre-maceration weight. The diameter of the finished product will depend on the type of variety used. Therefore, in the Lampong variety, 100 cc of white pepper will contain 1289 grains but in the variety Bangka there will only be 943. Borgman says that the main reasons are the following: harvesting before maturation, producing insufficiently developed grains; insufficient fertilization; too much maturity producing a dark brown pepper; too much time between harvest and washing also causing a dark colour; insufficiently renewed washing water, producing a greyish product; insufficient washing leaving pericarp pieces attached to the grain; and, finally, Dasynus Piperi attacks.

In India, where almost all the production consists of black pepper, a different method is used to obtain white pepper. Black pepper is macerated in water for 2 or 3 days and it is then rubbed between 2 coconut fiber carpets so as to remove the external parts of the pericarp.

A more common method is used in Cambodia where white pepper is also prepared from black pepper. Black pepper is calibrated in a winnowing machine so that the larger and riper berries will be retained. Jute bags are then used; they are filled up to 3/4 of their capacity and dipped into fresh water for a period of 10 to 15 days. The external part of the pericap of black pepper will then wrinkle, swell, go into putrefaction and separate easily from the grain through grinding and rinsing in a lot of water. White pepper is then dried under the sun, sieved and placed in bags. The weight loss is around 30%. This means that 100 kg of black pepper will yield about 70 kg of white pepper, i.e., 285 kg of pepper in clusters.

The way to check if a pepper is well dried consists in biting it. Drying is considered to be convenient when the grain, under teeth pressure, breaks into several small bits. Should it be crushed or divided into two, it is not well dried.

A certain quantity of white pepper is obtained in some countries by using

special machines which will peel the black pepper; these peppers are very white and have no black spots and are used by mayonnaise manufacturers.

The following rules should apply if a good white pepper is to be obtained:

- Wait for full but not excessive ripening;
- Take very little time between harvesting and maceration;
- Renewal of the maceration water;
- Considerable washing for removal of all waste.

b) b. - Red Pepper: This is a very special quality of white pepper and it is prepared in the Far East.

This product is not marketed but it is prepared only for consumption of the pepper grower himself or for special gifts. It is formed of very ripe grains, which are therefore red and this is why it bears this name. These grains are picked one by one in the clusters at the harvest time, they are immediately hulled under water for removal of the external part of the pericarp and put to dry. White pepper obtained in this way is of the very first class.

b) c. - Birds' Pepper: It is a very special white pepper, similar in quality to red pepper but prepared differently since this is not carried out by man but by birds and this is the reason why this is the name it was given. The birds pick on the red mature clusters. The fruit is hulled as it goes through the digestive tract of the animal, digesting the external part of the pericarp and rejecting the grain of white pepper through feaces. These grains are picked close to the base of the pepper shrubs or trees around the plantations, they are washed and dried and they form the "birds' pepper" which is supposed to have aphrodisiac properties.

The name birds' pepper is often used to distinguish very high quality pepper which has nothing to do with birds at all with the exception of the name.

This is for example the case of white pepper obtained in Gabon where nebulosity is comparatively strong in the dry season and protects the berries from the

sun beams, makes maturation complete gradually after harvest and enables some very experienced pepper growers to obtain a very high quality white pepper.

c) - Green Pepper: "Green Pepper" is also consumed in addition to the black and white pepper. This is a special preparation used for certain fatty meat or fish as the pepper aroma will be well impregnated. The most famous dish is pepper duck, which has a reputation for its very fine and wanted taste. Green pepper is harvested one to two months before its maturity so that it will not be very strong. After peeling, green pepper is washed and mixed in a filling which is placed into the meat or the fish before cooking; if harvested under the right conditions, pepper grains, as said, are not very strong and they are consumed at the same time as the filling. For example, 100 to 125 grs of green pepper are required to prepare a pepper duck.

Obviously, green pepper is usually consumed in the producing countries at very specific times during the year: generally at the end of the year in the North Hemisphere and in May/June in the South Hemisphere so as to extend the period when it is used. The product is maintained and the procedure to do so is to keep it in alcohol vinegar after peeling and rinsing. Green pepper may be kept for quite a while under sealed conditions.

M - Composition

The quality of both black and white pepper is assessed in accordance with several factors: the aspect, the aroma, the taste, the weight of 100 grains and density.

1 - Black Pepper: Black pepper is under the form of almost spherical grains with a diameter between 3 and 6 mm (generally 4 to 6 mm) and a more or less rugged surface. Colour varies from dark brown to black or dark grey.

The smell is typical, penetrating, aromatic and its taste is hot, piquant and burning.

The weight of 100 berries depends not only on the size of the grains but also on their density; this only gives an indication of the characteristics of the different commercial species since results vary in different samples of

one same variety and even in some hundreds of berries in the same sample. The figures below were taken from a study made by Redgrove on different black pepper varieties:

Variety	Weight of 100 grains
Mangalore	6.4 g
Ceylon	5.7 g
Tellichery	4.8 g
Lampong	3.0 g

Density or, to be more precise, mass/litre, is a very important piece of information since some pepper varieties, such as "Tellichery", "Malabar" and "Lampong", have consistent grains, whereas others, such as the low qualities of "Singapore" and "Acheen", are often hollow. This fault is clearly shown by the density figure but not necessarily by the weight of 100 grains. The table hereafter is quoted by Winton:

Variety	Weight of 100 grains (g)	Mass per litre (g)
Mangalore	8.6	574
Malabar	5.7	570
Lampong	3.6	511
Singapore	4.9	476
Acheen A	3.4	432
Acheen B	3.3	407
Acheen C	3.1	330

Minimum densities are set in national regulations. This density is 450 for "Gabon" and "Madagascar" and 480 for "Cambodia".

The number of berries/kg ratio in good quality and standard sized pepper shrubs is 18,300 berries.

Obviously the health condition of the product is extremely important and it should normally be free of insects, mould and mice hair, etc.

The quantity of foreign matters should be minimal and should not exceed 1.5% in mass in the whole black pepper. Foreign matters include dust, cluster fragments, pedicels, bits of leaves and other impurities.

Light grains are formed of aborted grains and there is a special quality (pin heads grade). The aborted percentage in normal lots of any grade of whole pepper should not be higher than 4%.

2 - White Pepper: White pepper is under the form of round, almost spherical grains, with a diameter of 4 to 5 mm. They have a smooth, slightly flat surface at one point and a small protuberance in the opposite side. Very light furrows come out of this protuberance. The smell is penetrating and aromatic and the taste is hot, piquant and burning.

There are 19,000 to 31,000 grains per kilo depending on the origin and grade.

The mass/litre of white peppers is higher than that of black peppers, on the one hand because the former has ripe grains and on the other because the pericarp was removed. The minimum density required in France for the Cambodia variety is 680 g, for Madagascar 650 and for Gabon 620.

N - Chemical Composition

The chemical composition of pepper varies in accordance with the type, quality, origin, etc. Konig quotes the following percentages:

TABLE VI

Chemical Composition of White and Black Peppers

	Black Pepper		White Pepper	
	Maximum	Minimum	Maximum	Minimum
Moisture	15.60	9.56	16.50	9.90
Total proteic matters	12.66	10.80	12.40	9.80
Essential oil	2	1	2	1
Starches and carbohydrates	50.0	32.1	69.0	54.3
Cellulose	15.5	11.9	7.8	4.2
Ashes	5.9	3.4	3.0	0.8
Dry alcoholic extract	13.3	6.5	11.9	8.5

The content of total ashes varies from 3 to 6.5% for black pepper and 0.8 to 3% for white pepper. Percentages above 8 and 4% respectively mean that there is a surplus of sand. The centesimal composition of mineral matter in the two pepper qualities is shown in Table VII.

TABLE VII

Mineral Composition of White and Black Peppers

	Black pepper	White pepper	White pepper as a percentage of black pepper
Silica (SiO_2)	5.55	7.72	133
Alumina (Al_2O_3)	1.21	1.90	157
Iron (Fe_2O_3)	1.00	0.98	98
Manganese (MnO)	0.26	0.32	123
Phosphoric Acid (P_2O_5)	11.25	20.85	186
Sulphates (SO_3)	8.62	4.15	43
Chlorides (Cl)	8.30	6.62	80
Carbonates (CO_2)	9.70	13.90	143
Lime (CaO)	16.10	18.15	113
Potassium (K_2O)	29.85	17.12	57
Magnesium (MgO)	7.62	8.12	105
Soda (Na_2O)	0.46	0.15	33

White pepper ashes usually have less iron, sulphur, chlor, potassium and soda than black pepper ashes. On the other hand, they are richer in magnesium, limestone, carbonic acid, magnesium and silica, aluminium and, especially, phosphoric acid. The dominant element in black pepper is potassium and in white pepper it is phosphoric acid.

The main non-nitrogenized component of pepper is starch accounting for 34.15% in black pepper and 56.47% in white pepper.

The alcohol content varies from 6.4 to 16.6 in black pepper and 5.6 to 12.6 in white pepper; the colour is olive green for black pepper and golden yellow for white pepper.

The alcohol extract varies from 5 to 10% in black pepper and 2.5 to 8% in white pepper. It is yellow or greenish yellow and becomes red when treated with concentrated sulphuric acid.

In addition to the compounds which are commonly found in the majority of fruits and grains, pepper also has three specific substances: an alcaloid (piperin), an essential oil and a resin (please see Fig. 17). Pepper provides them with the taste and aromatic properties as shown in Table VIII.

TABLE VIII

Comparison of the Chemical Composition of Black and White Pepper

	Black pepper	White pepper	White pepper as a percentage of black pepper
Ashes	4.51	1.62	36
Nitrogen	1.61	1.56	97
Cellulose	16.49	6.35	39
Sugarable matters	42.45	62.30	146
Fat matters	8.10	9.21	116
Alcoholic extract	14.66	11.04	75
Piperin	9.20	8.59	94
Essence	1.56	1.86	119
Resin	1.59	1.15	78

IV HISTORICAL CONSIDERATIONS ON THE INTRODUCTION OF PIPER NIGRUM IN S. TOMÉ E PRÍNCIPE

The first pepper plant and other spices were introduced in S. Tomé in about 1575 but pepper was forbidden in 1593. Nevertheless, the plants survived due to the ecological conditions found on the Island and they are still there.

The pepper shrub Piper Guinnensis is a spontaneous liana of the obo of São Tomé e Príncipe. The fruit is small and has no commercial value. The stalk is used extensively in typical dishes in ST.

The "bush pepper" as it is also known is used in typical food, such as calulu, jogó, cangado and soô, also under the name of "pepper stick" since, in actual

fact, only the stalk is used for cooking purposes, after being dry, washed and cut into 5 to 10 cm pieces.

When the economic cycles or cropping experience of S. Tomé e Príncipe are discussed, no reference is made to pepper, even when spices are mentioned.

References are made to the sugar cane, coffee and cocoa cycles and to rubrocythus, the plague leading S. Tomé e Príncipe to an economic standstill until technical development and the oleaceae started to balance economy. This brings us to the sixties from the point of view of crop diversification.

The colonial authorities at the time decided to provide incentives to agricultural entrepreneurs and engineers by setting up and facilitating credit conditions and by emphasizing the need to have "crop diversification".

The introduction of marketable banana trees was a useless attempt made by the Agricultural and Forestry Station and by the Água-Izé Estate.

Pineaples were tested under the initiative of Eng. Salustino da Graça do Espírito Santo and later on by the Director of the Agricultural and Forestry Station, Eng. T.M. Morbey Junior. Some results were satisfatory for the S. Caine Lisse variety but no concrete steps were taken for extensive use and exports.

Maracock was also tested and it was found to be easily adaptable at different heights.

Santa Margarida (SAC - Sociedade de Agricultura de S. Tomé e Príncipe, SARL/Sociedade Comercial Francisco Mantero, SARL) and Água-Izé made the first flower trials, with Boamaria Magnifica, Ipomea Sp. and Anarius. The latter was only tested at Santa Margarida. The results were convincing but market research was not satisfactory. However, no one gave up and other crops were tried out.

In 1965, Mr. Jaime Borges (Eng.) brought the first pepper stakes into the island of S. Tomé, as a result of what had been found with the "pepper sticks" (Piper Guinnensis). Unfortunately, this first attempt to introduce Piper Nigrum failed.

In 1967, Santa Margarida (SAC/F. Mantero, SARL) took this matter very seriously and brought, through its engineer Mr. Jaime Borges, three Piper Nigrum stakes, Singapore variety, from Brazil.

The Company Água-Izé also received some stakes which were multiplied and planted in the garden of its registered office, at Nova Olinda and Bombay, under association.

Priority at Santa Margarida (SAC/F. Mantero, SARL) was given to multiplication, for two reasons: one consisted in that it was shown that Piper Guinnensis survived all crises in 400 years and the other was of an economic nature in view of the operational costs and international prices.

The first small propagation field was thus set up in land around the registered office.

The plant selection and propagation work was slow because there was a shortage of mother peduncles and there was hardly sufficient material in 1970 to start operations in the trial fields.

However, there was a factor in 1971 which would be decisive for Santa Margarida and for the Engineer (Jaime Borges) and would bring benefits to the production of pepper: the cocoa prices underwent a crisis in 1971 and then the copra prices also fell and reached the lowest figures ever obtained in the last fifteen years.

The official authorities also became interested and Dispatch no. 4/72 was issued on January 4 1972. It is quite long and reference shall only be made under summarized form to the ... *setting up of the Diversification Studies Committee* under the direct supervision of Governor Cecílio Gonçalves and the formation of *the working party for the agriculture, industry and other similar areas.*

The conclusions regarding the agricultural area and products to be diversified were: banana, tropical fruits, palm and coconut oil, copra, coffee, forestry operations, spices (pepper and vanilla), flowers, rubber, tea, tobacco.

It seems that the Portuguese market alone will be able to absorb the whole quantity of pepper produced in S. Tomé in the short term but it may also compete in the international market.

Propagula brought from Brazil were then multiplied at the land adjacent to the registered office of Santa Margarida. Plants offered by SAC/F. Mantero, SARL were kept as samples at the Agricultural and Forestry Station. Trial plantations set up by private companies at the yard of Rio Lima (Santa Margarida) and Pinheira looked sound. These plantations were used not only for observation of plant behaviour and technical improvements but also for the propagation of propagula for the setting-up of plantations to be used for economic and commercial purposes.

According to the Diversification Studies Committee: *Zones suitable for the production of pepper in practical terms coincide with those for cocoa but they could be expanded into areas with a more humid climate where cocoa does not have such a good behaviour.*

Pepper will be a more profitable crop than cocoa and, therefore, in principle, some of the cocoa areas could be "sacrificed" for the production of pepper.

On the basis of estimates made in the late sixties and early seventies and considering the supply conditions for the Portuguese market at the time, imports were:

1969 - 124 tons
1970 - 115 tons
1971 - 162 tons

The main supplier was Macau with about 90% of the total imports.

Productions varying with cropping care and soil fertility may be estimated to be between 500 and 4,000 Kgs per hectare.

It was estimated that the first target should be a production of 150 tons and, since the average production per hectare would be 2,000 Kgs, the following figure would be achieved:

However, the following general comments were made by the authorities before the detailed analysis of each one of the mentioned crops:

- *Only a crop with a large expansion in the international market and produced on an industrial basis may undoubtedly counterbalance the "weight" of cocoa on the trade balance of S. Tomé e Principe. The same applies to banana and possibly rubber. With regard to the domestic market, meat and maize and, to a certain extent, vegetables will be of greater relevance. The latter may even be the object of exports to nearby countries.*

However, the representative of Santa Margarida (SAC/F. Mantero SARL) was so strong in his arguments for the introduction of pepper that the conclusions regarding spices were: *the Committee generally found that spices could play a very important role in the crop diversification in S. Tomé and would quite well meet the intentions of the dispatch setting up the Diversification Committee, i.e., that "the new crops to be tried will have to consist of those which will have a considerable trade value in view of their rarity and scarcity and which S. Tomé e Principe will be especially prepared to cultivate in small areas".*

All crops commonly known as spices may be cultivated in S. Tomé. Their economical production will depend, however, on the production technique and trade organization.

The possibilities of having different spices were discussed and it was found that pepper is the one providing the best projects; it should be noted that the Committee had already reached this conclusion before.

Several extensive references were made on this crop during the meetings and it was found that it has many advantages as it may planted in small plots by the housing areas and in large fields under ecologically favourable conditions.

Reference was also made to the hybrid variety "Paniur" which is claimed to be 4 times as productive as traditional ones and, therefore, should be introduced early before larger fields are used.

$$\frac{150,000}{2,000} = 75 \text{ hectares}$$

Considering areas for renewal and for rest, this figure could be rounded off to 100 hectares and this would correspond to about 0.4% of the area to be used for cocoa.

Should marketing be guaranteed and should there be no phytotechnical problem, the economic yield of pepper would be considerably higher than that of cocoa and the whole cropping intensification work and investment would be paid for. If one considers the absolutely acceptable quotation of 45 escudos per kilo at the time, a gross income of 90,000 escudos per hectare would be obtained for a production of 2,000 Kgs. This figure was quite incentivating even if it were considered to be academic.

Pepper shrub zones coincide in certain cases with those of cocoa but the truth is that their expansion should only be considered in marginal areas where cocoa is no longer produced because of its high production cost and because of the shortage of labour, i.e., in irrigated areas and in very humid zones which used to be occupied by other crops.

Empresa Santa Margarida (SAC/F.Mantero SARL) established its first trial field under these conditions in late 1971 at Rio Lima. Nevertheless, the mother plants developed in such a way that a second field was set up at Porto Real in the Island of Príncipe in 1972.

The two plantations were strictly controlled from a technical point of view and were to be used for the improvement of multiplication techniques for extensive plantations at Quinta das Flores and Vanguarda which were actually set up in 1973 and at Queluz in 1974.

While the propagation, studies and installation of the observation fields were being maintained with some discretion, the Agricultural Enquiry Mission, headed then by Mr. Vinício Pacheco Marques (Eng.) was technically assisted by Mr. Daniel dos Santos Nunes who was very closely linked to this crop due to his field work and as a consequence of two factors: the first one was of a professional and official nature as he was a representative of the Head of the Mission and secondly he was a very good friend of the owners and engineers of Empresa Sta. Margarida.

The results obtained at the trial field of Rio Lima were so interesting that the overall picture of exports from São Tomé e Príncipe was the following from October 1 to January 10 1974:

TABLE IX

Exports from October to January

PRODUCTS	Quantities (Kilos)	Amounts (Escudos)	Duties (Escudos)
1	2	3	4
TOTAL	11,984,267	280,984,109	1º,910,892$50
Cocoa	6,778,572	221,829,626	15,175,386$30
Copra	3,241,188	37,478,023	3,258,609$40
Coconut	1,491,000	14,123,300	1,213,017$70
Arabica Coffee	89,760	5,298,055	223,226$40
Cinnamon	4,730	54,966	2,337$00
Quina	15,089	377,225	7,075$20
Coconut oil	39,000	481,000	-
Pepper	1,200	60,960	-
Other	323,728	1,280,954	31,240$50

Please note that, for the very first time in fifty years, the exports picture of São Tomé e Príncipe underwent changes because another duly tested crop was possible: pepper.

The price list shown in Table X made the most "reticent" ones start moving and small companies became interested. Whereas the most important products were exported by medium and large companies at an average price of 23.44 and 11.56 escudos respectively, as shown in Table X, pepper from São Tomé was sold at 50.80 escudos although it was neither traditional nor advertised.

TABLE X

Price of Marketed Products

Products	Prices	% compared to pepper
Pepper	50$80	100
Cocoa	23$44	46.1
Copra	11$56	22.7
Coconut	9$47	18.6
Arabica Coffee	35$53	69.9
Cinnamon	11$62	22.9
Quina	25$00	49.2
Coconut Oil	12$33	24.3

When Santa Margarida (SAC/F.Mantero SARL) was installing the trial fields at different altitudes in São Tomé, i.e., the registered office at level 340, Rio Lima 100, Quinta das Flores 500, Vanguarda 400, Queluz 300 and at Porto Real in Príncipe at level 80, it was actually testing the adaptation capacity of pepper to the various types of climates and, indirectly, supplying data to Daniel Nunes who was responsible for the development program set up by the authorities.

The Rural Extension Service was set up in São Tomé e Príncipe in 1972 and Mr. Daniel dos Santos Nunes was invited to head it. He was made responsible for the setting up of the services, for the drafting of the working plan, for the methodology and for the action programs. The step to be taken consisted in finding the "problem" felt by small farmers and the motivation which would underlie the change. The priority incentive for the "change Plan" was pepper but the "Trial Fields of Santa Margarida" would have to become "Findings Fields". This question was put forward to the authorities who then authorized official contacts with Sta. Margarida (SAC/F. Mantero SARL), through Mr. Jaime Borges (Eng.) for things to get moving: observation of the most adequate cropping techniques, nursery management, technology, commercial classification, supply of some plants, etc.

The only requirement for the contacts and tacit acceptance was that Mr. Duarte Nunes should carry out the branch collection as, with the exception of Mr. Jaime Borges (Eng.), he was the only one duly qualified to do so and, in addition to this condition, mother plants identified in the fields of Rio Lima should not be destroyed.

The Extension Service was now in a position to act successfully and it started the radio motivation programs which were under the responsibility and drafting of Daniel Nunes until late 1975.

Requests then started to come from small farmers who had a very low income from a bad cocoa, then sold at Esc. 10$00 per Kilo, and from a good copra at Esc. 3$00 per Kilo; they visitted the Rio Lima field on a tour guided by Mr. Daniel Nunes and started to listen to the mentioned radio program.

The shortage of vegetation material again led to requests made to Santa Margarida for supplies of propagation material. The Extension Service was allowed to collect whatever was available.

Two of the most advanced small farmers were chosen to carry out tests in land which was not adequately located. This was the final trial which the Extension Services would be responsible for since both the Agricultural Enquiry Mission and Mr. Vinício Pacheco Marques (Eng.) were strong supporters of Mr. Daniel Nunes's work.

Results of the trials carried out by the two small farmers, i.e., Mr. Trindade at Caixão Grande, and Mr. Mé Doze at Bateio, and those at a collective piece of land of the Favorita Coffee Estate, were very compensating as they reached 10 Kgs/peduncle.

In short, in addition to the introduction of Piper nigrum in São Tomé e Príncipe, the following factors were also the result of work carried out thanks to Empresa Santa Margarida (SAC/F.Mantero SARL):

- choice of stakes and propagation of propagula;
- definition of distances;
- choice of props (this decision took three years);
- plantation trials under the sun (intensive operations) and under the shade (extensive and in association with other crops);

- trials at several heights;
- fertilization systems;
- identification of plagues and diseases;
- irrigation system for plantations under the sun;
- harvesting, technological preparation and drying in the specific case of S. Tomé e Príncipe;
- marketing and exports.

V - SOCIAL AND ECONOMIC ASSESSMENT OF THE IMPLEMENTATION OF PEPPER GROWING IN THE DEMOCRATIC REPUBLIC OF SÃO TOMÉ E PRÍNCIPE

A - Crop Diversification

The economy of the Democratic Republic of São Tomé e Príncipe is based on the primary sector and cocoa is her main source of income since it has an arable area of app. 45,000 ha and no known mineral resources.

Cocoa was introduced into the Island of Príncipe in 1822 and the country was at one time in the last century the main producer in the world.

Then and up until 1918/19, her Economy was totally based on one single crop. However, at the time of the great fellings, in 1919/20, there was an attack of Selecothripus rubrocinthus which caused a complete disaster in plantations and, subsequently, in the total Economy.

Farmers had no technical resources, had their land on very irregular heights and under climate conditions for rich products only as attested by the historical past and decided then to have crop diversification by planting coconut, Cocos nucifera L, olive oil palm tree, Elaeis Guineensis Jac., cola, Cola acuminata (B) et End., cinnamon, Cinnamomum zeilanicum Garc, coffee, Coffea liberia Bull and forest essences of a commercial value, such as the mulberry tree, Chlorophora excelsa Benth, white wood, Discoglypremna, caisson wood, Pycnanthus angolensis W, Ciderella, Ciderella odorata, as well as food and marketable timber trees, such as jack, Autocarpus heterophyllus Lam., izaquent, Treculia africana Decne, bread fruit, Artocarpus communis J R and E F, etc., and farms ceased to be used for one single crop and started being used for associated crops with all the disadvantages this may lead to.

The shortage and rise in costs of labour in 1960 led to a reduction in the cultivated areas. Hilly, small production zones and those where production costs were high were hardly used and crops continued to be cultivated in association with others, with one or two exceptions.

Farms, however, are taken in a new perspective as from 1964. Both engineers and economists started to rationalize the areas in accordance with the edaphoclimatic cropping requirements but did not leave aside mixed production and subsistence crops.

Cocoa hybrids appeared in 1967 and farms started to produce single crops such as coconuts, palm trees and cocoa plants; the latter were, in transition zones with good soils, still associated with coconut trees.

The introduction of Piper nigrum into the country and the first trials on this crop started also on that date so that a real profitable cropping diversification could be obtained.

Trials and studies were made for eight years and, in 1974/75, it was concluded that pepper would be the most feasible alternative although there are others which have not yet been subject to all necessary trials but show a lower profitability.

One of the aims of this study is to provide some knowledge and experience on this essential diversification at the Democratic Republic of São Tomé e Príncipe.

B - Small Farming

Small farming is found in areas with the best soils of S. Tomé and consists of 14,607 units, covering a total area of approximately 4,857.0 ha, run under an association system by 10,872 farmers.

It is always rather dangerous to claim that income in a small farm is ridiculous. Generally, this statement derives from the analysis of the overall production of products marketed for export purposes.

By looking at the food system and the necessary support for this same system, a somewhat disorganized reason will be found for the type of small farms and it will be concluded that the income from cocoa was but a small additional revenue.

Cropping disorganization and the low overall income are real facts.

Technically, the abundant quantity of marly wood, Mammea africana Sabine, is unacceptable and can only be used for fencing purposes. Other species, such as gophe, Cecropia peltata Linn, cola-congo, Buchozia coriacea Eg., phede wood, Celtis durandii Eng., false guegue, Polysias quintasii Exell, guegue, Spondias mombim Linn, muandim, Pentachletra macrophylla Bent., caisson wood, Pycnanthus angolensis W.W., bunga, Stercullia Sp., cabole, Anisophyllea cabole H., large cata, Voacanga africana Staph, etc., have very little commercial value.

Nutrient demand is highly reduced in view of the quantity of light available and considering the present mix of medicinal plants, fruit trees, forest species and cocoa.

There is a considerable need to rationalize small plantations with the double-fold aim of not destroying traditional food crops and the cultivation of cocoa but also of having more profitable farms from an economic and commercial point of view.

We will be showing later on in this report that the implementation of pepper growing by small farmers will considerably increase the profitability of the "glebes" with remarkable economic and social advantages, without spoiling the present agricultural structure although some of the present species should also be selected.

C - Greater Profitability of the Present State Agricultural Enterprises

This will be discussed later in this report and we will be showing that these companies will become more profitable if they will also be used for pepper growing.

VI - LOCATION

In accordance with the terms of reference given by the Institute for Economic Cooperation (I.C.E.) of Portugal for the purposes of this contract, three zones are mentioned for the implementation of pepper growing in the Democratic Republic of São Tomé e Príncipe.

The classification and setting of boundaries for the areas available within the zones mentioned by I.C.E. do not enable us to consider only one crop, with the exception of Pinheira, provided the total area of 360 ha will be considered.

The requirements of pepper growing were generally discussed under the first part of this report.

Let us now consider the actual conditions of the Democratic Republic of São Tomé e Príncipe.

Contrary to what could be assumed, the deviation from the weather equator did not provide São Tomé e Príncipe with a tropical type of climate. The profound influence of the hot water from the Gulf (27°C) involving the islands in a saturated steam atmosphere and the soft wind constantly loaded with steam and blowing from the SE and SW during the larger part of the year provide the country with an equatorial characteristic, with the due alterations resulting from topography and giving the Democratic Republic of São Tomé e Príncipe ideal conditions for pepper growing.

The vegetation and relief conditions of the islands do not allow for a single climate. Geologists have studied data obtained through observations carried out at dozens of Weather Stations in the island of São Tomé from 1958 and have divided it into three altimetric thermal regions, i.e.:

- the Megathermal Region, between 0 and 300 m altitudes, with an annual temperature range varying between 25 and 23°C;
- the Mesothermal Region between 300 and 600 m, 600 and 900 m and 900 and 1,500 m altitudes, with annual mean temperatures of 23 to 21°C, 21 to 18°C and 18 to 13°C respectively;

- the Microthermal region above 1,500 m, with an annual temperature equal to or less than 13.5°C.

On the other hand, the above mentioned regions include five types of rainfall climates, i.e.:

- super-humid;
- humid;
- sub-humid;
semi-arid;
- arid.

There is also a series of subtypes for micro-climatic regions which are abundant in S. Tomé.

Tables XI and XII were prepared to give details on the weter requirements for pepper growing.

Table XI shows that there is a short and dry "gravana" (cool wind blowing from the south and southeast) for two months in the North, Northeast and Upper Northeast zones, with the exception of Lagoa Amélia.

Rainfall is quite evenly distributed and, therefore, pepper may be grown in almost all zones with the exception of the Center Northeast one which has a low rainfall, a high temperature and a long "gravana" for 3 to 4 months.

Tables XI and XII show that pepper may be grown in the areas around "Cidade", around the Center Northeast, by carrying out irrigation either by gravity or by pumping water from the rivers.

The Guadalupe zone was not considered since it will require manuring, soil covering, heavy fertilization and irrigation.

The mentioned tables also show that the optimum temperature has a good monthly and annual average and a thermal range of approximately 8°.

TABLE XI

S. TOME E PRINCIPE

FEASIBILITY STUDY ON PEPPER CROPS

CLIMATE DATA - RAINFALL AND AVERAGE TEMPERATURE

LOCATION OF STATIONS	JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C
North: Rio do Ouro	113.8	24.3	106.3	25.7	152.5	25.9	189.5	25.7	175.5	25.3
Neves	82.5	25.8	112.8	26.2	145.4	26.4	209.6	26.4	139.3	26.0
Pontafigo	96.6	25.4	115.2	25.8	181.1	26.0	239.8	25.9	168.1	25.5
Center North:										
Boa Nova	123.5	23.8	183.9	24.3	182.2	24.4	228.0	24.4	222.2	24.0
Northeast:										
Town	81.5	25.7	81.3	26.0	127.3	26.2	141.7	26.2	132.9	25.8
High Northeast:										
Monte Café	195.1	22.4	187.9	23.0	231.9	23.1	324.7	23.2	248.3	22.8
Trindade	149.8	25.3	129.7	25.9	169.9	26.0	225.3	26.0	176.5	25.6
Lagoa Amélia	221.1	18.4	223.6	18.8	273.7	18.9	328.3	18.8	318.5	18.1
West:										
Sta. Catarina	257.4	25.7	215.0	26.0	276.2	26.2	328.9	26.2	348.7	25.8
Jul. de Sousa	470.2	25.8	343.2	26.3	396.1	26.4	397.8	26.4	502.8	25.9
South:										
Porto Alegre	496.7	26.4	268.9	26.0	287.9	27.1	312.7	27.1	307.6	26.6
Center Southeast:										
Cruzeiro	260.6	24.1	213.9	24.6	232.8	25.0	246.4	25.1	344.3	29.9
Angolares	336.9	25.9	187.4	26.4	247.0	26.6	270.3	26.5	351.3	26.0
D. Augusta	394.3	26.0	184.2	26.6	218.0	26.6	264.9	26.6	324.8	25.9
East:										
Água-Izé	141.1	25.9	129.0	26.2	163.1	26.4	219.3	26.4	226.3	26.0

TABLE XI (CONT.)
S.TOME E PRINCIPE

FEASIBILITY STUDY ON PEPPER CROPS

CLIMATE DATA - RAINFALL AND AVERAGE TEMPERATURE

LOCATION OF STATIONS	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C	Rain-fall	Temp. °C
North:														
Rio do Ouro	1.6	24.0	0.1	23.2	1.7	23.7	35.0	24.1	135.7	24.3	112.3	24.5	81.0	24.9
Neves	1.8	24.6	0.2	24.0	0.1	24.4	22.0	24.9	120.1	25.2	124.7	25.2	99.4	23.6
Pontafigo	2.6	24.1	0.1	23.1	0.3	24.1	38.5	24.5	142.2	24.4	136.0	24.5	98.0	24.9
Center North:														
Boa Nova	3.8	22.7	0.1	29.9	5.4	22.3	68.2	22.7	207.3	23.2	183.5	23.4	133.9	23.6
Northeast:														
Town	3.6	24.5	0.1	23.8	1.1	24.1	14.2	24.9	99.8	25.2	110.6	25.5	97.6	25.4
High Northeast:														
Monte Café	9.1	21.4	18.0	20.2	15.7	20.4	131.3	21.2	314.4	21.3	296.6	21.8	160.0	22.2
Trindade	5.4	24.2	0.8	23.3	6.2	23.5	64.3	24.0	178.3	24.5	203.8	24.8	136.1	24.3
Lagoa Amélia	20.7	17.4	16.6	43.2	16.4	16.4	271.5	17.1	443.6	17.8	394.6	17.7	203.0	18.0
West:														
Sta. Catarina	38.3	24.4	7.6	23.7	47.1	23.9	245.8	23.9	582.7	24.3	525.3	24.7	240.2	24.9
Jul. de Sousa	78.3	24.5	42.7	23.4	189.1	23.3	607.2	23.7	968.9	24.3	118.6	24.8	643.5	23.3
South:														
Porto Alegre	18.2	24.9	8.3	23.9	27.6	24.0	151.2	24.6	328.8	25.0	618.2	25.7	506.6	26.0
Center Southeast:														
Cruzeiro	64.0	21.4	91.3	20.4	195.4	20.8	396.2	21.6	562.4	22.4	461.0	23.1	341.8	23.6
Southeast:														
Angolares	32.6	24.0	98.1	22.9	207.5	23.1	350.1	24.0	491.5	24.6	579.6	25.4	385.6	25.7
Dona Augusta	33.9	23.9	40.7	22.6	177.6	22.6	311.3	23.5	526.5	24.2	684.7	24.9	527.6	25.6
East:														
Agua Izé	16.2	24.2	7.4	23.4	57.7	23.6	114.3	24.3	200.5	24.8	216.0	25.3	184.4	25.5

A comparison of Tables I and II with Tables XI and XII shows that the conditions at São Tomé are so good as the best ones in India or Madagascar if we consider that there is generally no need to use drainage works to fight surplus water caused by excessive rain or irrigation due to an uneven distribution of rain.

Winds at São Tomé are soft, with the exception of "tornados", they last a very short period and are not an impediment on pepper growing. Nevertheless, it leads to two specific requirements: curtains in areas under sea breezes and orientation of lines at the time of picktings.

Location of Enterprises

Blu-Blu: it has an area of 55 ha and is included in the Bela Vista State Enterprise; it is situated in the megathermal sub-humid climate sub-zone, it has a rainfall of 1,000 to 1,500 mm and irrigation is required.

Pinheira:it has about 360 ha, 30% of which in the megathermal sub-humid sub-zone and 70% in the megathermal semi-arid sub-zone; it has a rainfall between 1,500 and 1,000, requires irrigation and wind curtains.

In our opinion, pepper growing should take place in mono-crop farms in the areas of D. Augusta, Ribeira Peixe and in the South/Southwest side, where there are good soils and irrigation can be abolished completely.

We also believe that the crop could be grown in the West zones, as a complementary diversification crop. This would, for example be done at S. Manuel in Santa Catarina.

TABLE XII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

ANNUAL AVERAGE RELATIVE HUMIDITY - RAINFALL - TEMPERATURE

	HUMIDITY %		RAINFALL mm.	TEMPERATURE °C
	Day	Night		
North: Rio de Ouro	78/79	91	1105.6	24.7
Neves	77/77	94	1057.0	25.4
Pontafigo	80/80	91	1218.5	24.9
Center North:				
Boa Nova	80/83	95	1502.0	23.4
Northeast:				
Town	71/75	95	891.6	25.3
Center Northeast:				
Monte Costa	82/87	88	2116.8	21.8
Trindade	78/82	88	1446.1	24.8
Lagoa Amélia	91/91	93	2759.2	17.8
West:				
Sta. Catarina	83/82	90	3113.2	25.0
Juliana de Sousa	85/84	90	5758.6	25.0
South:				
Porto Alegre	85/84	90	3332.5	25.7
Center Southeast:				
Cruzeiro	90/89	94	3422.1	23.0
Angolares	83/82	93	3497.9	25.1
Dona Augusta	86/85	90	3688.5	24.9
East: Água-Izé	83/81	89	1685.6	25.2

Soils

Generally speaking and as described before, pepper shrubs prefer deep, argilico-silicous or silico-argilous, permeable, fresh soils with a watertable layer above two meters and accepting a high acidity. This means that the soil in S. Tomé is not a restraint for pepper growing, with the exception of those which have bad drainage or those at an altitude of more than 800 meters. In these cases, trial fields should be set in sites above the said level.

Blu-Blu: soils here are Paraferralitic (with aphanitic rocks). They are developed soils, of the A B C profile, with a low percentage of slime and a high clay content, a low cationic exchange in the mineral fraction when compared to the clay content. The S_iO_2/R_2O_3 and SO_2/AL_2O_3 ratios are lower than 2. The slime/clay ratio is sometimes higher than 0.25.

Soils are divided into red, yellow or brown soils depending on the colour of the sub-soil. Should the organic matter content be higher than 7.5%, they are classified as humic soils.

The clay content normally increases pro rata with depth. The content of surface horizons in organic matter is considerable. They are well drained, permeable soils which are easily penetrated by roots.

The cationic exchange capacity is low when compared to the clay content. Ca values are low and Mg undefined as it sometimes is low and some other times it is high. K is low and is sometimes dominated by Na. Fertilization is required for these soils to have a good yield.

Pinheira: the land at Pinheira is essentially formed by tropical phersealitic soils (formed of aphanitical eruptive rocks), with tropical red phersealitic spots and very low predominance of non calcareous black clay. Tropical phersealitic soils are evolved soils with an A B C profile. The S_iO_2/R_2O_3 is 2 and the S_iO_3/Al_2O_3 is slightly over 2. The cationic exchange capacity is generally higher than the one for paraferralitic soils.

They may be red, yellow or brown depending on the colour of the sub-soil. They are classified as humiferous if the organic matter content is higher than 7.5%.

The quantity of organic matter in the upper horizons is quite considerable, generally between 4 and 5%.

The cationic exchange capacity is high, generally above 20 mc/100 g. Ca is the dominating cation. Mg contents are median or high. The exchange K is normal and, sometimes, Na exceeds K. pH is neutral. These soils are richer than the paraferralitic ones.

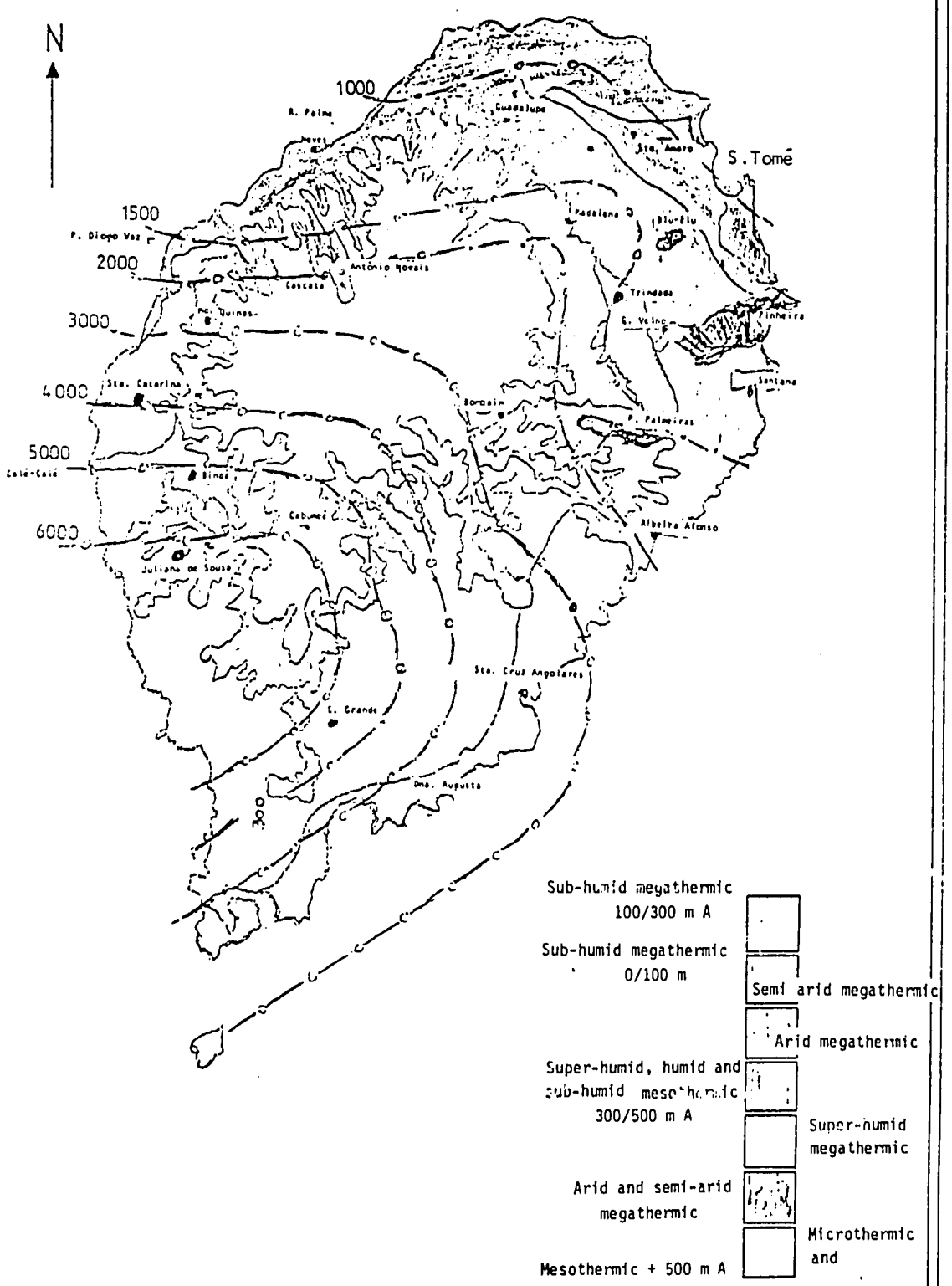
Black clays are evolving soils of the A B C profile, strongly argillous, black or very dark grey. They have special physical characteristics, an extremely firm consistency, a high plasticity and open cracks in the dry period. There is a high cationic exchange capacity. Internal and external drainage is very bad. They may be calcareous and non-calcareous.

These are rich soils but have bad physical properties.

Family Agriculture: it includes the soils described above, specially the phersealytic ones and some clays.

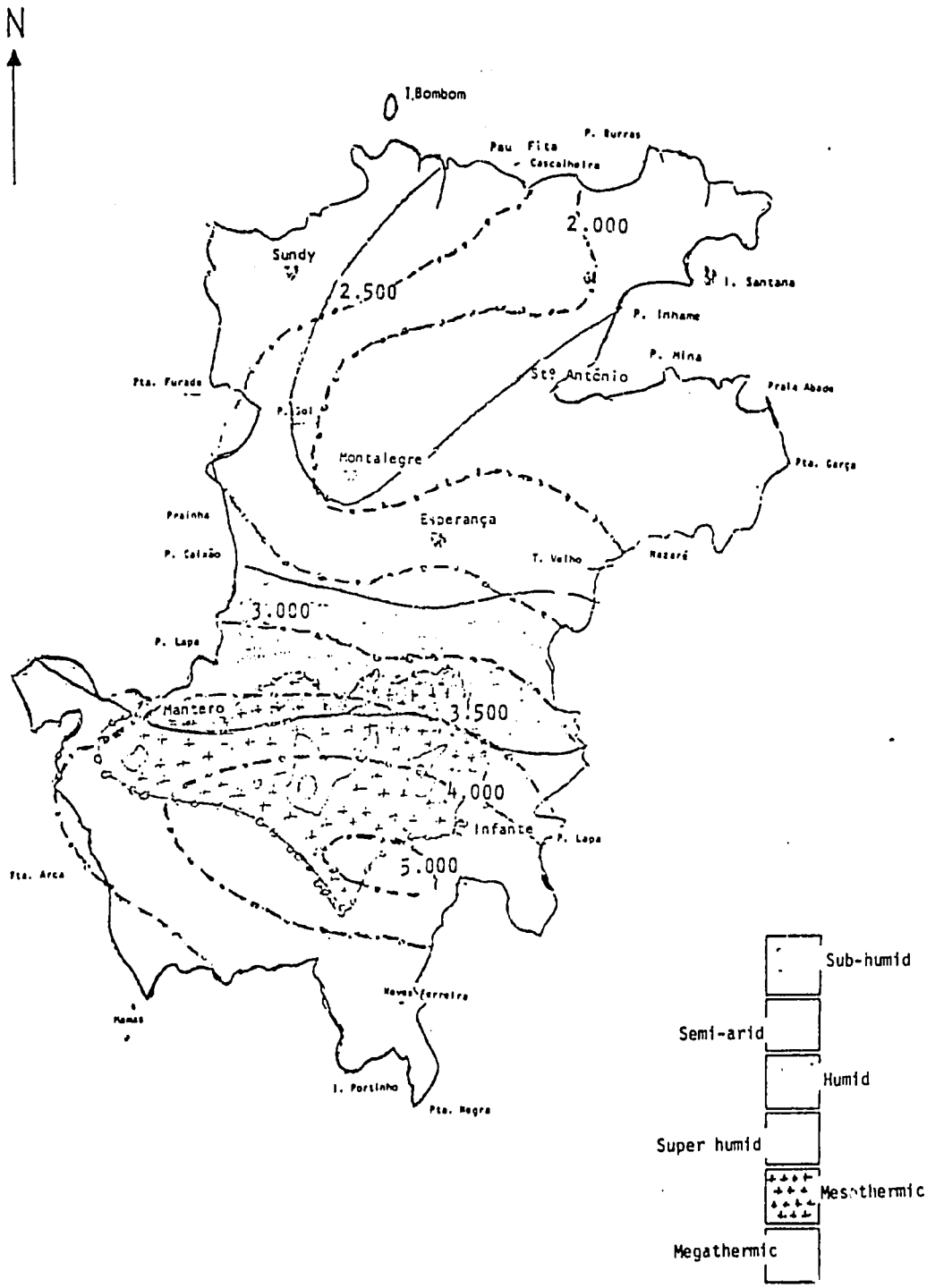
S. TOMÉ

ISOHYETS, CLIMATIC SUB-ZONES AND FARM BOUNDARIES



ISLAND OF PRÍNCIPE

ISOHYETS, CLIMATIC SUB-ZONES AND FARM BOUNDARIES



VII - LEGAL FRAMEWORK

The legal framework for the running and management of pepper plantations in the Democratic Republic of São Tomé e Príncipe should obviously fall within the scope of the first line legislation of this country.

The legislation consists in the Political Constitution of the Democratic Republic of São Tomé e Príncipe, the other Laws of the Republic as well as the principles of the M.L.S.T.P. and the Portuguese Legislation in force on the date of National Independence (July 12 1975) as expressly laid down in article 71 of the Political Constitution.

Assuming that foreign entities or companies will also be involved in the operations and management of pepper plantations, the legislation of São Tomé on this matter will apply.

In accordance with paragraph 2 of article 5 of the Political Constitution, land and natural resources belong to the State and the latter shall set the conditions for their development and use.

Paragraph 5 of this same article enables foreign capital to operate in the Democratic Republic of São Tomé e Príncipe after due authorization has been obtained in such a way as to harmonize those operations with the economic policy of the State.

Nevertheless, both the Portuguese Law applicable in the Democratic Republic of São Tomé e Príncipe in accordance with article 71 of the Political Constitution of that country and Comparative Law provide for different ways for the exercise of rights "in res aliena".

Since the entity promoting the management of the land will be an entity with foreign participation, special attention should be paid to legislation concerning foreign investments, i.e., Decree-Law no. 30/80 of August 5.

This Law provides for three forms of foreign investment:

A) Mixed Companies
B) Participated Association
C) Private Companies.

We believe the first form is the best one since the State may be directly associated to the implementation of the project and will not only be involved in what is of interest for the country's development but will also be able to control the activities.

The Law provides for mixed companies to be formed either as joint stock or as limited liability companies.

It is our view that a limited liability company should be chosen in view of its organizational and operational simplicity thus providing a greater efficiency in the implementation of the project.

Although the State participation should in principle correspond at least to 51% of the share capital, the Law stipulates that the Cabinet of Ministers may decide that such participation be less than 50% if this is really of interest to the development of the country.

In accordance with the mentioned Decree-Law no. 30/80, foreign investments in the Democratic Republic of São Tomé e Príncipe are subject to prior authorization by the Cabinet of Ministers upon which there will be a contract drawn between the São Tomé side and the foreign entity.

The foreign investment contract should fully define the involvement of all the interested parties, i.e., the Government of the Democratic Republic of São Tomé e Príncipe, the São Tomé company, the foreign company and the limited liability company to be formed.

Nevertheless, we know that the Government of the Democratic Republic of São Tomé e Príncipe has generally preferred to have a "participated association" whereby management contracts are signed with foreign companies.

Therefore, the nature, composition and operational conditions as well as the rights and duties of those forming the association shall have to be laid down in a contract after agreement is reached between the parties.

VIII - TYPE OF MANAGEMENT

Three types may be considered:

A - Small farms (family or traditional type)
B - Pepper plantations in areas included in the current State Agricultural and Cattle Breeding Companies (E.E.A.)
C - Setting-up of Companies for the exclusive purpose of the pepper plantations.

With regard to small farms, we believe that the Ministry of Agriculture and Cattle Breeding should organize a cooperative system after duly motivating farmers for pepper growing and after identification and choice of the most appropriate zones.

The organization of the cooperative system could be integrated into the structures of the Ministry which would coordinate the whole procedure for the assistance to be provided in the supply of rooted propagula, training and follow-up, by experts with qualifications for the purpose and plantation management, especially with regard to the fertilization and phytosanitation questions.

On the other hand, a product preparation and standardization center should be set up so as to take into account the commercial side and, thus, maximize exports. The facilities at Roça Favorita could be used for this purpose.

Alternatively, each small farmer could operate his plantation in accordance with its size and use the following technology:

- should there be water shortage, he will only produce black pepper;

- should there be water, he may produce 1/3 of white pepper and 2/3 of black pepper.

In these cases, drying would be done under sun exposure.

The areas included in the present E.E.A. and which in our view have the best capability for the purpose of setting up pepper plantations are:

- Blu-Blu at the Bela Vista E.E.A.;

- Pinheira at the Uba Budo E.E.A.;
- Ponta das Palmeiras at the Água-Izé E.E.A.;
- Assentada de S. Manuel at the Santa Catarina E.E.A.;
- Esperança at the Porto Real E.E.A.;
- Oeste at the Porto Real E.E.A.
- part of Terreiro Velho at the Sundy E.E.A..

With regard to companies which would exclusively be formed for the purposes of pepper plantations, we reccommend the following areas:

- D. Augusta;
- Ribeira Peixe;
- Juliana de Sousa;
- Assentada de Jou;
- Assentada de Monte Rosa

as well as the whole south of the Island of São Tomé where rainfall exceeds 2,500 m.

With regard to the economic survey on the three alternatives, please see our comments under the chapter concerning the Conclusions for small farms, for Blu-Blu integrated within the Bela Vista E.E.A., which is an example of B., and on the intensive and single crop plantations as described for Pinheira which is an example of alternative C.

Should it be decided that pepper plantations should be set up within the present E.E.A. with a potential for the purpose and should companies be formed for the sole purpose of pepper production, it is our clear view that the first type should be chosen for the following reasons:

1 - Investment and operational costs are lower since the cocoa drying equipment may be used for pepper drying.

2 - Additionally, pepper is harvested in January/February and July/August/September, i.e., the periods when there is no cocoa harvest and, therefore, the facilities of the E.E.A. are more available.

3 - For this same reason, pepper harvesting in January/February and during the "gravana" period would provide the E.E.A. with revenue at a particular time when such revenue is lower.

With regard to administrative organization, we will just say that the setting-up of a company solely for the purpose of pepper plantations would be the best since small farms have a kind of family organization and the areas included in the E.E.A. could use the latter's organizational structures.

The management of that type of companies would follow along the lines we propose in the organization chart included later on in this report.

The Plantation Manager would be responsible for the management of the company. He would be assisted by an agricultural expert who would be appointed General Bailiff and who should have training in crops in general and pepper in particular, thus being duly qualified for the work he will be required to do in the sector.

The Manager would be assisted by three sections: the Production Section, the Administration Section and the Service Section.

These sections would have their activities sub-divided in accordance with the contents of the above mentioned organizational chart.

1 - Production Section

Divisions: each division would have a bailiff. There will be 5 with an area of 72 ha each.

Phytosanitation: A special team would be formed for this purpose and for each division; the teams would follow the instructions of the Agricultural Expert and would be under the supervision of the bailiff in each division.

Technological sector: Products would be prepared, picked and sent to the industrial unit formed for the purpose.

2 - Administration Section

This section is divided into four sub-sections, i.e.:

Offices: Aiming at dealing with office matters, orders, exports of goods, imports of supplies and assistance to accounts.

Accounts: this sub-section would be under the responsibility of an accountant. Accountancy whould be easy since there is only one crop and all costs, including amortizations are borne by the production of pepper. We propose a costs and sales account and a balance sheet as shown in Tables LXXIV and LXXV.

Staff: They would be under the supervision of a clerk who would be assisted by the General Bailiff and would follow the instructions given by the Plantation Manager.

Technology: under the responsibility of the yard clerk who will supervise over the whole technological procedure planned for every stage.

Warehouses: these would be under the responsibility of the warehouse clerk who would control all goods and supplies coming in and going out in such a way that the accounts sub-section would always have available data on the stocks and Administration would be able to take timely measures for export purposes and so that there would never be a shortage of insecticides, fungicides, fertilizers, spares, etc. This clerk would also be responsible for the canteens.

3 - Service Section

It would be formed as follows:

Mechanical workshops: which would carry out repair, tuning and maintenance works on the whole material such as vehicles, atomizers, power supply, etc..

Building works: this would include the maintenance of buildings and their repair when required. This sub-section would also carry out the repair of irrigation ditches and all other items linked to building works.

Transport: This would be under the responsibility of the Yard Clerk who would coordinate transport in such a way as not to bave any useless losses and would avoid, if and when possible, one-way carriage and unprofitable travel.

Company's Registered Office: the whole urban part would be in the registered office. This would include staff members, workers, offices, technology, workshops, maceration tanks, etc.

The registered office should, if possible, be situated in a central part where there would be plenty of water supply (this is a very important point). Please remember that the major production period is during the "gravana".

In the case of Pinheira, for example, it could be located in the yard itself.

IX - MARKETING

The major trade centers for pepper are New York, London, Amsterdam/Rotterdam, Hamburg and Singapore. Trade is generally carried out by merchants operating in the above mentioned markets and who buy pepper from the producing countries, from each other on a spot or off-afloat basis or through contracts for deliveries on longer terms ("futures").

It is not uncommon for a pepper lot to be traded several times before reaching the final buyer.

However, the market structure has been undergoing significant changes in the last few years. There has been a rise in the number of direct contracts between exporters in the producing countries and importers in the consumer countries and the majority of final consumers of pepper have even established their own purchase contracts with the supply sources.

Pepper from Indonesia has, since 1974, been traded through two companies approved by the Government: black pepper by the Central Trading Company in New York and white pepper through UNIPRO in Amsterdam.

Another tendency is for merchants in importing countries to carry out their role in the market in closer contact with the final consumers rather than through a purely speculative action.

The classifications given to the best types of pepper are usually based on Specifications of the American Spice Trade Association, usually known as the ASTA Standards. For example, the Indian type AGMARK MG 1 (Malabar Garbled) corresponds to ASTA Standard pepper (i.e., less than 1% of small berries, 0.5% of impurities and 11% moisture). However, the types of pepper with a lower grade have no international standards and they are usually traded through samples.

Differences, no matter how small, in the preferences of final consumers have a great importance in the buyers' decisions. Although the flavour of white pepper from Brazil is not identical to the one from Sarawak or Muntok, many importers prefer it because it looks clean and has a uniform size.

Some spice consumers usually prefer black Lampong and Malabar pepper whereas, for example, Italian Salami makers are known for their strong preference for Bold Tellichery (black pepper from India).

In recent years, weak harvesting in the majority of the producing countries led to a rise in the price of white and black pepper in 1983. Brazil, Malaysia and Indonesia had lower yields and the estimated production for November/October 1983/1984 was even smaller than in the previous year. Therefore, consumption in 1983 exceeded production thus causing a rise in prices subsequent to a low supply when compared to demand.

The world production of pepper cannot be easily estimated since producers often prefer to have stocks rather than sell all their products in the currency of origin since these currencies are usually subject to unstable rates in view of the high inflation rate in many pepper producing countries.

On the other hand, producing countries who are members of the International Pepper Community have been making efforts towards the setting of a concerted exports policy aiming at stabilizing prices and at guaranteeing acceptable price levels to producers.

At the 11th Session of the IPC, held at Kuala Lampur, Malaysia, late in July 1983, agreement was reached for a minimum single price for black pepper notwithstanding its grade. The agreed price was 65 c/ lb CIF New York for pepper from Brazil, Malaysia and Indonesia and 72 c/ lb for Indian pepper; these prices came into force on August 8. The minimum price of 65 c/ lb went, however, up to 70 c/ lb on November 1 1983.

As usual in these cases, IPC was not successful in trying to force sales at the minimum set price.

World exports in 1982 were slightly lower than those in 1981.

Exports in 1983 are also estimated to be slightly lower than those for 1982 since lower quantities were loaded in Brazil, Malaysia and Indonesia although they were somewhat compensated by a rise in exports from India. Exports for 1984 have been estimated to be even lower because harvesting was lower in the main producing countries.

Pepper prices are set in accordance with significant variations in production in the producing countries. Speculation also influences the prices. However, this phenomenon has a smaller and smaller influence because of market restructuring.

The spot price for Brazilian black pepper in New York started at an average of 53 ¢ per lb (0.453549 grs) in 1983 but the average at the end of the year was 99 ¢ per pound.

High prices were maintained in January 1984 but they then decreased slightly. Stocks accumulated in producing countries helped to balance supply and demand in 1983 but this was done at the cost of the stocks.

Prices became stable again in 1985 and reached quite high figures. White pepper at present costs US$ 5,000 CIF and black pepper US$ 4,200 CIF; this means that the figure doubled in one year.

Considering that producers in some countries are retaining stocks in their warehouses for reasons which have already been given and that, on the other hand, consumer countries have reduced their stocks to face demand, we may say that generally when consumers do not hold large stocks there will be a firm market situation. However, high prices may lead to the installation of new plantations and this may contradict the present situation. Accordingly, we believe that the present price levels will be reduced by 20% in the next 15 years.

As said before, we ourselves have marketed white and black pepper from S. Tomé in the past. The product had an excellent quality and was successful in international markets, mainly in the Federal Republic of Germany.

The next few pages include statistical data on world exports and imports of pepper. (Source: FAO).

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
WORLD	165800	153866	166008	264523	220643	242301	173382	167248	162902	240560	209633	215260
AFRICA	12031	12491	13391	19941	16005	19711	1919	1898	507	3410	2571	663
ALGIERS	2791	2350	2712	5139	3900F	3837						
CAMEROON	3	3F		11	12		13	17	18F	10	19	20F
CAPE VERDE	7			19								
CENTRAL AFRICAN REPUBLIC	4			7								
CONGO	3			13								
DJIBOUTI	15			36								
EGYPT	3029	2929	3300	5049	2758	6000	72	63	60F	81	41	45F
ETHIOPIA	1			9								

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
GABON	7	6	7F	30	24	35F						
IVORY COAST	18	22	35	69	74	125	198	7		454	1	
MADAGASCAR							1440	1796	429	2135	2496	598
MAURITANIA	47	45	35F	83	63	50F	24	2		56	5	
MOROCCO	2700	3500	3500F	3420	4000F	4200F						
SENEGAL	595	272	380F	917	984	1100F	3	11		1	6	
SEYCHELLES	27	28	30F	60	63	65F						
SERRA LEO	13F	12F	12F	63F	70F	80F						
SOUTH AFRICA	1031	1168	980	1775	1838	1619						
SUDAN	735	250	400	1707	480F							

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
TUNISIA	981	1900	2000F	1483	1728	1800F	169			673		
ZAMBIA	3			13								
ZIMBABWE	21	6		38	11			2			3	
C.N.AMERICA	37238	35931	37190	51872	44067	44257	4543	4486	4903	9106	8945	9634
BARBADOS	48	50F	55F	140	145F	160						
BELIZE	39	22	50F	67	34	90F						
CANADA	2624	2882	2959	4658	4550	4688						
COSTA RICA	98	100F	109F	258	260F	283F	120	40	40	201	60F	65F
DOMINICAN REPUBLIC	148	161	176F	82	87	95F						
EL SALVADOR	103	140F	151F	190	280F	302F	38	50F	52F	133	180F	187F

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
GREENLAND	2	2	3	8	6	20						
GUADALUPE	6	13	30	39	65	150						
GUATEMALA	104	85F	90F	235	170F	200F	282	200F	200F	684	400F	450F
HAITI	262	320	350F	523	580F	660F						
HONDURAS	69	46	55F	155	102	130F						
JAMAICA	256	260F	260F	547	520F	720F	6	90	200	13	180F	400F
MARTINIQUE	10	13	35	37	56	140						
MEXICO	1883	800	500F	2609	1000F	650F	2574	2600F	2800F	3886	3900F	4300F
NICARAGUA	23	34	50F	77	82	103F						
PANAMA	128	115	90	572	490	390F						

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
N.ST.CHRIS.	2			9								
SÃO VICENTE	7	9		20	25							
TRINIDAD-TOBAG.	136	110	120F	323	252	280F	38	52	50F	92	139	140F
U.S.A.	31290	30769	32107	41323	35363	35196	1485	1454	1561	4097	4086	4092
SOUTH AMERICA	5671	3735	3412	9774	6577	5901	46927	46445	30814	58736	50805	35361
ARGENTINA	2265	2188	1749	4534	4112	3072						
BOLIVIA	194	1		120	5							
BRAZIL	51	35	37F	140	107	112F	46889	46178	30588	58653	50446	35013
CHILE	230	300	310	420F	600	620F						
COLOMBIA	1409	346	500F	2033	511	750F		241	200F		295	280F

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
ECUADOR	141	18	220	40								
FRENCH GUYANA	29	16	16F	44	58	54F	24	9	9F	49	26	28
GUYANA	64	65F	70F	127	130F	140F	14	15F	17F	33	35F	40F
PERU	537	293	200F	888	288	270F		2		1	3	
URUGUAY	108	105	80	208	148	123						
VENEZUELA	643	368	450F	1040	578	750F						
ASIA	48531	39354	40970	71849	53089	63357	116928	111650	122058	161154	140559	158906
BAHRAIN	214	210F	210F	404	330F	336F	7			6		
BANGLADESH	187	169	200	287	214	260F						
BRUNEI	7	16		16	40		9			9	1	

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
CHINA	3680F	1378F	627F	6670F	3203F	1900F		7F	7F		38F	35F
HONG-KONG	3400	1131	2105	6035	1644	3246	2772	1256	1433	4820	1755	2271
INDIA	400	320	520	750F	550F	880F	18636	20539	27980	28000F	29000F	37500
INDONESIA	12	4		30	24		34076	36327	45061	47151	44873	51998
IRAN	1294	67		1717	23		1			2		
IRAQ	200	100	200F	280F	135F	300F						
ISRAEL	892	787	1000F	1452	1228	1600F	11			21		
JAPAN	5186	4658	5144	8687	7108	8067						
NORTH KOREA	1070	1100	1200F	1600	1500F	1700F						
REPUBLIC OF KOREA	954	1238	1374	2064	2435	2656	73	124	20	254	264	83

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
KUWAIT	437	300	300	647	360F	330F	37			90		
LEBANON	150	150F	153F	330F	330F	336F						
MACAU	571	321	300	856	519	500F	408	361	341	875	765	662
MALAYSIA	179	229	220F	262	283	240F	28899	25304	23481	35688	28631	33711
OMAN	323	417	635	494	585	828	2		1	1		1
PHILIPINES	594	607	600	584	602	650F	84	109		154	195	
SAUDI ARABIA	3931	5401	5200	6040	7657	7500	175	136	175F	278	199	278F
SINGAPORE	21915	18819	18406	28307	21537	28421	29447	25972	21665	40764	32800	29627
SRI LANKA		10			45		2223	1301	1294	2921	1731	1890
SYRIA	630	168	300	893	258	480	2	4		3	9	

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
THAILAND		1		1	5		45	210	600	81	303	850
TURKEY	1023	603	876	1548	924	1127						
U.A.EMIRATES	397	300	800	782	550F	1400F	21			36		
YEMEN	885	850	600	1153	1000F	660F						
EUROPE	47019	47793	56538	85544	79749	90627	3063	2756	4620	8138	6677	10696
AUSTRIA	965	1018	1056	1720	1679	1645	7	9	10	18	25	25
BELGIUM-LUX.	1972	1913	2016	4066	3564	3830	451	306	764	1132	748	1844
BULGARIA	1075	700	672	1900F	1200F	1200F						
CZECHOSLOVAKIA	910	800F	1800	1411	1400F	3067						
DENMARK	601	762	798	1183	1294	1400	22	37	68	53	77	166

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
FAROE ISL.	2	2		7	7							
FINLAND	271	243	200	592	480	376		1			4	
FRANCE	8670	8252	8699	14196	12245	12488	1116	1015	811	4323	2006	2086
G.D.R.	2400	2900F	3000F	4400F	5300F	5700F						
F.R.G.	11432	11576	12850	20506	18956	20252	479	337	830	1394	1166	2520
GREECE	664	816	717	1213	1295	1127			2			6
HUNGARY	1441	1192	2285	2279	1895	3336						
ICELAND	19	17	18	69	59	61						
IRELAND	244	320	253	624	711	576	87	109	103	317	301	212

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
ITALY	2548	2782	3122	4542	4402	4682	17	14	35	75	44	106
NETHERLANDS	1960	2106	3489	3945	3847	5414	438	587	1587	926	1176	2775
NORWAY	268	302	260	604	623	583						
POLAND	848	483	2556	1247	542	2820						
PORTUGAL	287	483	500F	777	1096	1150F	32			137		
ROUMANIA	600	700F	920	1100F	1200F	1600F						
SPAIN	1271	1391	1500F	2623	2199	2600F	12	2		21	6	
SWEDEN	719	800	814	1489	1472	1504	26	29	25	110	119	102
SWITZERLAND	1273	1352	1407	2731	2873	2762	11	16	12	26	53	27
ENGLAND	4590	5090	5706	7913	8021	8754	364	287	373	1566	909	823

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
YOGOSLAVIA	2089	1793	1900F	4407	3389	3700F	1	7		12	43	
OCEANIA	1184	1214	1243	2339	2230	2063	2	13		16	76	
AUSTRALIA	1009	1002	1016	1845	1744	1518						
FIJI	12	12	10	36	28	25						
FEDERAL REPUBLIC OF POLYNESIA	8	8	8F	54	53	62F						
NEW CALEDONIA	21	28	29F	105	92	98F						
NEW ZEALAND	132	163	180F	289	307	360F	2	13		16	76	
PACIFIC ISLANDS					2							
SAMOA	2	1		1	4							

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
SOVIET UNION	14126	13348	13264	23204	18926	16385						
DEV.PED M E (1)	82009	82447	88691	133236	120350	125892	4561	4223	6181	12272	10839	14788
NORTH AMERICA	33914	33651	35066	45981	39913	39884	1485	1454	1561	4097	4086	4092
WESTERN EUROPE	39845	41018	45305	73207	68212	72904	3063	2756	4620	8138	6677	10696
OCEANIA	1141	1165	1196	2134	2051	1878	2	13		16	76	
OTH DEV.PED (1)	7109	6613	7124	11914	10174	11226	11			21		
DEV.PING M E (1)	57741	48818	50993	87476	65127	78701	168821	163018	156714	228288	198761	200437
AFRICA	7236	8144	8711	11410	10929	11292	1847	1835	447	3329	2530	618
LATIN AMERICA	8993	6013	5533	15657	10725	10254	49985	49477	34156	63745	55664	40903
WEST	13248	11745	12974	21004	15390	20097	317	203	236	497	249	324

(1) This table is based on data from FAO and these items were not translated

DESCRIPTION	IMPORTS						EXPORTS					
	QUANTITY MT			VALUE 1,000 $			QUANTITY MT			VALUE 1,000 $		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
EAST	28219	22865	23725	39192	27898	36853	116672	112503	121875	160717	140318	158592
OTH. DV. PING (1)	45	51	50	213	185	205						
CENTR PLANNC (1)	26050	22601	26324	43811	35166	37708		7	7		33	35
ASIAN CPE (1)	4750	2478	1827	8270	4703	3600		7	7		33	35
EAST EUROPE + SOVIET UNION	21300	20123	24497	35541	30463	34108						
DEV.PED ALL (1)	103309	102570	113188	168777	150813	160000	4561	4223	6181	12272	10839	14788
DEV.PING AL (1)	62491	51296	52820	95746	69830	82301	168821	163025	156721	228288	198794	200472

(1) This table is based on data from FAO and these items were not translated

X - COSTS OF THE INSTALLATION OF PIPER NIGRUM PLANTATIONS IN THE DEMOCRATIC REPUBLIC OF SÃO TOMÉ E PRÍNCIPE

1 - General Comments

Costs vary according to the type of plantation and to the zone where it is installed. There are several factors to take into account. First of all, we have three different types of farms:

A - Family or traditional agriculture (small agriculture);

B - A farm within a state agricultural and cattle breeding company (for example Blu-Blu);

C - Farm within a company specially formed for the purpose (as for example Pinheira).

We then have to consider the zone in the island where it will be installed, i.e.:

- Arid or semi-arid land;
- Land with a high rainfall rate.

The former need irrigation which is in itself very expensive. The latter do not. We also have to consider the land topography:

- Whether or not it is flat;
- Whether or not it consists of not very steep hills;
- Whether or not it consists of steep hills.

In the first case, drainage ditches will have to be open on each side of a row of pepper shrubs.

In the second case there will be no need for that.

In the third case, the land will have to be terraced at the level kerb.

In all cases, the dominant winds have to be taken into account so as to place the plantations in a most adequate position which, in principle will be facing the North and the East. Therefore, they will be more protected from the dominant South winds during the "gravana" period. In certain areas, there may have to be a wind breaker since the pepper shrub will not develop adequately if exposed to wind. As will be seen, when assessing costs, adjustments will have to be made in accordance with each specific case specially with regard to installation, maintenance and operational costs.

However, these studies were only made for the cases of family farming in the 55 ha of Blu-Blu and in the 360 ha of Pinheira which are the ones considered by the ICE and because thees will be the plantations which will have higher costs because they need irrigation. The future pepper grower will then be in a position to make an easy assessment of the costs in his special case.

2 - Vegetation

We made a list of the plants existing in S. Tomé, as follows:

List of Pepper Shrubs in S. Tomé e Príncipe

Sta. Margarida	1,300	plants
Rio Lima	2,900	"
Santy	256	"
Nova Olinda	150	"
Potó	190	"
Sta. Clara	50	"
Bombaim	40	"
Quinta das Flores	20	"
Caixão Grande (Trindade)	100	"
Clarisse	140	"
Pinheira (Casa da Guarda)	20	"
TOTAL	5,166	plants

Considering that each plant will, on average, supply 40 stakes with four knots, there is only vegetation for 129 ha. The first plantation will, therefore, have to be installed at Blu-Blu or at an equivalent area.

3 - Methodology

Costs were calculated on the basis of constant costs and prices since we cannot know what is going to happen to prices and costs in the next 15 years. However, we believe that if costs have the same kind of behaviour as the sale prices, there will not be too many deviations although we are aware of the fact that this is not always so.

We tried to make the economic survey on the base of Tables using sometimes hectares and some other times tons as the unit. This was done so that the data may be used for different sizes of farms and, therefore, our study will become universal.

The exchange rates used were the following:

1 US.$ = Dbs. 45
Esc. 1$00 = Dbs. 4.3

A - FAMILY OR TRADITIONAL AGRICULTURE (SMALL AGRICULTURE)

1 - General Comments

1.1 - This type of agriculture is characterized by having marlaceous wood fences, the yard is close to the road, there are several crops and the products are used in accordance with the needs. The estate is divided in the length direction. The "glebes" represented a natural charateristic unknown from the technical point of view up until 1963.

Family or traditional agriculture is based on 10,872 very small and small estates and represent 5.38% of the Island of São Tomé; it covers the best pieces of land both with regard to the location of what is known as the "rich zone" and from an agricultural point of view.

Due to the lack of a description of the characteristics, the Agricultural Enquiry Mission carried out a survey in 1963/66, within the scope of the first World Agricultural Census. The studies on the economic and social characteristics were not completed.

Production was irrelevant as will be seen on Table XIII which also shows the distribution according to parish areas.

In spite of the very low unit income resulting from market crops, as shown in Table XIV, small farms do not develop up until 1970, year when a radio programme on agricultural information was started.

The situation in 1971 became promising as a result of the new structure of large companies and of the radio motivation programs carried out by the Agricultural and Forestry Station and the improvement is shown on Table XV.

The acceptance and motivation resulting from the data included in Table XV showed that small farms could indeed be developed. The rural extension services were set up and a year later (1973), production of permanent crops was in a situation as described in Table XIV.

Tables XIII and XVI show that the rise in products during the years of 1964 to 1973 was: 59.4% for cocoa, 29.24% and 21.89% for copra and coconut respectively.

The rise in production resulting from the above activities was gradual and steady as shown in Table XVI1 which concerns the years of 1970/1975.

The annual growth was in average 12.8% for cocoa, 13.7% and 12.2% for copra and coconut but this latter product had a decrease by 16.69% in 1974. In 1975 only cocoa was used but there was a decrease by 33.9%. Statistics regarding family agriculture after that year are unknown.

1.2 - M.I.A.U. shows the traditional companies in accordance with their areas divided into 11 classes as shown in Table XIII.

The areas described in Table XVIII have not changed. If planning work is required, there will be a need to know how they are distributed in accordance with their inclusion in ecological zones and only then can planning go ahead.

The distribution in accordance with parish areas is included in Tables XIII and XVI.

TABLE XIII

TRADITIONAL AGRICULTURE

PRODUCTION

1964

PARISH AREAS	FARM AREAS ha	CROPS				
		Cocoa	Copra	Coffee	Palm Oil	Coconut
Conceição	583	7,088	7,013	323	36,428	46,086
Guadalupe	181	6,726	3,266	-	7,471	10,623
Madalena	434	79,169	1,825	67	14,554	22,792
Neves	54	1,407	2,147	98	3,328	4,491
Ribeira Afonso	116	5,224	2,630	-	3,880	5,756
Santana	418	22,591	17,250	86	22,219	31,148
Nsa. Sra. Fátima	1,285	22,680	46,965	414	93,895	117,036
Santo Amaro	725	23,252	15,932	62	36,629	47,275
Trindade	1,049	107,695	3,179	73	52,344	69,896
Sta. Cruz Angolares	12	-	948	-	-	-

TABLE XIV

GENERAL AVERAGE PRODUCTION PER PARISH AREAS

1964

PARISH AREAS	PRODUCTION				
	Cocoa kg/ha	Copra kg/ha	Coffee kg/ha	Palm Oil kg/ha	Coconut kg/ha
Conceição	12.2	12.0	0.6	62.5	79.0
Guadalupe	37.2	18.0	-	41.3	58.7
Madalena	182.4	4.2	0.2	33.6	52.5
Neves	26.1	39.8	1.8	61.6	83.2
Ribeira Afonso	45.0	22.7	-	33.4	49.6
Santana	54.0	41.3	0.2	53.2	74.5
Nossa Senhora Fátima	17.6	36.5	0.3	73.1	91.1
Santo Amaro	32.1	22.0	-	50.5	65.2
Trindade	102.7	3.0	-	49.9	66.6

TABLE XV

Cocoa	23.8%
Copra	11.3%
Coffee	24.0%
Palm Oil	31.3%
Coconut	55.0%

Another difficulty arising in planning is the lack of data on the characteristics of companies in accordance with their size. A classification of family agriculture from an economic point of view was made in 1976. We shall be using the classification as referred by Daniel dos Santos Nunes in his report "Subsídios para um Trabalho de Desenvolvimento Sócio-Económico em S. Tomé", S. Tomé 1975.

In view of our deep knowledge on the villages and parishes, we can quite well accept the regrouping of companies in four groups, according to the available areas but excluding housing and other useful surfaces as we did not consider the agricultural factor but did so with space.

GROUP 1 - Estates which cannot be reorganized and farmed in accordance with the traditional procedure, having an area of 0 to 0.490 ha, where there is a bad crop association and a lack of agricultural vocation.

GROUP 2 - Estates which can be organized and farmed: area between 0.5 and 1.99 ha, bad glebe structure, bad crop association and deficient preparation on the part of the farmer.

GROUP 3 - Farmable estates which can be easily organized and with an average income, with an area between 2.0 and 4.99 ha, bad crop association, bad training on the part of the farmer, and lack of a credit organization.

GROUP 4 - Profitable but decapitalized estates, deficient technique for cropping purposes. Area between 5 and 50 ha, justified association of crops, inadequate technical training and lack of an agricultural team.

Table XIX was prepared on the basis of the mentioned classification and includes production distributed in accordance with the mentioned groups.

1.3 - In view of a lack of updated data on traditional estates, the basis for analysis and calculation of income consists of data for 1964; these figures are considered to be probable and if we accept that the market has not got the necessary material or that has not developed in a normal way and plants

TABLE NO. XVI

PRODUCTION PER PARISH AREA

1973

PARISH AREAS	FARM AREAS ha	COCOA kg	COPRA kg	COFFEE kg	PALM OIL	COCONUT
Conceição	583	20.505	7.089	-	72.913	97.367
Guadalupe	181	12.468	2.137	2	9.075	11.877
Madalena	434	135.757	1.509	131	21.559	24.868
Neves	54	3.456	2.243	-	3.552	4.921
Ribeira Afonso	116	5.346	2.545	-	2.402	3.687
Santana	418	27.384	10.309	160	12.690	21.363
Na.Sa. de Fátima	1.285	22.420	74.038	438	89.791	124.165
Santo Amaro	725	65.629	24.759	679	56.591	79.271
Trindade	1.049	146.760	6.104	38	73.055	95.315
Angolares	12	-	-	-	-	-
Total	4.857	439.725	130.733	1.448	341.628	462.834

TABLE NO. XVII

S.TOME E PRINCIPE

FEASIBILITY STUDY ON PEPPER CROPS

PRODUCTION PER PARISH AREA IN 70/75

IN TONS

PARISH	AREA	COCOA						COPRA					COCONUT				
		1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Conceição	583	6.9	14.7	20.6	20.5	16.5	17.6	6.3	6.9	7.4	7.1	6.0	43.6	75.2	96.7	97.4	82.7
Guadalupe	181	6.8	9.9	11.4	12.5	10.1	9.7	2.9	2.4	2.3	2.1	1.8	10.1	10.1	11.6	11.9	10.1
Madalena	434	78.2	91.6	115.1	135.8	158.8	80.6	1.6	1.3	1.6	1.5	1.3	20.3	22.7	24.4	24.9	21.1
Neves	54	1.4	2.7	2.8	3.5	2.8	2.3	1.9	2.0	2.2	2.2	1.9	3.8	4.4	5.1	4.9	4.2
Rib.Afonso	116	4.0	4.1	4.3	5.3	4.3	3.6	2.5	2.2	2.3	2.5	2.1	4.2	3.8	3.4	3.7	2.0
Santana	418	22.7	21.2	22.7	27.4	21.9	18.3	16.3	11.1	10.9	10.3	8.8	29.7	20.6	19.9	21.4	11.6
N.S.Fátima	1.285	20.9	20.6	20.9	22.4	17.9	17.8	40.9	54.1	69.6	74.0	62.3	114.7	121.7	122.1	124.2	105.5
Stº Amaro	725	21.9	35.7	62.3	65.6	72.5	52.3	14.8	17.0	22.8	27.8	21.1	44.5	92.5	77.5	79.3	67.4
Trindade	1.049	106.9	133.3	140.0	146.8	167.4	110.0	3.0	2.5	2.5	6.1	5.2	63.8	88.9	94.4	95.3	81.1
Angolares	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	4.855	269.7	333.8	400.1	439.7	472.1	312.4	90.2	99.5	121.7	130.7	111.1	334.7	439.9	455.1	462.8	385.8

TABLE XVIII

S.TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

1975

FARM DIMENSION CLASS HA	F A R M S			
	Number	Area	Plots	
			Total Number	Average no. per farm
0 to 0.09	3,252	181.1407	3,510	1.08
0.1 to 0.19	2,680	385.1789	3,155	1.18
0.2 to 0.49	2,596	831.5320	3,618	1.39
0.5 to 0.99	1,250	873.0374	2,029	1.62
1 to 1.99	764	972.0690	1,465	1.92
2 to 2.99	159	378.0092	388	2.44
3 to 3.99	55	193.7850	167	3.04
4 to 4.99	28	122.9941	69	2.46
5 to 9.99	63	434.0935	215	3.41
10 to 19.99	15	210.2360	28	1.87
20 to 49.99	10	274.9440	39	3.90
TOTAL	10,872	4856.9698	14,683	

have not died, the present situation is at a stage which we already feared in view of a lack of motivation (1964).

The production mentioned in Table XIX has been given updated figures for:

	Prices/Ton			
Cocoa	US.$	1,735	Dbs.	78,075
Copra	"	140	"	6,300
Coconut	"	90	"	4,050
Black Pepper	"	3,054	"	137,430
White Pepper	"	3,662	"	164,790

These figures were used for drafting Table XX so as to be able to assess the average income of companies in accordance with the classification for each group. The gross income of US$ 563,670 would provide a false average per capita income of US$ 51.84 per company. If regrouping took place, the average annual revenue per group is, according to Table XX, US$ 16.2 for the first group, US$ 104.[illegible] for the second, US$ 334.63 for the third and US$ 1,527.7 for the fourth.

The analysis of the statistical division in accordance with areas and income, the physical structuring of companies and information on the environment make it possible for us to know the main factors affecting agricultural activities and propose three types of pepper farms in S. Tomé.

1.4 - We believe that family agriculture is of great interest and importance. It can have a double role: on the one hand, a social one enabling the family to have a higher income and, therefore, a higher standard of living; and the other is of a national nature to the extent that it will provide more foreign currency.

2 - Methodology

In order to assess the family agriculture accounts, we decided to study groups varying between 500 and 2,000 plants.

The difference in costs is quite considerable because, as will be seen in the respective Tables (Tables XXI to XXXV (a)) the whole work for group one

TABLE XIX
S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

PRODUCTION PER GROUPS OF FARMS (ACCORDING TO SIZE)

FARM DIMENSION CLASS Ha	Cocoa	Copra	Palm Oil	Coconut	Coffee	Banana
	kilos	kilos	kilos	kilos	kilos	kilos
0 to 0.40	70 814	31 524	91 288	119 911	253	1 038 979
0.5 to 1.99	89 280	32 529	101 368	130 083	331	802 273
2 to 4.99	43 042	11 694	40 297	51 953	152	326 545
5 to 4.99	72 696	25 408	38 083	53 156	387	348 467
T O T A L	275 832	101 155	271 036	355 103	1 123	2 516 264

TABLE XX

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

REVENUE FROM TRADITIONAL AGRICULTURE

FARMS		Area Ha		MARKETED PRODUCTS						REVENUE	
				COCOA		COPRA		COCONUT			
Group No.	Number	Total	Average	Ton.	Value US$ '000	Ton.	Value US$ '000	Ton.	Value US$ '000	Value US$ '000	Average US$
1	8,528	1,397.8	0.1628	70.81	122.9	31.52	4.41	119.91	10.79	138.10	16.20
2	2,014	1,845.1	0.9134	89.28	194.9	32.53	4.55	130.08	10.70	210.15	104.30
3	242	694.7	2.8581	43.04	74.7	11.69	1.64	51.95	4.64	80.98	334.63
4	88	919.3	10.4021	72.69	126.1	25.41	3.56	53.16	4.78	134.44	1,527.7
Total	10,872	4,856.9	-	275.82	518.6	-	14.16	-	30.91	-	-

TABLE XXI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

FAMILY AGRICULTURE

AREA FOR PEPPER CROPS

NO. OF PLANTS	AREA (m^2)	NO. OF FARMERS	TOTAL AREA (ha)
100	400	1,700	62
500	2,000	600	120
1,000	4,000	170	68
2,000	8,000	40	32
		TOTAL	288

TABLE XXII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF INSTALLING 500 PEPPER SHRUBS - (2,000 m^2)

FAMILY AGRICULTURE

YEAR 0

IN DBS.

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	51.5	120	6,180	-
Plants	500	4.1	2,050	37.5
Stakes	500	50	2,500	-
Fertilizers kg	500	18	9,000	100
Insecticides and Fungicides	-	-	65	100
Mechanical saw hr	2	80	160	70
Atomizer hr	4	5	20	
			19,975	
Contingencies 5%			999	
			20,974	

TABLE XXIII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF MAINTAINING 500 PLANTS BEFORE PRODUCTION STARTS (2,000 m^2)

FAMILY AGRICULTURE

YEARS 1 AND 2

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	9	120	1,080	-
Plants	25	4.1	102.5	37.5
Fertilizers kg	750	18	13,500	100
Insecticides and Fungicides	-	-	65	100
Atomizer hr	4	5	20	70
			14,767.5	
Contingencies 5%			738.	
			15,505.5	

TABLE XXIV

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF FARMING AND CROPPING 500 PEPPER BUSHES (2,000 m^2)

FAMILY AGRICULTURE

YEAR 3

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	20.5	120	2,460	-
Fertilizers kg	750	18	13,500	100
Insecticides and Fungicides	-	-	65	100
Atomizer hr	4	5	20	70
Plastic m^2	20	50	1,000	80
			17,045	
Contingencies 5%			852	
			17,897	

TABLE XXV

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF FARMING AND CROPPING 500 PEPPER BUSHES (2,000 m^2)

FAMILY AGRICULTURE

YEAR 4

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	22.5	120	2,700	100
Fertilizers kg	1,000	18	18,000	100
Insecticides and Fungicides	-	-	65	100
Atomizer hr	4	5	20	70
Plastic m^2	60	50	3,000	80
			23,785	
Contingencies 5%			1,189	
			24,974	

TABLE XXVI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF FARMING AND CROPPING 500 PEPPER BUSHES (2,000 m^2)

FAMILY AGRICULTURE

YEAR 5

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	27	120	3,240	100
Fertilizers kg	1,250	18	22,500	100
Insecticides and Fungicides	-	-	65	100
Atomizer hr	4	5	20	70
Plastic m^2	100	50	5,000	80
			30,825	
Contingencies 5%			1,541	
			32.366	

TABLE XXVII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

ANTICIPATED IN KG/HA/YEAR OF 500 PEPPER BUSHES

FAMILY AGRICULTURE

DESCRITION	YEAR 3	YEAR 4	YEAR 5
BLACK PEPPER	336	1,008	1,344

REVENUE IN DBS.

DESCRIPTION	YEAR 3	YEAR 4	YEAR 5
BLACK PEPPER	52,950	158,580.7	211,801

TABLE XXVIII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

FAMILY AGRICULTURE

CASH-FLOW - 500 PEPPER BUSHES

IN DBS.

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue				52,959	158,850.7	211,801.0
Operational and Investment Costs	20,974	15,505.5	15,505.5	17,897	24,974.0	32,366.0
Balance	-20,974	-15,505.5	-15,505.5	+35,053	+133,876.7	+179,435.0
Accumulated Balance	--	-36,479.5	-51,984.0	-16,931	+116,945.7	+296,380.7

TABLE XXIX

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

STUDY OF THE INSTALLATION OF 2,000 PEPPER BUSHES (8,000 m^2)

FAMILY AGRICULTURE

YEAR 0

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour	263	120	31,560	-
Plants	2,000	4.1	8,200	37.5
Stakes	2,000	50	100,000	-
Fertilizers kg	2,000	18	36,000	100
Insecticides and Fungicides	-	-	260	100
Atomizer hr	8	5	40	70
Mechanical saw	8	80	640	70
Tractor hr	10	350	3,500	70
			180,200	
Contingencies 5%			9,010	
			189,210	

TABLE XXX

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF MAINTAINING 2,000 PEPPER BUSHES BEFORE PRODUCTION STARTS (8,000 m^2)

FAMILY AGRICULTURE

YEAR 1 AND 2

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY $
Labour md	75	120	9,000	-
Plants	200	4.1	820	37.5
Fertilizers kg	3,000	18	54,000	100
Insecticides and Fungicides	-	-	380	100
Atomizer hr	8	5	40	70
			64,240	
Contingencies 5%			3,212	
			67,452	

TABLE XXXI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF FARMING AND CROPPING 2,000 PEPPER BUSHES (8,000 m^2)

FAMILY AGRICULTURE

YEAR 3

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	147.5	120	17,700	-
Fertilizers kg	3,000	18	54,000	100
Insecticides and Fungicides	-	-	380	100
Atomizer hr	3	5	15	70
Tractor hr	3	350	1,050	70
Plastic m^2	80	50	4,000	80
			77,145	
Contingencies 5%			3,857	
			81,002	

TABLE XXXII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF FARMING AND CROPPING 2,000 PEPPER BUSHES (8,000 m^2)

FAMILY AGRICULTURE

YEAR 4

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	312	120	37,440	-
Fertilizers kg	4,000	18	72,000	100
Insecticides and Fungicides	-	-	380	100
Atomizer hr	3	5	15	70
Tractor hr	8	350	2,800	70
Plastic m^2	240	50	12,000	80
			124,635	
Contingencies 5%			6,232	
			130,867	

TABLE XXXIII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF FARMING AND CROPPING 2,000 PEPPER BUSHES (8,000 m^2)

FAMILY AGRICULTURE

YEAR 5

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	367	120	44,040	-
Fertilizers kg	5,000	18	90,000	100
Insecticides and Fungicides	-	-	380	100
Atomizer hr	3	5	15	70
Tractor hr	12	350	4,200	70
Plastic m^2	350	50	17,500	80
			156,135	
Contingencies 5%			7,807	
			163,942	

TABLE XXXIV

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

ANTICIPATED YIELD IN KG/HA/YEAR OF 2,000 PEPPER BUSHES

FAMILY AGRICULTURE

DESCRIPTION	YEAR 3	YEAR 4	YEAR 5
BLACK PEPPER	1,316	4,032	5,376

REVENUE IN DBS

DESCRIPTION	YEAR 3	YEAR 4	YEAR 5
BLACK PEPPER	207,388	635,403	847,204

TABLE XXXV

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

FAMILY AGRICULTURE

CASH-FLOW - 2,000 PEPPER BUSHES

IN DBS

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue				207,388	635,403	847,204
Operational and investment costs	189,210	67,452	67,452	81,002	130,867	163,942
Balance	-189,210	- 67,452	- 67,452	+126,386	+504,536	+683,262
Accumulated balance	-	-256,662	-324,114	-197,728	+306,808	+990,070

TABLE XXXV (a)
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

FAMILY AGRICULTURE
CASH FLOW
TOTAL ACCUMULATED BALANCES FOR PLOTS OF 500 PLANTS IN 188 ha AND 100 ha WITH PLOTS OF 2,000 PLANTS

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8
ACCUMULATED BALANCE (500 pl.) in 188 ha	-	-34,290,730	-48,864,960	-15,915,140	109,928,958	278,597,858	557,195,716	835,793,574	1,114,391,432
ACCUMULATED BALANCE (2,000 pl.) in 100 ha	-	-32,082,750	-40,514,250	-24,716,000	38,351,000	123,758,750	247,517,500	371,276,250	495,035,000
TOTAL	-	-66,373,480	-89,379,210	-40,631,140	148,279,958	402,356,608	804,713,216	1,207,069,824	1,609,426,432

	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
ACCUMULATED BALANCE (500 pl.) in 188 ha	1,392,989,290	1,671,587,148	1,950,185,006	2,228,782,864	2,507,380,722	2,785,978,580	3,064,576,438
ACCUMULATED BALANCE (2,000 pl.) in 100 ha	618,793,750	742,552,500	866,311,250	990,070,000	1,113,828,750	1,237,587,500	1,361,346,250
TOTAL	2,011,783,040	2,414,139,648	2,816,496,256	3,218,852,864	3,621,209,472	4,023,566,080	4,425,922,688

which can go up to 1,000 plants, is manual and, in the second group, from 1,000 to 2,000 or more plants, machines will have to be used. In the first group and in areas where rainfall is higher than 1,500 mm, irrigation will probably not be required because the crop may be shaded by the surrounding trees. We have also considered the technical assistance, supply of plants, fertilizers, insecticides and other materials will be supplied by the Ministry of Agriculture against cash but technical assistance will be free of charge. The accounts only take into consideration black pepper technology not only because it is the easiest but also because of the water requirement in the case of white pepper technology. Maceration of white pepper may be carried out in containers, tanks and rivers although the latter would not be convenient because of water pollution. The cropping techniques are the same as for intensive farming. The props could be live ones, such as "quina wood" or "guegue", highly resistant plants which can survive without branches for a long period. The price would be 50 Dbs./prop, which is 500.8% cheaper than the reinforced concrete props. The necessary quantities would be easily obtained since these are very small areas.

3 - Conclusions

The investment to be made for 180 ha with 500 plant plots is about Dbs. 48,864,960, Dbs. 40,514,250 being for 100 ha with 2,000 plant plots. The costs are almost all concerning fertilizers and labour.

The operational cost from the 5th to the 15th year is kept constant.

Depreciation of the invested capital will take place in the 4th year and the operational balances will then be always positive.

Table XXXV (a) shows that the total positive balances accumulated in 15 years may reach Dbs. 4,425,922,688, i.e., US$ 98,353,838.

We believe that the figures are sufficiently clear on the economic, social and national importance of the implementation of pepper growing in family agriculture.

B -55 HA AT BLU-BLU

1 - In this particular case, this is an area which is included in the Bela Vista EEA, a company where the cocoa cultivation is dominating but there are other crops, such as coconut trees, palm trees, banana trees and others.

The crop diversification would be distributed as follows if 55 ha of pepper shrubs were to be planted:

Cocoa	1,792 ha
Coconut trees	460 "
Palm trees	429 "
Pepper shrubs	55 "
Banana trees	55 "
Other	76 "
TOTAL	2,867 ha

This is the type of company where pepper growing at company level becomes cheaper and more interesting. It is cheaper because pepper can also be dried in the cocoa drying facilities. It is more interesting because pepper is picked (January/February and July/August/September) during the periods of smaller cocoa collection and the technological drying facility is more available. The EEA will therefore have revenue at a time when it is lower. Finally, the Blu-Blu plantation would also be used to protect the existing vegetation of S. Tomé, the propagation age of which is reaching the limit of 15 years. It would be a kind of nursery for more extensive plantations.

2 - Assessment of management, technical assistance and logistical support costs: considering that pepper operational costs would be four to five times higher than those for cocoa and that the cocoa costs at the Bela Vista EEA account for 55% of the total costs and also considering that there would be production of cocoa and pepper, we may come to the conclusion that the general management, technical assistance and logistical support costs would be assigned to each of the crops as follows:

Cocoa	55%
Pepper	20%
Other	25%

Since these costs at the Bela Vista EEA, as shown in Table XXXVI, represent DBs. 9,040,400, the annual costs assigned to pepper would be 20%, i.e., Dbs. 1,808,080.00. This is the figure we should be using in the case of Blu-Blu.

3 - Installation and maintenance costs: Tables XXXVIII and XXXIX were prepared for determination of the costs. Costs in years 0, 1 and 2 derive from investments. In year 2 the plantation will already be operational.

We used prices for black and white pepper which are 20% below the present ones, i.e., Dbs. 164,790 per ton FOB S. Tomé for white pepper and Dbs. 137,430 for black pepper (See Table XLVIII).

4 - Irrigation facilities: as shown in Table XL, this investment amounts to Dbs. 3,619,004.5.

The detailed study on the irrigation facility as made by Mr. Pais Ramos (Eng.) is attached hereto.

5 - Material and building: as shown in Table XLII, this investment amounts to Dbs. 3,877,345. It is limited to the building of the maceration tanks and of a shed which will be used to shelter workers.

6 - Total investments: as will be seen in Table XLIII, we have considered that everything done or purchased in years 0 to 2, including interest, is investment. The investment amounts to US$ 1,750.000 = Dbs. 78,750,000 distributed as follows:

Year 0 - Dbs. 58,275,000
Year 1 - Dbs. 10,238,000
Year 2 - Dbs. 10,237,000

7 - Operations: the plantation will come into operation in year 3. During the period of 13 years of operations, cashflow will be constant as shown in Table LIV and no profit has been assigned.

We are also submitting a cashflow without any loans considering for example the possibility of the company increasing its capital by US$1,750,000 or the fact that the investment may be borne by a company with sufficient cashflow to provide for self-investment.

8 - Production and sales: with regard to production, please see Table XLVII and the following quantities of commercial white and black pepper have been considered:

In the 3rd year	1,520 kgs/ha
In the 4th year	4,560 kgs/ha
In the 5th year	6,130 kgs/ha

1/3 corresponds to white pepper and 2/3 to black pepper. These are the productions anticipated in Brazil for a density of 1,600 plants/ha. We are proposing a density of 2,500 plants/ha. Table XLIX shows the production and sales for Blu-Blu.

9 - Technology: technological costs are shown in Tables L and LI. They are the following:

White Pepper - Dbs.	11,071 per ton
Black Pepper - Dbs.	7,807 per ton

10 - Amortizations: we propose the ones mentioned in Table LII. There will be a 5 year period of shortage. The investment will be amortized in 11 years. The material will be amortized in 4 instalments of 25% each. The remaining investments are based on 1/11 per year.

11 - Interest: let us assume that investment will be provided by an international credit institution on the following basis:

- Amount US$ 1,750,000 = Dbs. 78,750,000
- 15 years
- Amortization in 1 shortage period of 5 years. During this period only interest will be payable. Amortization will take 11 years.
- Interest 5%/year.

This type of loan is based on a currently used formula. Please see details in Table LII.

12 - Economic and financial analysis: cash flow, as shown in Table LIV, was studied per year so as to provide not only a financial aspect but also an

economic one. The gross cash flow, i.e., excluding amortization and interest, was not prepared but the amounts in Table LIII is sufficient as it was used as the basis to assess fixed costs. In any case, we have considered that amortizations and interest are a fixed cost of the financial year because we believe this is a healthy and realistic approach.

It would obviously be more precise to have a cash flow per month in each year so as to determine the rolling capital required for the operational fund. This would be so because 80% of the crop is harvested in July/August/September and 20% in January/February. Therefore, the necessary operational fund will be equivalent to a 5 months expenditure, as this is the period between April and August and the amount would be Dbs. 5,000,000 in year 3, Dbs. 3,000,000 in year 4 and self-finance will be provided after year 5.

The important amount to be considered is the one for fertilizers (please see Table LV) which goes up to Dbs. 5,000,000/year. However, as they are ordered in July for shipment in September, this cost will easily be covered.

13 - Accounts: we are not submitting a draft cost and profit account nor the subsequent balance sheet because, as already said, this plantation is part of a crop diversification company and, therefore, the pepper plantation is just one more account within the Bela Vista EEA which will have its accounts established in a way which we still ignore. Nevertheless, the development of the cash flows easily show the operational results in each year.

14 - Foreign currency balance: this is shown in Table LVI. As can be seen in the mentioned Table, foreign currency expenditure amounts to US$ 2,772,994 in 16 years.

On the other hand, revenue resulting from pepper sales, as shown in the cash flow table (Table LIV) reach US$ 12,999,460 at the end of year 16 which means a foreign currency positive balance of:

Imports of foreign currency	US$ 12,999,470
Expenditure of foreign currency	US$ 2,772,994
	US$ 10,226,476

In conclusion, there will be 4.69 currencies more than those spent.

TABLE XXXVI
S. TOMÉ E PRÍNCIPE
FEASIBILITY STUDY ON PEPPER CROPS

ALLOCATION OF MANAGEMENT, TECHNICAL ASSISTANCE AND OTHER COSTS TO THE 55 HA PLANTATION AT BLU-BLU AT EEA BELA VISTA

	DBS/YEAR
Manager	2,160,000
Agricultural Engineer	1,350,000
Yard Manager	62,000
Farm Bailiffs	550,000
Foremen	1,060,000
Lumbermen	82,400
Head Clerk	350,000
Accountant	270,000
Clerks	400,000
Head of Warehouse	72,000
Assistant to Head of Warehouse	48,000
Mechanics	144,000
Drivers	216,000
Tractor Operators	180,000
Carpenters	162,000
Masons	162,000
Tinker	27,000
Plumbers	54,000
Painters	90,000
Turner	54,000
Motor Saw Operators	140,000
Electricians	54,000
Head of Kindergartens	215,000
Cooks	180,000
Children's Nurses	350,000
Watchmen	470,000
Social Center	138,000
	9,040,400

Allocation of 20% to Pepper cropping DBS 1,808,080.00

TABLE XXXVII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

ASSESSMENT OF COSTS FOR 1 PEPPER BUSH

	COSTS IN DBS
800 m^2 shed with a capacity for 14,150 plants	
112 sticks x 24 db.	2,688
184 bamboos x 30 db.	5,520
Placing of sticks 112:10 = 11.2 x 120 db.	1,344
Fixing of bamboos 184	80
Nails 1 kg	110
14,150 bags x 1.5	21,225
Ceiling coverage and stowing of bags 28 mh x 120 db.	3,360
Filling of bags 38 mh x 120 db.	4,560
Transport 5ht x 350 db.	1,750
Preparation of stakes 28 mh x 120 db.	3,360
Planting of stakes 28 jh x 120 db.	3,360
Supervision, irrigation and harvesting 48 mh x 120 db.	5,760
Loading and unloading 28 mh x 120 db.	3,360
Transport 5 ht x 350 db.	1,750
TOTAL	58,227

One plant costs 4.10

TABLE XXXVIII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF THE INSTALLATION OF 1 HA OF PEPPER

YEAR 0

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour				
Man day	323.3	120	38,800	-
Plant	2,750	4.1	11,275	37.5
Stakes	2,500	290	725,000	90
Mechanization (ha)				
Tractor D_6	10	1,500	15,000	70
Wheel tractor	19	350	6,650	70
Mechanical saw	16	80	1,280	70
Fertilizer (kg)	1,250	18	22,500	100
Insecticide kg	2	135	270	100
Fungicide	1	55	55	100
		Total	820,830	

TABLE XXXIX

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

COST OF MAINTAING 1h BEFORE PRODUCTION STARTS

YEAR 1 AND 2

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour md	113.5	120	13,620	-
Plants	120	4.1	13,620	-
Mechanisation (ha)				
Wheel Tractors	9	350	3,150	70
Atomizers	15	5	75	70
Fertilizers (kg)	2,500	18	45,000	100
Insecticide kg	2.4	135	324	100
Fungicide kg	2	55	110	100
		Total	62,771	

YEAR 3

BEGINNING OF OPERATIONS

TABLE XL

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

INSTALLATION OF THE IRRIGATION AND PUMPING NETWORK FOR THE 55 HA AT BLU-BLU

BUDGET ESTIMATE

IN DBS

		Currencies %
R_1	580,750	80
R_2	369,825	80
R_3	458,400	80
Tank and accessories	29.5	60
2 75 Hp motorpumps and 10" dia. pipe	1,425,000.0	100
Spares 20%	285,000.0	100
Engine Room	500,000.0	60
	3,619,004.5	

TABLE XLI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

Estimate for a 240 m^3 (3m x 100m x 0.8m) tank for technological preparation of white pepper (maceration) (1)

^{v}Concr. on sill - 60 m^3

^{v}Concr. on walls - 32.832 m^3

^{v}Total: 1.05 x 92.82 = 97.5 m^3

Mark 1:2:4

Cement - 97.5 x 270 : 50 = 527 bags x 420.00	=	221,340.00 Dbs.
Sand - 66.3 x 250.00	=	16,575.00 "
Pebble stone - 88.7 x 400.00	=	35,480.00 "
Wood for formworks:		
164.16 m^2 = 220 planks x 200.00	=	44,000.00 "
Beams - 11 x 300.00 (3 m beams)	=	3,300.00 "

LABOUR		Days	Carpent.(MD)		
2 DAYS	Formworks	2	(2x9hx67,00)	=	2,412.00 "
	Assembly	2	(1x9x43.60)	=	784.80 "
1 DAY	Removal of moulds		2x9x67.00	=	1,206.00 "
			1x9x43.60	=	392.40 "

Tank Filling

Labour - 5 x 12 x 9 = 540 x 43.60	=	23,544.00 "
Concrete - 12 x 8 = 96 x 300.00	=	28,800.00 "
Stones - 12 x 2 x 9 x 67.00	=	14,472.00 "
3 bags - 3 x 9 x 12 x 43.60	=	14,126.40 "
	Total	406,432.60 "

Contingencies = 1,05 x 406,432.60 = 426,754.20

(1) A tank with these dimensions will be usable for an 11 ha pepper plantation

TABLE XLII
S. TOMÉ E PRÍNCIPE
FEASIBILITY STUDY ON PEPPER CROPS

INVESTMENTS

MATERIAL TO BE PURCHASED FOR TECHNOLOGY PROCESSING OF PEPPER AT THE 55 HA OF BLU-BLU

MATERIAL	QUANTITY	UNIT COST	COST	SUB-TOTAL	CURRENCIES
					%
Generator unit - 7.5 CW	1	123,000	123,000		100
Motor pump	1	127,075	127,075		100
Pipeworks	100 m	30,750	30,750		100
Picking machine	1	240,000	240,000		100
Washing machine 5 ton/h	1	250,000	250,000		100
Conveyor belts	4	68,250	273,000		100
Winnowing machine 4 ton/h	1	109,250	109,250		100
Pneumatic separators	1	101,000	62,500	1,215,575	
BUILDING WORKS					
Crushing tanks	5	426,754	2,133,770		90
Hangar	88 m^2	6,000	528,000	2,661,770	80
		TOTAL		3,877,345	

TABLE XLIII
S. TOMÉ E PRÍNCIPE
FEASIBILITY STUDY ON PEPPER CROPS

INVESTMENTS
55 ha BLU-BLU

DBS and US$ '000

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	TOTAL DBS	TOTAL US$
Administration, technical assistance and office work	1,808	1,808	1,808	5,424	121
Assembly	45,146			45,146	1,003
Maintenance		3,453	3,453	6,906	153
Irrigation Network	3,619			3,619	80
Building materials and works	3,877			3,877	86
	54,450	5,261	5,261	64,972	1,443
Contingencies 2%	1,089	105	105	1,299	29
	55,539	5,366	5,366	66,271	1,472
Interest 5%	2,777	3,045	3,313	9,135	203
TOTAL	58,316	8,411	8,679	75,406	1,675

TABLE XLIV

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

OPERATIONS AND HARVEST COSTS FOR 1 HA OF PEPPER IN THE 3rd YEAR

YEAR 3

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY
Labour md	81	120	9,720	-
Mechanization				
Tractors (ha)	18	350	6,300	70
Atomizers (ha)	15	5	75	70
Fertilizers (kg)	3,750	18	67,500	100
Insecticides kg	3	135	405	100
Fungicide kg	2	55	110	100
Cropping	96	120	11,520	-
		Total	95,630	

TABLE XLV

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

OPERATIONS AND HARVEST COSTS FOR 1 HA OF PEPPER IN THE 4th YEAR

YEAR 4

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour (md)	87	120	10,440	-
Mechanization				
Tractors (hr)	34	350	11,900	70
Atomizers (hr)	15	5	75	70
Fertilizers (kg)	5,000	18	90,000	-
Insecticides	3	135	405	100
Fungicides	2	55	110	100
Cropping	288	120	34,560	-
		Total	147,490	

TABLE XLVI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

OPERATIONS AND HARVEST COSTS FOR 1 HA OF PEPPER FROM THE 5th TO THE 15TH YEAR (YEARLY)

YEAR 5

IN DBS

	QUANTITY	UNIT COST	TOTAL COST	IN FOREIGN CURRENCY %
Labour (md)	81	120	9,720	-
Mechanization				
Tractors (hr)	43	350	15,050	70
Fertilizers kg	5,000	18	90,000	100
Insecticides	3	135	405	100
Fungicides	2	55	110	100
Cropping	384	120	46,080	-
		Total	161,365	

TABLE XLVII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

PRODUCTION FORECAST FOR COMMERCIAL PEPPER IN KG/HA/YEAR

YEARS	COMMERCIAL PEPPER				
	Black			White	
	Fresh	Fresh	Dry	Fresh	Dry
3	4,800	3,200	1,120	1,600	400
4	14,400	9,600	3,360	4,800	1,200
5	19,200	12,800	4,530	6,400	1,600

Production for the 5th and 15th years in equal.

Production of fresh pepper will give 1/3 white and 2/3 black pepper, corresponding to 35% and 35% dry pepper respectively.

TABLE XLVIII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

VALUE OF PEPPER FOR ECONOMIC STUDY PURPOSES

Description	CIF/ton Value in $	$ Expenditure per ton	FOB Value in $/ton	- 20%	In Dbs. Ton.FOB
White Pepper	5,000		4,577	3,662	164,79[illegible]
Black Pepper	4,200		3,817	3,054	137,43[illegible]
Freight		173			
Sundry White Pepper		250			
Sundry Black Pepper		210			

TABLE XLIX
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

ANTICIPATED PRODUCTION FOR THE 55 HA OF COMMERCIAL BLACK AND WHITE PEPPER
IN TONS

DESCRIPTION	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Black Pepper	61.6	184.8	249.15	249.15	249.15	249.15	249.15	249.15	249.15	249.15	249.15	249.15	249.15
White Pepper	22	66	88	88	88	88	88	88	88	88	88	88	88
TOTAL	83.6	250.8	337.15	337.15	337.15	337.15	337.15	337.15	337.15	337.15	337.15	337.15	337.15

S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

SALES CONCERNING BLU-BLU
Pepper prices were applied as per Table XLVIII and production as included in the above Table
US$ and DBS '000

YEARS	3	4	5	6	7	8	9	10	11	12	13	14	15
Total in US$	268.6	806.0	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1	1,083.1
Total in Dbs.	12,091.	36,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2	48,742.2

TABLE L

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

Technological costs for 1 ton of commercial white pepper

Operations	Quantity	Unit Cost	Cost Dbs	
Crushing md	4.	120.	480.	
Bags	62.1	30.6	1,900.	
Loading workers md	0.5	120.	60.	
Truck mt	0.8	1,000.	800.	
Washer md	0.2	120.	24.	3,264.
Drying				
Drier md	6.8	219.	720.	
Fuel (wood)	4.6	120.	552.	1,272.
Gauging md and other machines	6.3	89.	561.	
Total energy Kw	57.5	4.	230.	
Bags (comm. pepper)	28.4	30.6	869.	
Thread	15.	9.	135.	
Packing	2.	120.	240.	
Transport and loading			4,500.	6,535.
		TOTAL		11,071.

TABLE LI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

Technological costs for 1 ton of commercial black pepper

Operations	Quantity	Unit Cost	Cost Dbs.	
Drying				
Drier md	6.8	219.	720.	
Fuel (wood)	4.6	120.	552.	1,272.
Gauging md and other machinery	6.3	89.	561.	
Total energy Kw	57.5	4.	230.	
Bags (comm. pepper)	28.4	30.6	869.	
Thread	15.	9.	135.	
Packing	2.	120.	240.	
Transport and loading			4,500.	6,535.
		TOTAL		7,807.

TABLE LII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

INTEREST AND AMORTIZATION OF INVESTMENT OF DBS 66,271,000
DBS '000

YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		TOTAL	
Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization
3,045		3,313		3,313		3,313		3,313		16,297	
									6,218		6,218
YEAR 6		YEAR 7		YEAR 8		YEAR 9		YEAR 10			
Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization
3,026		2,692		2,381		2,070		1,774		11,943	
	6,218		6,218		6,218		5,914		5,914		30,482
YEAR 11		YEAR 12		YEAR 13		YEAR 14		YEAR 15			
Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization	Interest	Amortization
1,479		1,183		887		591		295		4,435	
	5,914		5,914		5,914		5,914		5,914		29,570
										32,675	66,270

TABLE LIII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROP

CALCULATION OF FIXED EXPENDITURE FOR 55 HA AT BLU-BLU
DBS '000

DESCRIPTION	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Operational costs	5,259.7	8,112.0	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1	8,875.1
Admin., assist. and other costs	1,808.0	1,808.0	1,080.0	1,080.0	1,080.0	1,080.0	1,808.0	1,808.0	1,808.0	1,808.0	1,808.0	1,808.0	1,808.0
Tecnol. costs	724.5	2,173.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4	2,919.4
Interest	3,313.0	3,313.0	3,313.0	3,026.0	2,692.0	2,381.0	2,070.0	1,774.0	1,479.0	1,183.0	887.0	591.0	295.0
Depreciation			6,218.0	6,218.0	6,218.0	6,218.0	5,914.0	5,914.0	5,914.0	5,914.0	5,914.0	5,914.0	5,914.0
Bags	110.	320.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0
	11,215.2	15,726.4	22,865.5	22,578.5	22,244.5	21,933.5	22,046.5	21,750.5	21,455.5	21,159.5	20,863.5	20,567.5	20,271.5

TABLE LIV
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

CASH FLOW AND FINANCING
55 HA AT BLU-BLU - DBS '000

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Negative Balance	58,316	8,411	8,679													
Financing	58,275	10,238	10,237													
Revenue				12,091	36,273	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742
Fixed costs				11,215	15,726	22,865	22,578	22,244	21,933	22,046	21,750	21,455	21,159	20,863	20,567	20,271
Balance	-41	+1,827	+1,558	876	20,547	25,877	26,164	26,498	26,809	26,696	26,992	27,282	27,583	27,879	28,175	28,471
Accummulated balance	-41	+1,786	+3,344	+4,220	+24,767	+50,644	+76,808	+103,306	+130,115	+156,811	+183,803	+211,090	+238,673	+266,552	+294,727	+323,198

CASH FLOW WITHOUT FINANCING

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Negative balance	58,316	8,411	8,679													
Revenue				12,091	36,273	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742	48,742
Fixed costs				11,215	15,726	22,865	22,578	22,244	21,933	22,046	21,750	21,455	21,159	20,863	20,567	20,271
Balance	-58,316	-8,411	-8,679	876	20,547	25,877	26,164	26,498	26,809	26,696	26,992	27,287	27,583	27,879	28,175	28,471
Accummulated balance	-58,316	-66,727	-75,406	-74,530	-53,983	-28,106	-1,942	+24,556	+51,365	+78,061	+105,053	+132,340	+159,923	+187,802	+215,977	+244,448

TABLE LV
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

ANNUAL EXPENDITURE IN FERTILIZERS, INSECTICIDES AND FUNGICIDES
55 HA AT BLU-BLU
In DBS and US$

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	DBS.	US$
FERTILIZERS	1,237,500	2,475,000	2,475,000	3,712,500	4,950,000	4,950,000	19,800,000	440,000
INSECTICIDES	14,850	17,820	17,820	22,275	22,275	22,275	117,315	2,607
FUNGICIDES	3,025	6,050	6,050	6,050	6,050	6,050	33,275	739
TOTAL	1,255,375	2,498,870	2,498,870	3,740,825	4,978,325	4,978,325	19,950,590	443,346

TABLE LVI
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

CURRENCY EXPENDITURE - 55 HA BLU-BLU

IN US$

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5 TO 15	TOTAL
PLANTS	5,168						5,168
STAKES	797,500						797,500
TRACTORS D_6	12,833						12,833
WHEEL TRACTORS	5,689	2,695	2,695	12,876	10,181	12,876	175,772
MECHANICAL SAW	1,095						1,095
ATOMIZERS		64	64	64	64	64	960
BUILDING MATERIALS AND WORKS	8,642						8,642
IRRIGATION	72,380						72,330
BAGS				2,444	7,111	10,222	121,997
MATERIAL	27,013						27,013
FERTILIZERS	27,500	55,000	55,000	82,500	110,000	110,000	1,540,000
INSECTICIDES	330	396	396	495	495	495	7,557
FUNGICIDES	67	134	134	134	134	134	2,077
TOTAL	958,217	58,289	58,289	98,513	127,985	133,791	2,772,994

C. 360 HA AT PINHEIRA

1. Methodology

Pinheira is an estate within Uba Dubo EEA. However, let us assume that the 360 ha will be farmed within a single crop plantation having no infrastructures and, therefore, requiring everything to be done.

The figures we shall be using are the same as for the 55 ha of Blu-Blu and quoted hereafter:

- Installation of the plantation: Dbs. 820,830/ha (see Table XXXVIII)
- Maintenance of the plantation: Dbs. 62,771/ha (see Table XXXIX)
- operations in the 3rd year: Dbs. 95,530/ha (see Table XLIV)
- operations in the 4th year: Dbs. 147,490/ha (see Table XLV)
- operations in the 5th year: Dbs. 161,365/ha (see Table XLVI)
- Technology costs
  - white pepper: Dbs. 11,071/ton (see Table L)
  - black pepper: Dbs. 7,807/ton (see Table LI)
- Production (commercial pepper) - see Table XLVII:

	Black	White
- Year 3	1,120 Kgs/ha	400 Kgs/ha
- Year 4	3,360 Kgs/ha	1,200 Kgs/ha
- Year 5	4,530 Kgs/ha	1,600 Kgs/ha

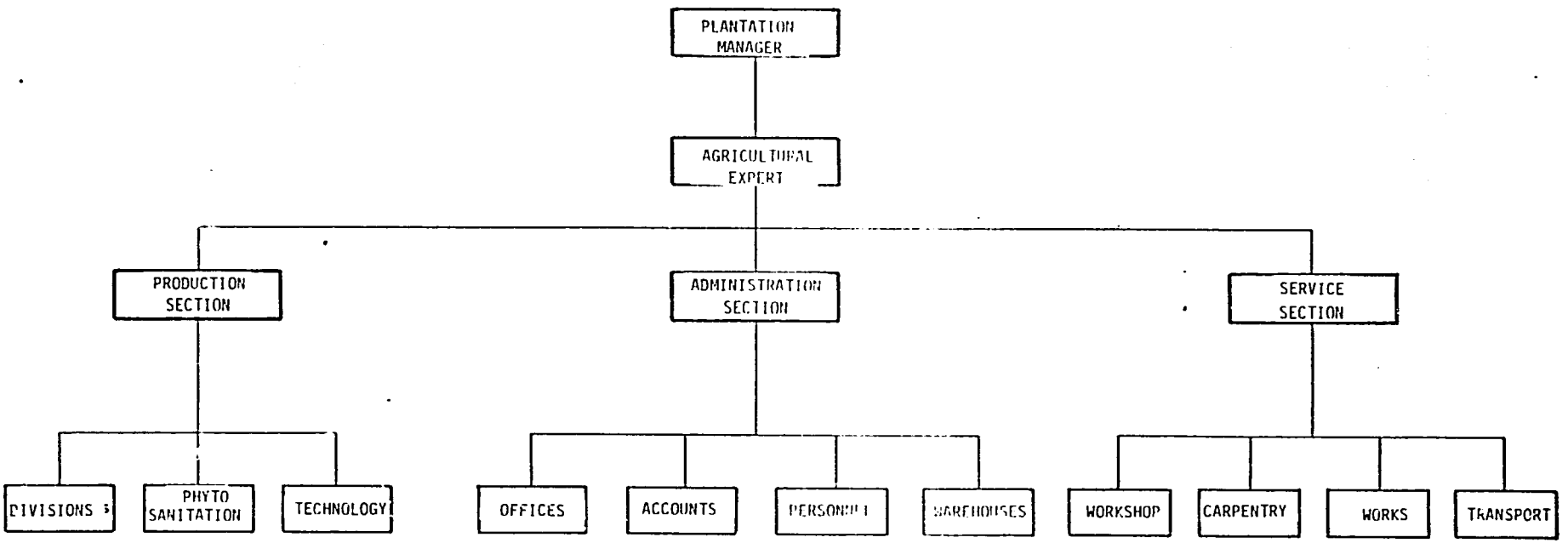
- Prices of commercial pepper - See Table XLVIII:
  - White pepper: Dbs. 164,790
  - Black pepper: Dbs 137,430

Table LVII shows the details of the project for the 360 ha at Pinheira.

2. Assessment of Costs and Investments

2.1 Management Costs: Salary costs are included in Table LVIII. However, our economic survey will exclude labour costs since these are already included in Tables XXXVIII and XXXIX as well as XLIV, XLV and XLVI for labour in plantations as well as the cost of technologies for their production. Please see the organizational chart on the next page.

ORGANIZATIONAL CHART



2.2 Irrigation installation cost: the irrigation installation cost amounts to Dbs. 16,454,250 as shown in Table LXI. Details on the costs and works to be carried out are included in the Appendix on Irrigation attached hereto.

2.3 Installation and Maintenance Cost for 360 Ha of pepper shrubs: Tables XXXVIII and XXXIX explain and quantify the amount of this investment.

2.4 Material: The list of items we believe to be required is included in Table LXII and amounts to Dbs. 69,843,000.

2.5 Physical Facilities: The drier should have a peak drying capacity for 20 tons/day. All necessary facilities are described under Table LXIII and amount to Dbs. 123,098,882. Costs of technological equipment, such as moderation tanks and hangars, are also included in the same Table.

2.6 Agricultural Equipment: it is listed under Table LXIV.

2.7 The total investment cost is allocated througnout a time scale as shown in Table LXVI. A loan of US$ 12,500,000 will be required for this project.

2.8 Operational Costs in Years 3, 4, 5 and following: Table LXVII explains how the different figures are entered for the different operational years. Cost calculations are included in Tables XLIV, XLV and XLVI. Obviously, the pepper shrubs of the first 72 ha plot should be removed at the end of the 15th year and planted again. Props should be turned upside down and again placed in the same site. This will go on and on in such a way that production will be constant.

2.9 Peoductions and Sales: anticipated production figures are included in Table LXVIII. This Table also shows the figures for sales in Year 3 through to Year 15.

2.10 There will be five years of shortages as in the case of Blu-Blu. Amortizations will, therefore start in year 5. Just as in the case of Blu-Blu and in order to have comparable figures for the two projects, amortizations will also be made at a rate of 1/11, i.e., in eleven years at the different stages of the investment. Amortizations will only be completed in Year 21. Therefore, the amount of Dbs. 79,921,000 corresponding to what was to be amortized in the 15th year will be carried to the subsequent years. Please see Table LXIX.

2.11 Interests: the rate is 5% as from year 1. Accordingly, we have prepared the calculations payable until year 15. Payment of interests only ceases in year 21. Therefore, interest payable after the 15th year shall be included in the costs for the subsequent years. See Table LXX.

2.12 Calculation of fixed costs: the calculation of fixed costs is detailed in Table LXXI. Item "Salaries" includes 80% of the salaries payable to foreign staff.

2.13 Cashflow: We have not prepared a cashflow without loans in this case. It would be utopic since the investment will come to a high amount reaching US$ 12,500,000. The cashflow details for Pinheiro is included in Table LXXII. It shows that the operational capital will have to be distributed as follows:

year 1 - Dbs. 12,000,000
year 2 - Dbs. 27,000,000
year 3 - Dbs. 46,000,000
year 4 - Dbs. 38,000,000
year 5 - Dbs. 8,000,000.

The company will be self-sufficient as from the 5th year.

2.14 Foreign currency balance: the tables on Foreign Currency Expenditure and Revenue, i.e. Tables LXXXIII and LXVIII, show a favourable balance of US$ 51,228,176 in the 15 year period and this means 3.44 times the amount spent in foreign currency.

2.15 Accounts: Table LXXV includes the Profit and Loss Account for Year 9; this is one of the most representative years since there will be no further investments and production will reach its highest levels. The Balance Sheet included in Table LXXIV concerns Year 9. It includes all amortizations in previous years and the interests corresponding to that specific year. The loan is already paid up because of the countervalue of amortizations in previous years.

2.16 Balance Sheet Review: This is a very simple matter since we are dealing with one crop only. All costs are assigned to that crop. The Balance Sheet shows that the company has a remarkable cashflow situation. The balance held

in Banks is Dbs. 543,381,000 and this amount would, on its own, be sufficient to cover all bank loans unless profits had been distributed in previous years.

The total amount of the loan could be paid up during this year and the respective interest could be saved.

Alternatively, this cash availability could be used for other investments but this will depend on the criteria followed by the company.

Liabilities include an arbitrary amount of US$ 100,000 = Dbs. 4,500,000 and its counterpart is included in the balance of the Current Deposits. The profit and loss account is positive with an amount of Dbs 168,824,505, representing an amount which is 37 times the company's capital.

With regard to Reserves, no amounts were included herein as this will depend on the decision to be made by the management. Nevertheless, reserves should be formed so that the subsequent plots of 72 ha may be self-financed as they will be approaching the 15 years.

In conclusion, the company will have a healthy and highly promising economic situation.

3. Domestic Profitability Rate (TIR)

TIRs for the 3 alternatives under study are:

- Family Agriculture:

  - 500 plants: TIR - 86.5%
  - 2,000 plants: TIR - 62.7%

- 55 ha at Blu-Blu: TIR - 71.9%
- 360 ha at Pinheira: TIR - 65.4%

4. Profitability Economic Rate (TER)

- Family Agriculture: this was not assessed as it is difficult in view of

a lack of data.

- 55 ha at Blu-Blu: TER - 68.3

- 360 ha at Pinheira: TER - 144.1

TABLE LVII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

DEVELOPMENT OF AGRICULTURAL PROJECT WITH THE 360 HA AT PINHEIRA

DESCRIPTION	YEAR 0 HA	YEAR 1 HA	YEAR 2 HA	YEAR 3 HA	YEAR 4 HA	YEAR 5 HA	YEAR 6 HA	YEAR 7 HA
PREPARATION OF SOIL	72	72	72	72	72			
PICKETING	72	72	72	72	72			
CONSTRUCTION OF STAKES	72	72	72	72	72			
STAKE LAYING ON SOIL	72	72	72	72	72			
INSTALLATION		72	72	72	72	72		
MAINTENANCE			72	144	144	144	72	70
START OF OPERATIONS				72	72	72	72	72

TABLE LVIII
S. TOMÉ E PRÍNCIPE
FEASIBILITY STUDY ON PEPPER CROPS

SALARY COSTS AT THE 360 HA OF PINHEIRA

	DBS/YEAR
Plantation Manager (1)	1,620,000 *
Agricultural Engineer (1)	1,000,000 *
Yard Foreman (2)	200,000
Farm Bailiffs (5)	360,000
Foremen (10)	440,000
Field Workers (500)	16,000,000
Temporary Workers (500)	16,000,000
Lumberman (4)	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Office Clerks (4)	[illegible]
Pepper Technology (2)	[illegible]
Head of Warehouse (1)	[illegible] *
Assistant to Head of Warehouse (1)	90,000
Mechanics (2)	108,000
Drivers (3)	216,000
Tractor Operators (5)	300,000
Carpenters (2)	93,600
Masons (2)	93,600
Tinkers (1)	54,000
Plumbers (2)	108,000
Painters (1)	46,800
Turner (1)	54,000
Stoker (2)	75,600
Assistant stoker (3)	256,000
Electricians (1)	54,000
Heads of the Kindergarten (2)	78,000
Cooks (3)	96,000
Children's Nurses (4)	128,000
Watchmen (6)	144,000
Head of Social Center (1)	69,000
TOTAL	39,476,200

* -80% of these salaries in US$

TABLE LVIX
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROP

COST OF BAGS

In DBS and US$

No. of bags	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Years 9 to 15	Year 16	Year 17	Year 18
4,582	140,200									
18,250		558,450								
36,457			1,115,595							
59,582				1,823,220						
82,500					2,524,500					
91,957						2,813,895				
91,957							2,813,895			
73,582								2,251,624		
55,166									1,688,100	
36,750										1,124,550
TOTAL DBS.	140,200	558,450	1,115,595	1,823,220	2,524,500	2,813,895	2,813,895	2,251,624	1,688,100	1,124,550
TOTAL US$	3,116	12,409	24,791	40,516	56,100	62,531	62,531	50,036	37,513	24,990

TABLE LX

S. TOME E PRINCIPE

FEASIBILITY STUDY ON PEPPER CROPS

ANNUAL EXPENDITURE IN FERTILIZERS, INSECTICIDES AND FUNGICIDES

360 ha at PINHEIRA

In DBS and US$ '000

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEARS 7 to 15	YEAR 16	YEAR 17	YEAR 18	DBS.	US$
FERTILIZERS	1,620.0	4,860.0	8,100.0	14,580.0	21,060.0	24,300.0	29,160.0	32,400.0	25,920.0	19,440.0	12,960.0	453,600.0	10,080.0
INSECTICIDES	19.4	42.7	66.1	114.7	128.3	134.1	145.8	[illegible]	116.6	87.5	58.3	2,225.9	49.5
FUNGICIDES	4.0	11.9	19.7	31.7	39.6	39.6	39.6	[illegible]	31.7	23.8	15.8	613.8	13.6
TOTAL	1,643.4	4,914.6	8,185.8	14,726.4	21,227.9	24,473.7	29,345.4	32,[illegible]	26,068.3	19,551.3	13,034.1	456,439.7	10,143.1

TABLE LXI

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

INSTALLATION OF THE IRRIGATION NETWORK FOR THE 360 HA AT PINHEIRA

ESTIMATE

IN DBS.

		CURRENCIES
R.1	[illegible]	[illegible]
R.1-1	[illegible]	[illegible]
R.1-2	4,503,317	80
R.2	6,194,405	80
	14,179,465	
Branch line	2,062,500	70
Total Catchment	16,241,965	

TABLE LXII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

INVESTMENT IN EQUIPMENT
360 ha Pinheira - price DBS. '000

	Quantity	Immediate	Quantity	1st Year	Quantity	2nd Year	Quantity	3rd Year	Total
Tunnel drier	-	-	-	-	-	-	3	36,000	
Wheel tractors	3	2,400	1	800	1	800	2	1,600	
Crawler tractors with bulldozers	1	2,475	-	-	-	-	-	-	
Tilting towers	3	900	2	600	1	900	2	600	
Trucks	1	1,700	1	1,700	-	-	1	1,700	
Toyota jeeps	2	1,800	1	900	-	-	-	-	
Motorsaws	15	450	5	150	-	-	-	-	
Sprayers	-	-	1	70	-	70	1	70	
Atomizers	10	300	5	150	-	150	-	-	
Stores	-	-	1	120	1	120	-	-	
Tools	1 set	1,000	-	-		-	-	-	
Workshop furniture	1 set	225	-	-		-	-	-	
Motorcycles	3	90	1	30	1	30	1	30	
Mechanical drill	3	105	1	35		-	-	-	
Concrete mixer	2	210	-	-	-	-	-	-	
Spares - 20% of purchase value	-	1,906	-	767	-	210	-	680	
House furniture	-	8,000	-	-	-	-	-	-	
TOTAL		21,561		5,322		2,280		40,680	69,843

TABLE LXIII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

PREMISES

360 Ha Pinheira

In Dbs. '000

Premises	Cost m^2	Area m^2	Total
DWELLINGS			
1 Plantation Manager	[illegible],	[illegible]	[illegible],
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible],	[illegible]	[illegible],
[illegible]	17,	120	[illegible],
1 Accountant	17,	120	2,040,
2 Office Clerks	16,	110	1,760,
1 Head of Warehouse	16,	120	1,920,
500 for workers	16,	5,500	88,000,
OTHER BUILDINGS			
1 Store for drier			14,000,
1 Store for supplies			3,500,
Kindergartens	16,	50	800,
		TOTAL	120,560,

PEPPER TECHNOLOGY

	Quantity	Unit Cost		Currencies %
Tanks	33	426.754	14,082.882	90
Hangar	576 m^2	6.	3,456.	80
		TOTAL	138,098.882	

TABLE LXIV
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

AGRICULTURAL EQUIPMENT
360 ha Pinheira - Price in Dbs.

SMALL PIECES OF EQUIPMENT	QUANTITY	UNIT COST	IMMEDIATE	YEAR 1	YEAR 2	YEARS 3 TO 15	YEAR 16	YEAR 17	YEAR 18
Jaws	245	90	22,050	44,100	66,150	110,250	88,200	66,150	44,100
Pruning hooks	22	80	1,760	3,520	5,280	8,800	7,040	5,280	3,520
Spades	52	350	18,200	36,400	54,600	91,000	72,800	54,600	36,400
Pickaxes	62	500	31,000	62,000	93,000	155,000	124,000	93,000	62,000
Pitchforks	27	90	2,430	4,860	7,290	12,150	9,720	7,290	4,860
Pruning shears	10	960	9,600	19,200	28,800	48,000	38,400	28,800	19,200
Triangular files	570	100	57,000	114,000	171,000	285,000	228,000	171,000	114,000
Flat files	75	120	9,000	18,000	27,000	45,000	36,000	27,000	18,000
Waterers	5	162	810	1,620	2,430	4,050	3,240	2,430	1,620
Buckets	5	32	160	320	480	800	640	480	320
Shovels	65	250	16,250	32,500	48,750	81,250	65,000	48,750	32,500
Wheelbarrows	5	658	3,290	6,580	9,870	16,450	13,160	9,870	6,580
Gloves	245	90	22,050	44,100	66,150	110,250	88,200	66,150	44,100
Rubber boots	245	450	110,250	220,500	330,750	551,250	441,000	330,750	220,500
Rams	10	800	8,000	16,000	24,000	40,000	32,000	24,000	16,000
Plummet	1		3,000						
Surveyor's poles	14	250	3,500	7,000	10,500	17,500	14,000	10,500	7,000
			318,350	630,700	946,050	1,576,750	1,261,400	946,050	630,700

TABLE LXV

S. TOME E PRINCIPE

FEASIBILITY STUDY ON PEPPER CROPS

INVESTMENT FOR THE INSTALLATION AND MAINTENANCE OF [illegible] AI PINHEIRA

DBS '000

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL
Installation - 72 ha	59,100	59,100	59,100	59,100	[illegible]			295,500
Maintenance - 72 ha		4,519					4,519	9,038
Maintenance - 144 ha			9,039	9,039	[illegible]	9,039		36,156
TOTAL	59,100	63,619	68,139	68,139	[illegible]	9,039	4,519	340,694
Total in US$	1,313	1,414	1,514	1,514	1,514	201	100	7,570

DEMOCRATIC REPUBLIC OF SÃO TOMÉ E PRÍNCIPE

BLU-BLU ESTATE

OF THE STATE COMPANY OF BELA VISTA

IRRIGATION NETWORK FOR 53 HECTARS

PRELIMINARY STUDY

NOVEMBER 1985

Mário V. Pais de Ramos

Agricultural Engineer

TABLE LXVI

S. TOME E PRINCIPE

FEASIBILITY STUDY ON PEPPER CROPS

TOTAL INVESTMENT AND ITS DISTRIBUTION

360 HA PINHEIRA

DBS AND US$'000

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL DBS	TOTAL US$
INST. AND MAINTENANCE	59,100	63,619	68,139	68,139	68,139	[illegible]	4,519	340,694	7,571
PREMISES	138,099							138,099	3,069
IRRIGATION FACIL.	16,242							16,242	361
MATERIAL	21,561	5,322	2,280	40,680				69,843	8,552
AGRICULTURAL EQ.	318	631	946					1,895	42
TOTAL DBS	235,320	69,572	71,365	108,819	68,139	[illegible]	4,519	566,773	
TOTAL US$	5,229	1,546	1,586	2,418	1,514	201	101		12,595

TABLE LXVII

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

OPERATIONAL COSTS

IN DBS and US$ '000

HA	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEARS 9 to 15
72	6,885						
144		17,505					
[illegible]							
[illegible]				40,741			
360					52,359		
360						57,092	
360							58,091
TOTAL DBS	6,885	17,505	29,123	40,741	52,359	57,092	58,091
TOTAL US$	153	389	647	905	1,163	1,269	1,291

TABLE LXVIII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

ANTICIPATED PRODUCTION ON THE 360 HA OF COMMERCIAL BLACK AND WHITE PEPPER
IN TONS.

DESCRIPTION	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18
Black Pepper	81	323	645	1,056	1,462	1,631	1,631	1,631	1,631	1,631	1,631	1,631	1,631	1,305	978	652
White Pepper	29	115	230	374	518	576	576	576	576	576	576	576	576	461	346	230
TOTAL	110	438	875	1,430	1,980	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	1,766	1,324	882

S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

SALES CONCERNING PINHEIRA
Pepper prices of Table XLVIII and production as per the above table were applied
US$ and Dbs. '000

YEARS	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Total US$	353	1,407	2,812	4,595	6,362	7,090	7,090	7,090	7,090	7,090	7,090	7,090	7,090	5,674	4,254	2,833
Total Dbs.	15,911	63,341	126,544	206,757	286,284	319,067	319,067	319,067	319,067	319,067	319,067	319,067	319,067	255,314	191,424	127,506

TABLE LXIX
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

CALCULATION OF AMORTIZATIONS

360 HA PINHEIRA

DBS and US$'000

	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20	YEAR 21
	21,393	21,393	21,393	21,393	21,393	21,393	21,393	21,393	21,393	21,393	21,393						
		6,325	6,325	6,325	6,325	6,325	6,325	6,325	6,325	6,325	6,325	6,325					
			6,488	6,488	6,488	6,488	6,488	6,488	6,488	6,488	6,488	6,488	6,488				
				9,893	9,893	9,893	9,893	9,893	9,893	9,893	9,893	9,893	9,893	9,893			
					6,194	6,194	6,194	6,194	6,194	6,194	6,194	6,194	6,194	6,194	6,194		
						822	822	822	822	822	822	822	822	822	822	822	
							411	411	411	411	411	411	411	411	411	411	411
TOTAL DBS	21,393	27,718	34,206	44,099	50,293	51,115	51,526	51,526	51,526	51,526	51,526	30,133	23,808	17,320	7,427	1,233	411
TOTAL US$	475	616	760	980	1,118	1,136	1,145	1,145	1,145	1,145	1,145	670	529	385	165	27	9

TABLE LXX

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

INTEREST ON THE INVESTMENT OF DBS 562,500,000

DBS '000

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
11,766	15,245	18,813	24,254	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26,727	[illegible]	[illegible]	[illegible]	[illegible]
YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
18,487	15,910	13,334	10,758	8,181

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TABLE LXXI
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

CALCULATION OF FIXED EXPENDITURE

360 HA PINHEIRA

DBS '000

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
OPERATIONAL COSTS			6,885	17,505	29,123	40,741	52,359	57,092	58,091	58,091	58,091	58,091	58,091	58,091	58,091
ADMINISTR. AND OTHER COSTS			7,476	7,476	7,476	7,476	7,476	7,476	7,476	7,476	7,476	7,476	7,476	7,476	7,476
TECHNOLOGICAL COSTS			948	5,690	11,465	15,287	19,109	19,109	19,109	19,109	19,109	19,109	19,109	19,109	19,109
INTEREST	11,766	15,245	18,813	24,254	26,591	26,727	26,628	26,133	23,618	21,063	18,487	15,910	13,334	10,758	8,181
AMORTIZATIONS					21,393	27,718	34,206	44,099	50,293	51,115	51,526	51,526	51,526	51,526	51,526
BAGS			140	558	1,115	1,823	2,524	2,814	2,814	2,814	2,814	2,814	2,814	2,814	2,814
	11,766	15,245	34,262	55,483	97,163	119,772	142,302	156,723	161,402	159,668	157,503	154,926	152,350	149,774	147,197

TABLE LXXII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

"CASH-FLOW"

360 HA PINHEIRA

DBS '000

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Financing	235,320	69,572	71,365	108,819	68,139	9,039	4,519									
Revenue				15,911	63,341	126,544	206,757	286,284	319,067	319,067	319,067	319,067	319,067	319,067	319,067	319,067
Investment	235,320	69,572	71,365	108,819	68,139	9,039	4,519									
Fixed expenses		11,766	15,245	34,262	55,483	97,163	119,772	142,302	156,723	161,402	159,668	157,503	154,926	152,350	149,774	147,197
Balance		-11,766	-15,245	-18,351	+7,858	+29,381	+36,985	+143,982	+162,344	+157,665	+159,399	+161,564	+164,141	+166,717	+169,293	+171,870
Accumulated balance		-11,766	-27,011	-45,362	-37,504	-8,123	+78,862	+222,844	+385,188	+542,853	+702,252	+863,816	+1,027,957	+1,194,674	+1,363,967	+1,535,837

TABLE LXXIII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

CURRENCY EXPENDITURE - 360 HA PINHEIRA

IN US$

DESCRIPTION	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEARS 9 TO 15	TOTAL
PLANTS	6,765	6,765	6,765	6,765	6,765						33,825
STAKES	1,044,000	1,044,000	1,044,000	1,044,000	1,044,000						5,220,000
D6 TRACTORS	16,800	16,800	16,800	16,800	16,800						84,000
WHEEL TRACTORS	7,444	7,444	7,444	7,444	7,444	13,162	13,162	13,162	13,162	13,162	182,002
MECHANICAL SAW	1,434	1,434	1,434	1,434	1,434						7,170
ATOMIZERS	84	84	84	84	84	84	84	84	84	84	1,344
PREMISES	2,455,091										2,455,091
IRRIGATION	284,163										284,163
BAGS				3,116	12,400	24,791	40,516	56,100	62,531	62,531	637,171
MATERIAL	1,552,074										1,552,074
AGRICULT. EQUIPMENT	7,074	14,015	21,023	35,039	35,039	35,039	35,039	35,039	35,039	35,039	497,619
FERTILIZERS	36,000	108,000	180,000	324,000	468,000	540,000	648,000	720,000	720,000	720,000	8,784,000
INSECTICIDES	431	949	1,469	2,549	2,851	2,980	3,240	3,240	3,240	3,240	43,629
FUNGICIDES	89	264	438	704	880	880	880	880	880	880	12,055
MAINTENANCE			3,612	7,224	7,224	7,224	7,224	7,224	7,224	7,224	97,524
SALARIES TO FOREIGNERS	70,578	70,578	70,578	70,578	70,578	70,578	70,578	70,578	70,578	70,578	1,129,248
TOTAL	5,482,027	1,270,333	1,353,647	1,519,737	1,673,499	694,738	818,723	906,307	912,738	912,738	21,020,915

TABLE LXXIV
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS
360 HA PINHEIRA

BALANCE SHEET FOR THE 9th YEAR

ASSETS	Gross Assets	Provisions Amortizations Depreciation	Net Assets
AVAILABILITIES			
Cash			
Current Deposits	543,381,000		543,381,000
SHORT TERM CREDIT			
Clients	319,067,000		
Suppliers			
Other Debtors			
	319,067,000		319,067,000
STOCKS			
Products			
Goods			
TANGIBLE ASSETS			
Buildings and other premises			
Basic and other facilities, machinery and premises			
Fixtures and tools			
Loading and handling material			
Adm., social and sundry equim. and furniture			
Bottles and packages			
Investments for the account of RDSTP			
Investments	177,709,000	177,709,000	
	177,709,000		
Total provisions			
Total amortizations and depreciations		177,709,000	
Total assets	360,243,000	177,709,000	684,739,000

LIABILITIES	Liabilities and Net Worth
SHORT TERM DEBTS	
Clients	
Suppliers	76,330,495
Other creditors	
Provisions for risks and costs	
	76,330,495
MEDIUM AND LONG TERM DEBTS	
Bank loans (investments)	435,084,000
Other loans	
Total Liabilities	511,414,495
NET WORTH	
CAPITAL	
Share capital	4,500,000
RESERVES	
Other special reserves	
NET PROFITS	
Current profits of the year	168,824,505
Extraordinary profits of the year	
	168,824,505
Total net worth	173,324,505
Total liabilities and net worth	684,739,000

TABLE LXXV
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

SUMMARY OF NET RESULTS
360 HA PINHEIRA

		PURCHASE DEDUCTIONS					SALES DEDUCTIONS		
GENERAL OPERATIONAL EXPENDITURE	36,854,295		36,854,295		PRODUCT SALES	319,067,000			319,067,000
PERSONNEL EXPENDITURE	39 176,200								
FINANCIAL EXPENDITURE	23,619,000		63,095,200						
AMORTIZATIONS AND DEPRECIATION			50,293,000	150,242,495					
NET RESULTS				168,824,505					
				319,067,000					319,067,000

XI - TECHNOLOGY AND PROJECT DEVELOPMENT

A - FAMILY OR TRADITIONAL AGRICULTURE

I - Justification and advantages of the Project

Family or traditional agriculture has a good potential but should, as said before, be subject to planning in accordance with their sizes and ownership. We have decided to divide them into four categories and assume that they have an average income of US$51.84. We have established a real income in accordance with the areas and characteristics of the farms and, as shown in Table XX, this provides the following figures:

US $ 16.2 for the 1st group
US $ 104.3 for the 2nd group
US $ 334.6 for the 3rd group
US $ 1,527.7 for the 4th group

In order to assess the gross income, we based our calculations on the foreign quotation which was actually used for the purposes of this study.

The percentage fraction was determined by choosing the entrepreneurs who had greater land availabilities and were more willing to undergo changes, as follows:

20 % for Group 1
28.5 % for Group 2
70 % for Group 3
45.4 % for Group 4

The decision to take a percentage was the result of our need to obtain a figure which would enable us to make a feasible projection in a comparatively short period and during the period for the relaunching of the EEA.

Table LXXV (a) was prepared for the calculation of the plants and respective areas and this will cover about 2,510 family companies.

The said table shows that the decision made aimed at having an occupation

of such restricted areas that, for example, in the case of the first group, even under intensive cropping, there would not be more than 400 m^2 of single crop units.

A good extension team, after duly identified, well trained and guided will be able to increase the family income at the end of the third year from US$ 51.84 to US$ 514.2, as shown in Table LXXVI, which also includes data on the family income from the 5th to the 15th year.

Table LXXVII shows that, considering that family labour will be earning 30% over the current prices, the investment accumulated in the first three years will, together with the rationalization of crops, provide advantages for the Democratic Republic of São Tomé e Príncipe as a consequence of pepper growing and will result into the entry of foreign currency into the country.

2 - With regard to the sites for implementation of the project, it is our view that the authorities of the Democratic Republic of São Tomé e Príncipe alone should take a decision as to the best criteria to be followed. We shall, of course, be willing to provide full collaboration as may be required and which may be useful for the implementation of this project which, in our view, is highly positive and advantageous for the Democratic Republic of São Tomé e Príncipe.

3 - Project Development

Year Zero

- Choice of sites and location of areas as said above.

- Preparation of the land:

  - Associated crops: selection of plants to be used as props;
  - Intensive farming - in association with other crops - felling of trees in the available area and plantation of Newboldia laevis (Beauw) Sem. and Spondias monbin Linn.

- Soil Picketing: Picketing is required if several crops are to be associated and this should be done as described later for the 55 ha of Blu-Blu.

- Application for supply of plants and materials from the relevant authority.

Years 1 and 2

The same procedure as defined for Blu-Blu later in this report should be carried out. As far as technology is concerned, only black pepper should be considered since it is simpler.

All other operations are similar to those described for the 55 ha of Blu-Blu.

4 - Although not included in the terms of reference of the contract established by I.C.E. (Portugal), we were planning a visit to the Island of Príncipe so as to make a survey into the present areas occupied by small farmers who could probably move into pepper growing.

However, this was not possible.

Our knowledge of the Island and of the weather conditions, however, enable us to say that Príncipe has a higher relative rainfall and humidity than S. Tomé. We may then conclude that the Island of Príncipe has the ideal characteristics for pepper growing, with the exception of Assentada de Santa Rita, the Airport zone, Oque Gaspar and other zones with such a topography that they are not adequate.

However, the first trial field installed at Porto Real, in 1969, should be looked into and the still existing vegetation material should be the object of an inventory.

In addition to the small farms, the following zones could be considered ideal:

- Porto Real
- Esperança
- S. Joaquim
- Fundão
- Bela Vista
- Abade
- Paciência
- Nova Estrela

as well as other flat zones. However, plantations should also be installed in sloped areas with a gradient up to 5% as these are suitable for water drainage. In zones of greater slopes plantations should be implemented in terraces at level kerbs as done in the main pepper producing countries.

TABLE LXXV (a)

S. TOMÉ E PRÍNCIPE

FEASIBILITY STUDY ON PEPPER CROPS

FAMILY AGRICULTURE

NUMBER OF FAMILIES COVERED BY THE BENEFITS

1st STAGE

CROP	NO. OF FAMILIES	AREA HA	PLANTS PER COMPANIES
1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	40	32	[illegible]
TOTAL	2,510	288	

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TABLE LXXVI
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROP

FAMILY AGRICULTURE

EVOLUTION OF TOTAL INCOME PER GROUPS AFTER [illegible] YEAR

GROUP	NO. OF PLANTS	NO. OF COMPANIES	TOTAL INCOME PER GROUPS					
			3		4		5*	
			US$	DOBRAS	US$	DOBRAS	US$	DOBRAS
1	100	1,200	292,400	1,315,800	[illegible]	46,756,800	1,713,420	62,240,400
2	500	600	529,380	23,821,800	[illegible]	83,140,800	2,455,020	110,475,600
3	1,000	170	295,596	13,301,820	[illegible]	45,444,740	1,347,488	60,636,960
4	200	40	173,456	7,805,160	[illegible]	22,934,280	668,452	30,080,320
TOTAL		2,510	1,290,832	462,445,800	[illegible]	1,082,736,200	6,184,380	2,634,433,280

* Income from the 5th to the 15th year

TABLE LXXVII
S. TOME E PRINCIPE
FEASIBILITY STUDY ON PEPPER CROPS

FAMILY AGRICULTURE

INVESTMENTS WITH FAMILY LABOUR USE

GROUP	NO. OF PLANTS	NO. OF COMPANIES	INVESTMENTS					
			YEARS					
			0		1		2	
			US$	DOBRAS	US$	DOBRAS	US$	DOBRAS
1	100	1,700	93.2	4,194.8	68.9	3,101.1	68.9	3,101.1
2	500	600	466.1	20,974.0	344.6	15,505.5	344.6	15,505.5
3	1,000	170	2,102.3	94,605.0	749.4	33,726.0	749.4	33,726.0
4	2,000	4	4,204.6	189,210.0	1,498.9	67,452.0	1,498.9	67,452.0
TOTAL		2,474	6,866.2	308,983.8	2,661.8	119,784.6	2,661.8	119,784.6

B. 55 HA AT BLU-BLU

1 - Year Zero

Yard: the farm yard may be located at Vila Fernanda, at a distance of two kilometers from the farm where there are the necessary infrastructures.

Purchase of materials: in accordance with Table XLII.

Building of the maceration tanks: the maceration tanks should be located as close to the riverheads at a higher level so that there may be water for irrigation. The mentioned location has two advantages: there will be no discharge and the environment protection against pollution and an improved [illegible] conditions.

Irrigation installation: Please see our description on this subject made in the Appendix hereto.

Building of nurseries: nurseries should be situated close to the banks of Água Grande not only because of better water supply conditions but also because of the microclimate at this zone.

Material: it should be as rustic as possible and, therefore, the material from the bush clearing works should be used. However, for caution sake, we have taken into account the possible purchase of the building material (please see Tables CLII and XLIII). The local workers are fully accustomed to the advisable building technique. Plumb bobs which are used as the supports for the cover are made of forest wood. They should be placed and aligned in 3 x 3 squares and occupy one or more available areas in a total of 8,000 m^2; this has been estimated as sufficient for multiplication of stakes for 80 ha of plantation.

The lines under the cover shall be made of bamboo sticks placed together with a fixed ring and joined. The cover shall be arranged as an "andala" and in such a way as to allow a passage of 50% of light.

Availability of mother peduncles: The existing and available material was the object of a survey so that the availability of plants could be quantified.

Depending on the sites, we found that there are 5,166 plants which may provide about 120,000 stakes. In view of a plant shortage, the mentioned calculation considers the use of five knot stakes from orthotropic branches or plagiotropic stakes with an orthotropic sprig.

Propagation of plants: only asexual. The mother peduncles or plants in Democratic Republic of São Tomé e Príncipe shoould be used in the next three years as they are now approaching the so-called ideal limit.

Stake rooting: plantation of stakes should be carried out in 12 x 5 plastic bags with three knots under the ground and two over the ground.

Arrangement: Bags in nurseries should lean against [illegible] the lines [illegible] at a distance of [illegible]

Management of nurseries: In addition to [illegible] should be altered in such a way that by the fourth month the plants have already got used to the sun. Fertilization using about 5 grs of ammonium sulf[illegible] is essential.

Props: We decided to consider intensive operations with non lignous props, i.e., with reinforced concrete props (three irons with an intersection support 1 x 2 x 4), triangular profile, section 12 x 12 x 2 and a length of 2.5 meters. This type of prop was chosen in view of the shortage of long lasting wood, of the sanitation aspect and of future plantations up until the end of the 15th year. The live props which had better results in S. Tomé were not chosen as their quantity would not be sufficient for farms with more than 3 ha.

Preparation of the land: Felling should be made by using a crawler truck and non usable wood should be chopped and spread in the space between the lines so as not to hinder maintenance works and also to act as a possible cover for the processing of organic matter which pepper shrubs require.

Picketing and placing of props: "Cracked andalas" from palm or coconut trees after trunk removal should be used for the preparation of picketing stakes. Stakes should be between 50 and 75 com long. The rate at which they should be placed is 2 x 2 and the props should be placed in such a way that they will all face the same side and will be buried at a 50 cm depth.

2 - Year 1

Plantations should be started in October. This is the first month of rain. Year zero should therefore only have 9 months. 40 x 40 x 40 holes should be placed at a distance of 30 cm from the prop and always on the east side.

Plantation: each hole will take two rooted plants which will be at a distance of 30 cm from the prop and will be placed at a 45° angle. Some moulding up will have to be carried out after plantation.

Fertilizers: compounds 4.1.2 in the mentioned quantities per ha as shown in Table [illegible].

Fertilization: this is essential [illegible] should be made in accordance with the crown projection over the soil.

Irrigation: piped at a rate of [illegible] m^3/ha.

Soil Covering: seeding of Calapagonium at the beginning of the rain season.

Preventive Treatment: sulphate application on the stalks at soil level using bordeaux mixture, decrowning, hoeing and moulding up.

3 - Year 2

Plantations should be checked to find out if there are any dead plants and provide for their substitution. Plant management with pruning and lashing to the prop at the level of each knot.

Fertilization: this is needed in a circle around the shade provided by the shrub crown,using compound fertilizer 4.1.2.

Irrigation of the peduncle as done in the first year.

Continue seeding of Calapagonium mucanoides.

Phytosanitation as described for the previous year.

4 - Year 3

Management of plants as in previous years: pruning and lashing.

Fertilization with compound fertilizers 4.2.1 in accordance with Table XLIV the quantity of which will be corrected in accordance with tests.

Irrigation as described for the previous year.

Seeding of Calapagonium at the beginning of the rain season.

Phytosanitation as prevention.

[illegible] ripe pepper for production of black and white pepper.

Technology:

- White pepper: separate ripe grains from unripe grains.
  Place ripe grains into bags.
  Place bags in maceration tanks and macerate.
  Removal of berry pulp and washing
  Drying
  Selection and placing into bags.

- Black pepper:
  Degraining of unripe pepper
  Drying under the sun or in a classical drier
  Selection and placing into bags.

C - 360 HA AT PINHEIRA

1 - Year zero

Yard: it may be located in the old yard which will have to be renewed.

Acquisition of material: in accordance with Table LXII

Building of tanks: the tank should be in the yard because of the location of the registered office and because supply is by gravity. Should the ideal location not be possible, raise the bottom of the tank and the level for irrigation by gravity. These measures aim at using the maceration water. Please see Appendix on irrigation for more details.

Location and erection of nurseries: nurseries should be erected close to the yard for a better use of the maceration water for irrigation purposes. This will have the added advantage of a better supervision.

2 - With regard to the remaining operations, not only for year zero but also for the other years, please [illegible] technology described [illegible] of [illegible].

VII - FINAL COMMENTS

As time went by and techniques evolved, it was found that soils and climatic conditions at the Island of São Tomé are adequate for cocoa in different areas from Santa Catarina to the south of Água-Izé.

Climate changes in the south of Ribeira Afonso and becomes more rainy and less light. These conditions render cocoa production expensive and unprofitable. Phytosanitation is expensive and there is product rottening. The use of fertilizers is also not profitable because of the lack of light.

Coconut trees were planted at Dona Augusta which is the area with less light in the Island of São Tomé. However, coconut trees need light and, therefore, this area is not suitable. It was a mistake in our view.

Pepper is an alternative because Piper Nigrum is an umbrophyl plant with a natural habitat in tropical forests with high rainfall and little light.

We are aware of the fact that pepper shrub stalks can also be attacked by rottening. But, if copper syrup is used from time to time, this will be controlled.

We also know that pepper shrubs may be attacked by nematodes. But this may be controlled by having them in sites where mushrooms grow.

Should all this and every comment made in the previous chapters be taken into account, we may feel confident that this area which resulted into so many problems for cocoa and other crops will be suitable for the pepper alternative which seems to be a considerable asset which was so far under cover awaiting an opportunity to come out.

We would like to suggest that 1 ha trial stations be installed as quickly as possible at Dona Augusta, Ribeira Peixe, Porto Alegre, S. Miguel and Juliana de Sousa so that conclusions may be drawn.

We sincerely hope that the possibilities we foresee will soon become a fact for the benefit of Agriculture and Economy in the Democratic Republic of São Tomê e Principe. We believe this is the best tribute that can be paid to the work we have just completed.

DEMOCRATIC REPUBLIC OF S. TOMÉ E PRÍNCIPE

BLU-BLU BRANCH

53 HECTARE IRRIGATION NETWORK

PRELIMINARY STUDY

November 1985

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Agricultural Engineer

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53 HECTAR IRRIGATION NETWORK

INTRODUCTION

This Preliminary Study concerns the improvement of a 55 ha zone within Blublu through irrigation.

The whole layout of the network was carried out on a topographical chart at a scale of 1:10,000, with contour lines at equal distances of 10.00 m in height and a considerable shortage of levels which, obviously, is a drawback when preparing the layout, the profiles and location of irrigation tanks and intakes.

This is only a Draft Project which will have to be completed by a local survey into the whole distribution network if the Project is to work.

On the other hand, water potential in "gravana" periods is unknown because there are no flow meters in the mentioned rivulet and because this is a hydro-agricultural scheme with water coming from a raising station at a specific point of Ribeira Água Grande (closer to the area to be irrigated), with pumping of a flow of 160 l/s and a rise of 18.0 m.

In this case we have considered the pumping need but were unable to consider the possibility of replacing it by a catchment/headwater channel system which would drive the water by gravity to the source of the irrigation system which was established and calculated.

There would be a basis for comparison on a savings assumption, since, as is known, a pumping station based on gasoil motor pump units is a permanent cost during the irrigation period, considerable maintenance and assistance are required and the economic characteristics of the whole project has to be taken into account. It would originate a higher cost per irrigated hectare as will be shown later in this report.

This Preliminary Study has the relevant details such as for example those on accessories required for an implementation project included in drawings attached hereto.

IRRIGATION ALLOCATION

Theoretical allocation = 440 m^3/Ha

Irrigation efficiency = 0.65

Practical Allocation $= \frac{440\ m^3/Ha}{0.65} = 676.9 = 670\ m^3/Ha$

Data:

Daily Irrigation Period = 10 hours

Irrigation Intensity = 1 week

Period of weekly irrigation = 6 days (no irrigation on sundays)

Unit or Module Flow

$$\frac{670\ m^3/Ha}{6\ d \times 10\ h \times 3{,}600\ s} = \frac{670{,}000\ l/Ha}{216{,}000} = 3.1 = 3\ l/s/Ha$$

Module = 3 l/s/Ha

For the irrigation of Blu-Blu:

53 Ha x 3 l/s/Ha = <u>160 l/s</u>

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IRRIGATION SYSTEM

Water pumped from the raising station is taken to an 18 meter height in 10" dia. pipes into a rectangular tank (3.00 m x 2.00 m) which has 3 drains - R.1, R.2 and R.3 - through the operation of 3 bottom weirs. There is an irrigation nozzle in this tank.

The 3 drains will irrigate three different blocks:

R.1	26 Ha	Q = 80 l/s
R.2	20 Ha	Q = 60 l/s
R.3	7 Ha	Q = 25 l/s

This last block is on the right bank of Água Grande rivulet.

The whole network is formed of underground fibrocement pipes with a total extension of 1,550 m distributed as follows:

R.1 = 650 m - 0.25 m dia.
R.2 = 500 m - 0.20 m dia.
R.3 = 400 m - 0.15 m dia.

The fibrocement pipes are 5.00 m long and are joined by "comet" gaskets; they belong to class 6.

The drawings include all the network data such as:

- Plan at a scale of 1:10,000
- Gross-sections of the drains
- 0.80 m dia. simple and pressure tanks
- Depth and nozzle weirs
- 3 1/2" dia. valves and irrigation nozzles.

In order to make the inverted S-trap crossing of Água Grande rivulet, pressure tanks have tape valves with coupled irrigation nozzles. These tanks have screwed lids and are also used for cleaning purposes.

The irrigation tanks were placed along the drain layout at distances of about 100.00 m. The irrigation nozzles are connected to the land ditches to be used for irrigation of the crops; they form the secondary network and follow the most appropriate conditions for the purpose.

HYDRAULIC CALCULATIONS

Data and prices, including freight, for the two 80 l/s motor-pump units were supplied by ABOL - Aspersão e Bombagem, Lda. of Rua da Boavista, 78, Lisbon.

Flows and diameters of class 6 fibrocement pipes, with "comet" gaskets, were assessed in accordance with General Price list no.16 - January 1985" of Lusalite - Fibrocimento, following Scimemi's exponential formula for fibrocement pipes.

Scimemi's Formula:

$V = 158.R^{0.68}.J^{0.56}$ $\quad Q = 48.3.D^{2.68}.J^{0.56}$

R = Average radius = $\frac{A}{U}$

D = Diameter

J = Load loss per meter

The load losses in the irrigation tanks were calculated in accordance with formulae used for sudden widening and for sudden narrowing.

The former result from Borda's formula:

$$h's = \frac{(V - V1)^2}{2g}$$

where:

V = Speed in pipe

V_1 = Speed in tank which will normally be considered as zero.

Therefore: $h's = \frac{V^2}{2g}$

where g = gravity acceleration = 9.8182

Load loss due to sudden narrowing results from

$$h''s = K\frac{V^2}{2g}$$

K is a coefficient resulting from the ratio between the areas or diameters of the sections under consideration.

The load loss should not exceed $0.5\frac{V^2}{2g}$

The loss load caused by a tank was calculated using the following formula:

$$h's + h''s = \frac{V^2}{2g} + 0.5\frac{V^2}{2g}$$

IRRIGATION NETWORK OF BLUBLU

Quantities of Material

R.1

- Fibrocemente pipes, class 6, 0.25 m dia = 650 m ..... 130 5 m units
- "Comet" Gaskets ..... 129 units
- 0.80 m dia. tanks (average height 2.00 m) ..... 6 units
- Depth weirs for 0.25 m dia. ..... 5 units
- Nozzle weirs ..... 5 units
- Irrigation nozzles ..... 6 units

R.2

- 0.20 m fibrocement pipes = 500 m ..... 100 5 m units
- "Comet" gaskets ..... 99 units
- 0.80 m dia. tanks (average height 2.00 m) ..... 4 units
- Depth weirs for 0.20 m dia. ..... 3 units
- Nozzle weirs ..... 3 units
- Irrigation nozzles ..... 4 units

R.3

- 0.15 m fibrocement pipes = 400 m ..... 80 5 m units
- "Comet" gaskets ..... 79 units
- 0.80 m dia. tanks (average height 2.00 m) ..... 2 units
- 0.80 m dia. pressure tanks (reinforced) ..... 4 units
- 3 1/2" dia. valves ..... 4 units
- Depth weirs for 0.15 m dia. ..... 1 unit

- Nozzle weirs ..... 1 unit
- Irrigation nozzles ..... 6 units

Pumping Station

- 75 HP motor pump unit with spares (80 l/s) ..... 2 units
- 10" dia. pipes ..... 200 m
- Engine Room (50 m^2) ..... 1 unit
- Tank (2.00 m x 3.00 m) - reinforced concrete .....2.729 m^3
- Depth weirs for 0.15, 0.20 and 0.25 m dia. ..... 3 units
- Nozzle weirs ..... 1 unit
- Irrigation nozzles ..... 1 unit

Summary - R.1 - R.2 - R.3

- 0.25 m pipes	650 m	
- 0.20 m pipes	500 m	
- 0.15 m pipes	400 m	.....1 550 m
- "Comet" gaskets for 0.25 m dia.	129 units	
- "Comet" gaskets for 0.20 m dia.	99 units	
- "Comet" gaskets for 0.15 m dia.	79 units	... 307 units
- 0.80 m dia. tanks		12 units
- 0.80 m dia. pressure tanks		4 units
- Depth weirs		12 units
- Nozzle weirs		10 units
- Irrigation nozzles		17 units
- 3 1/2" dia. valves		4 units
- 75 HP motorpump units		2 units
- Engine Room (50 m^2)		1 unit
- 10" dia. pipes		200 m

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Cost Estimate

R.1

- 0.25 m dia. pipes including freight, laying (opening and closing of ditch) and "Comet" gaskets		505.814 DBs
- 0.80 m dia. tanks	6 x 5.000 DBs	30.000 DBs
- Depth weirs	5 x 6.250 DBs	31.250 DBs
- Nozzle weirs	5 x 1.250 DBs	6.250 DBs
- Irrigation nozzles	6 x 1.250 DBs	7.500 DBs
		580.814 DBs

R.2

- 0.20 m dia. pipes including freight, laying (opening and closing of ditch) and "Comet" gaskets		324.575 DBs
- 0.80 m dia. tanks	4 x 5.000 DBs	20.000 DBs
- Depth weirs	3 x 6.250 DBs	18.750 DBs
- Nozzle weirs	3 x 1.250 DBs	3.750 DBs
- Irrigation nozzles	4 x 1.250 DBs	5.000 DBs
		372.075 DBs

R.3

- 0.15 m dia. pipes including freight, laying (opening and closing of ditch) and "Comet" gaskets		206.900 DBs
- 0.80 m dia. tanks	2 x 5.000 DBs	10.000 DBs
- 0.80 m pressure tanks	4 x 7.500 DBs	30.000 DBs
- 3 1/2" dia. valves	4 x 2.000 DBs	8.000 DBs
- Depth weirs	1 x 6.250 DBs	6.250 DBs
- Nozzle weirs	1 x 1.250 DBs	1.250 DBs
- Irrigation nozzles	6 x 1.250 DBs	7.500 DBs
		269.900 DBs

Pumping Station

- Motorpump units - 2 units - and pipes		1.425.000 DBs
- Spares (20%)		285.000 DBs
- Engine room		500.000 DBs
- Tank (2.00 m x 3.00 m) - reinforced concrete - 2.729 m^3 x x 3750 DBs/m^3)		10.234 DBs
- Depth weirs	3 x 6.250 DBs	18.750 DBs
- Nozzle weirs	1 x 1.250 DBs	1.250 DBs
- Irrigation nozzles	1 x 1.250 DBs	1.250 DBs
		2.241.484 DBs

SUMMARY

R.1	580.814 DBs		
R.2	372.075 DBs		
R.3	269.900 DBs		
Pumping Station	2.241.484 DBs		
	3.464.273 DBs		
Rounding off .	727 DBs	.....	3.465.000 DBs

COST PER HECTARE

For the irrigation of 53 Ha ..... 65.377 DBs

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DEMOCRATIC REPUBLIC OF S. TOMÉ E PRÍNCIPE

PINHEIRA BRANCH

OF

THE UBA-BUDO STATE COMPANY

400 HECTARE IRRIGATION NETWORK

PRELIMINARY STJDY

November 1985

Mário V. Pais de Ramos
Agricultural Engineer

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400 HA IRRIGATION NETWORK

INTRODUCTION

This preliminary study concerns the improvements of a 400 ha zone in Pinheira through irrigation.

The whole layout of the network was carried out on a topographical chart at a scale of 1:10.000, with contour lines at equal distances of 10.00 m in height and a considerable shortage of levels which, obviously, is a drawback when preparing the layout, the profile and location of irrigation tanks and intakes.

This is only a draft project which will have to be completed by a local survey into the whole distribution network if the project is to work and the catchment and head water channel system, with contour lines at an equal distance of 1.0 m in height and a large number of levelled point will have to be taken into account. The Implementation Project will then be able to be prepared.

The whole irrigation network provides for an irrigation of 400 ha but only 360 ha will be used for pepper cropping purposes. The irrigation network may also be used by other crops, such as maise which is being used at Pinheira and cocoa the production of which is to be improved during the dry periods. This irrigation system will provide the plants with water at a minimum loss. The flow of river Manuel Jorge is unknown because of a lack of measuring equipment but it may be used for this irrigation system. We know that water from this river is already used for multiple purposes such as irrigation and supply.

IRRIGATION ALLOCATION

Theoretical allocation = 440 m^3/Ha

Irrigation efficiency = 0.65

Practical allocation = $\frac{440\ m^3/Ha}{0.65}$ = 676.9 = 670 m^3/Ha

Data:

Daily Irrigation Period = 10 hours

Irrigation Intensity = 1 week

Period of weekly irrigation = 6 days (no irrigation on sundays)

Unit or Module Flow

$$\frac{670\ m^3/Ha}{6\ d \times 10\ h \times 3{,}600\ s} \qquad \frac{670{,}000\ l/Ha}{216{,}000} = 3.1 = 3\ l/s/Ha$$

Module = 3 l/s/Ha

For the irrigation of Pinheira:

53 Ha x 3 l/s/Ha = <u>160 l/s</u>

IRRIGATION SYSTEM

A flow of 1,200 l/s will be required for the irrigation of 400 Ha. This will originate at a catchment and headwater point of River Manuel Jorge for a 1,500 m long channel which has a small gradient (0.003 m/m) up until it reaches the level (155.00) at a square 1 m tank which will be the source for the whole supply.

The zone is divided into blocks situated between River Manuel Jorge and Clara Dias Rivulet. These are two other streams between them, i.e., Água Nova Olinda and Água Carambola.

The block distribution network was designed because of the zone's topography resulting from the mentioned streams and from a hillock with its peak at Nova Olinda.

The 400 ha are divided into the following blocks:

Block 1	=	20 ha
Block 2	=	30 ha
Block 3	=	20 ha
Block 4	=	8 ha
Block 5	=	230 ha
Block 6	=	92 ha

The irrigation of these blocks is done through a distribution network formed of two drains - R.1 and R.2 is divided into two branches: R.1-1 and R.1-2.

The flow from River Manuel Jorge is, as said, 1,200 l/s. There is an irrigation intake (T-1) in the terminal box of the channel. The areas and flows of each one of the drains are:

R.1:

From T-1 to T-4 (irrigation of the 20 ha blocks) - 308 Ha - Q = 924 l/s
T-4 to T-5 - 288 Ha - Q = 864 l/s

T-5 is located in a 1.00 square tank and is the source of R.1-1 and R.2-2.

T-5 to T-11 (irrigation of the 50 Ha blocks) - 50 Ha - Q = 150 l/s
T-11 to T-12 (irrigation of the 20 Ha blocks) - 20 Ha - Q = 60 l/s

R.1-1 (irrigation of the 8 ha blocks) - 8 ha - Q = 24 l/s
R.1-2 (irrigation of the 230 Ha blocks) 230 Ha - Q = 690 l/s

R.2:

Originated at T-1 of R.1, terminal of the headwater, irrigation 92 Ha - Q = 276 l/s.

Drain R.1 and its branch R.1-1 is formed of fibrocement pipes class 6 with "Comet" gaskets at depths depending on the diameter, as shown in the standard drawing attached hereto.

The irrigation tanks which include the irrigation nozzles are placed at distances of about 100.00 m, they are all made of simple concrete and have a 0.80 m dia. with the exception of T.1 (source of R.2) and T.5 (source of R.1-1 and R.1-2) which are square, 1.00 m side, with an irrigation nozzle and a depth weir for 0.15 m and 0.60 m dias.

Branch R.1-2 has two sections: in fibrocement pipes for crossing Água Carambola Rivelet, with reinforced 0.80 m dia. pressure tanks, with a rectangular section of 0.85 x 0.60 m and a length of 2,930 m. Since it follows the top line, it has irrigation nozzles on both sides of the channel at distances of about 100.00 m/200.00 m. There are double nozzle weirs upstream each pair of intakes which will fully or partially stop the waterflow downstream. There will only be one intake, one surface discharger and one terminal bottom discharge at the end of the channel.

Drain R.2 is fully made of class 6 fibrocement pipes with 0.45 m dia. "Comet" gaskets. The irrigation nozzles are distributed in accordance with the criteria for the drains and branch lines of the distribution system. The irrigation nozzles are placed in simple 0.80 m dia. tanks and there are 6 0.80 m pressure tanks with 3 1/2" valves and respective irrigation nozzles in the crossing of the 2 slopes of Água Nova Olinda Rivulet.

The drawings and profiles include the standard drawings, the water levels and the location of the intakes.

HYDRAULIC CALCULATIONS

Flows and diameters of class 6 fibrocement pipes, with "comet" gaskets, were assessed in accordance with General Price list no. 16 - January 1985 of Lusalite - Fibrocimento, following Scimemi's exponential formula for fibrocement pipes.

Scimemi's Formula:

$$V = 158.R^{0.68}.J^{0.56} \qquad Q = 48.3.D^{2.68}.J^{0.56}$$

where:

R = Average radius $= \frac{A}{U}$

D = Diameter

J = Load loss per meter

The load losses in the irrigation tanks were calculated in accordance with formulae used for sudden widening and for sudden narrowing.

The former result from Borda's formula:

$$h's = \frac{(v - V1)^2}{2g}$$

where:

V = Speed in pipe

V_1 = Speed in tank which will normally be considered as zero.

Therefore: $h's = \frac{V^2}{2g}$

where g = gravity acceleration = 9.8182

Load loss due to sudden narrowing results from

$$h''s = k\,\frac{V^2}{2g}$$

K is a coefficient resulting from the ratio between the areas or diameters of the sections under consideration.

The load loss should not exceed $0.5 \frac{V^2}{2g}$

The loss load caused by a tank was calculated using the following formula:

$$h's + h''s = \frac{V^2}{2g} + 0.5 \frac{V^2}{2g}$$

The section of the rectangular channel of R.1-2 for the flow of 276 l/s was calculated by using Manning Strickler's formula with a K_s value of 75.

$U = K_s.R^{2/3}.i^{1/2}$ with K_s being a coefficient depending on the rugosity of the channel walls.

This formula may also be written as:

$$U = C_s\, C'_K \quad \text{and} \quad Q = C_s.C_k$$

where

$$C_s = K_s.i^{1/2}; \quad C'_K = R^{2/3} \quad \text{and} \quad C_k = S.R^{2/3}$$

C_s is a function of the wall rugosity and of the slope.

The headwater channel section was also calculated through Manning Strickler's formula but using 70 for K_s because there may be a greater rugosity.

IRRIGATION NETWORK OF PINHEIRA

Quantities of Material

R.1

- Fibrocement pipes, class 6, 0.70 m dia. = 420 m	84 5 m units
- " " " 0.30 m dia. = 610 m	122 5 m units
- " " " 0.20 m dia. = 330 m	66 5 m units
- "Comet" gaskets for 0.70 m dia.	83 units
- " " for 0.30 m dia.	121 units
- " " for 0.20 m dia.	65 units
- Square 1.00 m tank (source of R.1 and R.2)	1 unit
- " " " " of R.1-1 and R.1-2)	1 unit
- 0.80 m dia. tanks (average height 2.00 m)	10 unit
- Depth weirs (average for 0.70 m; 0.60 m; 0.45 m; 0.15 m; 0.20 m and 0.30 m)	14 units
- Nozzle weirs	11 units
- Irrigation nozzles	12 units

R.1-1

- Fibrocement pipes, Class 6, 0.25 m dia. = 230 m	46 5 m units
- "Comet" gaskets for 0.25 m dia.	45 units
- o.80 dia. tank (average height 2.00 m)	1 unit
- Irrigation nozzles	1 unit

R.1-2

- Fibrocement pipes, Class 6, 0.60 m dia. = 340 m	68 5 m units
- "Comet" gaskets for 0.60 m dia.	67 units
- Rectangular channel (0.85 m length x 0.60 m height)	2,930 m
- 0.80 m dia. pressure tanks (average height 2.00 m)	4 units
- Square 1.00 m tanks (source of rectangular channel)	1 unit
- 3 1/2" dia. valves	4 units
- Nozzle weirs	47 units

- Irrigation nozzles (4 in valves and 43 in channel) ..... 47 units
- Bouble nozzle weirs (0.45 m x 0.60 m) in channel ..... 21 units
- Slope falls with bumper tank, in channel average height 3.60 m ..... 12 units

R.2

- Fibrocement Pipes, class 6, 0.45 m = 3,400 m ..... 680 5 m units
- "Comet" gaskets for 0.45 m dia. ..... 670 units
- Pressure tanks , 0.80 m dia. (average height 200 m) ..... 6 units
- 0.80 m dia. tanks (average height 2.00 m) ..... 18 units
- Depth weirs for 0.45 m dia. ..... 17 units
- Nozzle weirs ..... 17 units
- Irrigation nozzles (6 for valves and 18 for tanks) ..... 24 units
- 3 1/2" dia. valves ..... 6 units

Catchment - Headwater channel

- Rectangular channel (1.50 m x 1.30 m) ..... 1,500 m

Summary - R.1 - R.1-1 - R.1-2 - R.2

- 0.70 m dia. Pipes	420 m	
- 0.60 m dia. Pipes	340 m	
- 0.45 m dia. Pipes	3,400 m	
- 0.30 m dia. Pipes	610 m	
- 0.25 m dia. Pipes	230 m	
- 0.20 m dia. Pipes	330 m	..... 5.330 m
- "Comet" Gaskets for 0.70 m dia. ..	83 un.	
- "Comet" Gaskets for 0.60 m dia. ..	67 un.	
- "Comet" Gaskets for 0.45 m dia. ..	679 un.	
- "Comet" Gaskets for 0.30 m dia. ..	121 un.	
- "Comet" Gaskets for 0.25 m dia. ..	45 un.	
- "Comet" Gaskets for 0.20 m dia. ..	65 un.	..... 1,060 un

- 1.00 m square tanks ..... 3 units
- 0.80 m dia. Pressure tanks .... 10 units

- Depth weirs	31 units
- - Nozzle weirs	75 units
- Irrigation nozzles	84 units
- Double nozzle weirs, in channel	21 units
- 3 1/2" dia. valves	10 units
- Falls with bumper box (average height 3.60 m)	12 units
- Rectangular channel (0.85 m x 0.60 m)	2,930 m

ESTIMATE

R.1

- 0.70 m dia. pipes including freight, laying (opening and closing of ditches) and "comet" gaskets	1,258,400 Dbs
- 0.30 m dia. pipes including freight, laying (opening and closing of ditches) and "comet" gaskets	1,697,375 Dbs
- 0.20 m dia. pipes including freight, laying (opening and closing of ditches) and "comet" gaskets	214,500 Dbs
- Square 1.00 m tanks ..... 2 x 10,000 Dbs	20,000 Dbs
- 0.80 m dia. tanks ..... 10 x 5,000 Dbs	50,000 Dbs
- Depth weirs ..... 14 x 6,250 Dbs	87,500 Dbs
- Nozzle weirs ..... 11 x 1,250 Dbs	13,750 Dbs
- Irrigation nozzles ..... 12 x 1,250 Dbs	15,000 Dbs
	3,356,525 Dbs

R.1-1

0.15 m dia. Pipes, including freight, laying (opening and closing of ditch) and "comet" valves	118,968 Dbs
- 0.80 dia. tank ..... 1 x 5,000 Dbs	5,000 Dbs
- Irrigation nozzle ..... 1 x 1,250 Dbs	1,250 Dbs
	125,218 Dbs

R.1 - 2

- 0.60 m dia. pipes including freight, laying (opening and closing of ditch) and "comet" gaskets	946,067 Dbs
- Rectangular channel (0.85 m x 0.60 m) - 250 Kg/m^3 reinforced concrete with AQ 50 mesh closed with mastik ... 2,930mx1,125	3,296,250 Dbs

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- 0.80 m dia. pressure tanks	1 x 10,000 Dbs	30,000 Dbs
- 3 1/2" dia. valves	4 x 2,000 Dbs	8,000 Dbs
- Nozzle weirs	47 x 1,250 Dbs	58,750 Dbs
- 1.00 m tanks (channel source)	1 x 10,000 Dbs	10,000 Dbs
- Irrigation nozzles	47 x 1,250 Dbs	58,750 Dbs
- Double nozzle weirs	21 x 1,250 Dbs	52,500 Dbs
- Sloped falls with bumber box	12 x 10,000 Dbs	120,000 Dbs
		4,580,317 Dbs

R.2

- 0.45 m dia Pipes, including freight, laying (opening and closing of ditch) and "comet" gaskets		5,889,905 Dbs
- 0.80 m dia. Pressure tanks	6 x 7,500 Dbs	45,000 Dbs
- 0.80 m dia. tanks	18 x 5,000 Dbs	90,000 Dbs
- Depth weirs	17 x 6,250 Dbs	106,250 Dbs
- Nozzle weirs	17 x 1,250 Dbs	21,250 Dbs
- Irrigation nozzles	24 x 1,250 Dbs	30,000 Dbs
- 3 1/2" dia valves	6 x 2,000 Dbs	12,000 Dbs
		6,194,405 Dbs

CATCHMENT-HEADWATER CHANNEL

- Rectangular channel (1.50 m x 1.30 m) - 1,500 m x 1,375 Dbs/m 2,062,500 Dbs

SUMMARY

R.1		3,356,525 Dbs
R.1-1	125,218 Dbs	
R.1-2	4,580,317 Dbs	4,705,535 Dbs
		8,062,060 Dbs
R.2		6,194,405 Dbs
CATCHMENT-HEADWATER CHANNEL		2,062,500 Dbs
Rounding off		35 Dbs
		16,319,000 Dbs

COST PER HECTARE

For the irrigation of 400 Ha ..... **40,800 Dbs**