SPICES

Research Achievements and Experiences

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Introduction

Ethiopia is a homeland for many spices and stimulants such as Korarima (Aframomum korarima), Long pepper (*Piper* Spp.), 'Gesho' (*Rhamnus prinoides*), Black cumin (*Nigela sativum*), Bishops weed or 'Nech azmud', Coriander (*Coriandrum sativum*), Sesame (*Sesamum indicum*), Chat (*Catha edulis*) Endi (Parry 1969) and coffee. The country is also secondary center for many others plant species. Besides, in south southwestern, western and southern parts of Ethiopia all exotic spices are grown due to favorable climatic conditions. For these reasons spices namely: `insilal' (*Anethum* Spp.),`mitmita' (*Capsicum* sp.),`besobila' (*Ocimum* Spp.),`gesho', korarima, mints, and thyme grow in wild.

In gardens and on small plots in the homesteads enset, chat, banana, korarima, ginger, and other spices are also cultivated in wet regions. Wild ginger is also abundant in many areas. The history of spices use in Ethiopia is ancient and dated back to the history of Queen Sheba and King Solomon mentioned in the Bible. The culinary use in Ethiopian traditional feeding habits forms a unique plat form from the rest of the world.

Jima Research Center, Tepi Research sub-Center and Bebeka testing site are mixed coffee-based farming systems representing the humid areas of Ethiopia. The major crops grown in the areas are maize, coffee, taro, and enset. Intercropping of horticultural crops like banana, citrus, mango, papaya by subsistence farmers as compound farming is also common. In these regions indigenous horticultural crops like anchote, enset, aerial yam, root yam, *Capsicum sp*, korarima, long pepper and others grow in wild. These areas are characterized by heavy rainfall and are the wettest parts of the country with only two to four dry months in a year. The mean annual rainfall is about 1,500 mm. The rainfall distribution, elevation temperature, and geographical locations of Jima, Bebeka and Tepi are shown in Tables 1 and 2. In addition Montane moist evergreen forest (rain forest) is also found in these areas. The existing forest community (*Pouteria-Albizzia* association) is very complex that Westphal (1975) identified four stratum where korarima and long pepper are found as wild, grown in the last and poor strata. This Research report summarizes the details of reserch achievements and experiences gained on korarima, ginger, turmeric, cardamon, pepper and cinnamon at Jima, Tepi and Bebeka.

Table 1. Geographical locations of Jima, Tepi and Bebeka

	Longitude	Latitude	Altitude (m)	Mean Min.Temp	Mean Max. Temp
Jima	36°.57'E	7°.33'N	1750	11.2°c	26.0°c
Tepi	35°.18'E	7°.10'N	1250	15.3°c	29.8°c
Bebeka	35°.16'E	6°.49'N	1000	14.3°c	30.7°c

Table 2. Monthly (January to December) rainfall and temperature of Jima, Tepi and Bebeka

Mean rainfall (mm)			Temperature (air) (°C)					
Jima	Tepi	Bebeka	Jima		Tepi		Bebeka Gacheb	
(1968-93)	(1974-93)	(10 years)	(1969-93		(1986-93)		(1980-86)	
			Mean min.	Mean max.	Mean min.	Mean max.	Mean min.	Mean max.
34.4	45.9	51.2	9.0	27.3	14.3	31.2	12.3	33.3
55.1	43.2	58.9	10.3	27.3	15.0	32.0	13.4	34.0
96.8	107.7	117.7	12.1	27.9	14.8	32.3	14.5	32.3
119.6	156.3	164.9	12.8	27.3	15.8	31.2	16.0	30.9
184.9	211.3	220.5	13.0	26.0	16.5	30.1	15.2	28.6
211.7	171.8	162.4	12.8	24.6	16.2	28.2	14.8	28.9
230.5	190.5	228.9	12.7	23.0	15.7	26.3	14.4	27.8
224.5	236.3	218.8	12.7	23.2	15.8	27.3	14.2	29.9
195.5	209.3	223.2	12.4	24.4	15.6	28.6	14.7	29.2
104.3	154.6	144.5	10.6	25.6	15.3	29.7	14.6	30.9
53.7	87.2	73.9	8.5	26.2	14.4	30.1	14.1	30.7
30.0	54.2	61.2	7.9	26.9	14.2	30.5	12.5	31.3
1541.0	1668.3	1726.1	-	-	-	-	-	-
-	-	-	11.2	25.9	15.3	29.8	14.3	30.7

Importance and Distribution

Korarima spice has been a part and parcel of each and daily Ethiopian dish in preparation of curry powder for culinary purpose. Korarima seeds are used to flavor all kinds of `Wet', for which they are ground and usually mixed with other spices, to flavor coffee, sometimes tea and bread. Compared with other Aframomum spp., the seeds of korarima have a less peppery pungent taste, and milder, sweeter flavor (Janson 1981). Its capsule which, once up on a time, had been used as money for exchange is totally harvested from wildly grown in the forests of many places of Ethiopia (Table 3).

Korarima

Besides the large domestic consumption of korarima, Ethiopia exported to Sweden, Finland, Sudan, India, Egypt and Saudi Arabia (Janson 1981). Ethiopian korarima was notably penetrated the Scandinavian market and priced at $US 9 per kilogram in early 1978 as cardamom substitutes (Purseglove *et al* 1981). It is very similar in vegetative growth and aroma to cardamom, and is a perennial herb that starts bearing after three years of planting and continue giving yield for long time under well managed shades. Korarima grows naturally at about 1000-2000 m on shaded places, in same habitat with coffee, under coffee and other bushy plants. Hence, it is an important under growing and shade loving spice that fits coffee diversification at higher altitudes whereas cardamom grows below 1500 m, where korarima can not not perform well.

Genetic Diversity

Korarima collection was started in 1972. In the same habitat with *Aframomum korarima* another species, *Aframomum zambesiacum* which is a sub-species of *puberulum*, the so called Monkey's Korarima, that grows near marshy areas, but not used as spice. Variety development is still not in progress because under natural conditions it grows under heavy shades in the lowest (poorest) strata of preclimax forest, where it receives highest soil moisture, no physical disturbance like trampling, therefore, it seems that it is very difficult to simulate or establish such a heavy natural shade on large experimental plots which accommodate all collections and their replications.

Table 3. Korarima growing places of Ethiopia

Zones	Specific areas
Kefa (Jima)	All weredas
Welega	Gimbi, Nekemet, Horo Guduru, Arjo
Sidamo	Sidama, Arero
Bale	Wabe, Ganale, Dolo
South and North Omo	Kulo, Gamo, Galeb and Hamar Bako, Gofa
Illubabour	All weredas
East and West Gojam	Deber Markos, Kola Dega Damot, Metekel, Agew Mider

Shade Management

Korarima and cardamom are delicate plants that do not tolerate direct sun light. Korarima favors the southwestern Ethiopia preclimax rain forest, while cardamom favors the evergreen rain forests like that southern India and Sirilanka (Purseglove *et al* 1981). Their association with other crops are very complex and they are shade loving plants under natural conditions. The shade level requirement for both korarima and cardamom were studied at Jima and Bebeka using artificial black polytheen screen. The shade levels were: 0% (open field), 43%, 47%, 55%, 63% and 72%. In both experiments plants under 55% up to 63% shade levels gave highest capsule yield and those planted in open field did not survive at all (Table 4). Either under natural or artificial plantation, trees 55% to 63% shade should be selected or pruned down to this optimum level. Similarly the korarima planted under less shade performed better in summer probably due to cloud cover and moisture availablity than those planted under similar shade in winter. The trees used for shade should retain their leaves during dry season.

Table 4. Performance of korarima plant under different shade levels at Jima

Shade level (%)	Plant height (cm)	No. of leaves/ pseudosetm	Fresh capsule length (cm)	Dry capsule length (cm)	Wt. of fresh capsule (g)	Wt. of dry capsule (g)	Dry capsule yield (q ha^{-1})
0%	-	-	-	-	-	-	-
43%	89.05	16.07	25.38	3.82	25.35	4.31	2.23
47%	102.45	19.87	27.70	3.92	27.67	4.71	5.39
55%	118.45	19.77	27.42	4.36	27.42	5.02	6.39
63%	131.10	19.77	26.99	4.05	26.99	5.61	8.11
72%	134.47	20.67	25.83	4.19	25.83	5.01	5.69
Mean	115.10	19.23	26.66	4.07	26.65	4.77	5.56

Source: Jima Research Center Progress Reports (1984/85, 1985/86 and 1986-1991)

Shades create suitable microclimate for korarima and cardamom plantations and regulate moisture and temperature. Thus, creating a microclimate for optimum vegetative growth is essential. The microclimate prevailing in shade gardens create a favorable environment for root development, particularly when korarima rhizomes produce very shallow roots at each nodes. As soon as the soil is directly exposed to influence the climate, soil moisture and soil temperature fluctuate considerably, therefore, the root development of shallow rooting plants will be limited if protective shade covering is missing or cut down. The protective influence of shade in maintenance of soil fertility, moisture reserve, facilitating decay of organic matter, weed depressing is fundamental therefore, digging, tillage, mulching, weeding requirement is of little importantance in korarima plantation.

At present, korarima is collected only from preclimax forest: however, forest denude, collectivization, settlement, State Farm expansion and land per head reduction currently brought irreversible threatening of the existence of korarima plant in Ethiopia.

Chemical Composition

The seed of korarima contains about 2% essential oil (Janson 1981). The oil has a typical odor and is sometimes called 'nutmeg-cardamon'. Stem-distilled dried comminuted fruits for 8 hours can give about 3.5% of pale yellow volatile

oil with a flat cineolic odor which is found in the following compounds.

Compound	Percent
1,8-cineole	35.1
α-pinene	3.2
-terpinene	2.6
Camphere	0.2
P-cymene	3.9
β-pinene	6.8
Terpinene-4-ol	5.4
Sabinene	6.7
α- terpineol	3.4
Myrcene	0.4
gerniol	4.8
α-phellandrene	0.3
α-terpinene	0.9
terpinolene	0.4
Limonene	13.5

Purseglove *et al* (1981) also identified the following constituents in the essential oil of korarima:

Monoterpene hydrocarbons

P-cymene
camphere
limonene
myrcene
α-phellandrene
α-pinene
β-pinene
sabinene
α-terpinene
γ- terpinene
terpinolene
Epoxides and Carbonyls
1,8 cineole
Monoterpene alcohols
geraniol
α-terpineol
γ-terpinene-4-ol

Ginger

Importance and Distribution

Ginger (*Zingiber officinale*) `Zingible' is Known in Ethiopia since the beginning of the 13th century. It is cultivated in wider environments than any other spices (Borget 1993 and Purseglove *et al* 1981). It is popular in the daily dish of every Ethiopian and is used as sole or together with other spices for flavoring a variety of foods and local drinks. In the past, Ethiopia has been importing large quantity of ginger from India and Jamaica (Anand 1982), but today besides large domestic use, export is made to Egypt, Saudi Arabia, Yemen, Kenya and Djibuti (Janson 1981). In addition Ethiopia is exporting ginger oleoresin (Bahiru and Nigist 1992).

Germplasm Collection and Introduction

Nationwide collection of ginger germplasm started jointly by Jima Research Center and PGRC/E in 1972. In 1971 survey questionnaires were distributed through Ministry of Agriculture to Kefa, Illubabour, Welega, and others in order to get ginger crop cultivation status and other relevant ginger production information (Table 5).

Table 5. Ginger growing areas in Ethiopia

Zones	Specific areas
East and West Gojam	Bahir Dar, Degen, Debere Markos, Kola Dega Damot, Metekel and Agew Midder,
Illubabor	All
Kefa (Jima)	All
North and South Omo	Gamo, Galeb and Hamer Bako, Gofa and Kulo Konta,
Bale	Wabe, Dolo and Genale,
Sidamo	Sidama and Araro,
Welega	Gimbi, Nekemt, Horo Guduru and Arjo

Besides collections, sixteen varieties were introduced from top commercial ginger producing countries from 1973 to 1979. These cultivars were evaluated for their fresh rhizome yield at Tepi (Table 6).

Table 6. Yield of ginger accessions at Tepi

Accessions	Fresh yield* (q ha^{-1})
Ging. 16.79	203.4
Ging. 141.73	230.4
Ging. 41.79	361.2
Ging. 305.72	242.6
Ging. 180.73	358.6
Ging. 37.79	278.1
Ging. 39.79	231.9
Ging. 36.79	237.4
Ging. 38.79	362.1
Ging. 296.79	269.0
Ging. 190.73	168.0
Ging. 15.79	260.2
Ging. 316.73	196.9
Ging. 181.73	221.3
Ging. 28.79	364.6
Ging. 40.79	339.3
Mean	266.6

Source: Jima Research Center Progress Reports (1984/85, 1985/86 and 1986-1991.)

** Mean of five seasons*

Some of these cultivars were analyzed by the Ethiopian Spice Extraction Factory (Table 7). Variety Ging.38.79, Ging.190.73, Ging.36.79, Ging.37.79 and Ging.28.79 gave highest essential oil yield percentage. Variety Ging.36.79, Ging.16.79, Ging.307.72, Ging.37.79 and Ging.28.79 gave highest oleoresin yield.

Variety Evaluation

Nine ginger cultivars were evaluated at Tepi for their fresh rhizome yield and yield components for six seasons. The local check, Mizan (Miz.cu.180.73) gave highest cumulative yield of 374.9 q ha^{-1} followed by the introduced cultivar Mau.37.8 with fresh rhizome yield of 357.8 q ha^{-1} (Table 8) while the cultivar collected from Maji (Maji.190.73) gave yield 229.7 q ha^{-1}.

Table 7. Essential oil and oleoresin content of ginger cultivars from Tepi

Cultivar	Source (Origin)	Color	Essential oil yield (V/W)	Oleoresin yield (%)
Ging. 307.72	Wellaita	LY	1.4	10.9
Ging. 190.73	Maji	LY	1.9	9.4
Ging. 180.73	Mizan	LY	1.3	9.7
Ging. 36.79	Austiralia	LY	1.8	13.3
Ging. 37.79	Austiralia	Y	1.8	10.8
Ging. 38.79	Austiralia	LY	2.1	7.3
Ging. 296.79	Rafinfua	LY	1.6	9.3
Ging. 16.79	Rafinfua	LY	1.5	9.5
Ging. 40.79	Riodejanero	LY	1.3	7.3
Ging. 41.79	Riodejanero	LY	1.2	9.0
Ging. 16.79	Mainland	Y	1.5	11.0
Ging. 28.79	Mauritius	LY	1.8	10.2
Ging. 316.73	Surinam	LY	1.0	6.5
Mean			1.5	9.5

L.Y = Light yellow, Y = Yellow
Source: Ethiopian spice Extraction Factory (Unpublished,)

Table 8. Fresh rhizome yield and yield components of ginger cultivars at Tepi

Cultivars	Plant height (cm)	No. of tillers per plant	Length of rhizome (cm)	Width of rhizome (cm)	Yield (q ha^{-1})
Sib.36.79	63.8	10.8	12.3	8.5	296.8
Maw.37.79	67.8	11.7	12.4	9.2	357.8
Mar.38.79	62.9	9.5	11.9	9.0	344.1
Mal.38.79	72.5	11.8	11.4	8.2	238.5
Aus.141.73	78.6	13.5	10.6	7.9	239.3
Miz.c.180.73	64.5	11.5	11.5	8.6	374.9
Miz.w.181.73	72.4	11.8	11.2	7.9	258.7
Maj.190.73	58.8	11.5	9.4	6.8	229.7
Wall.305.73	71.1	11.2	11.4	9.1	335.1
Mean	68.1	11.5	11.3	8.3	297.2

Source: Edossa (1995)

The quality of ginger is assessed based on general appearance, size, physical form of rhizomes, aroma, flavor, oleoresin content, and quality (Purseglove *et al* 1981). In general, ginger yields 5 to 6% of the oleoresin based on analysis made by Solomon *et al* (unpublished). The oleoresin yield of ginger varieties from Tepi ranges from 6.01 to 8.22 and relatively higher yield and volatile content were obtained for the variety Mar.38.79 and Tepi local.

According to the Indian standard, the volatile oil content of ginger oleoresin is 16 to 35%. Nevertheless, the volatile oil content of ginger cultivars, evaluated at Tepi, was from 28.9 to 43.76% (Table 9). Based on Indian standard, the physical characteristics, specific gravity and refractive index values for volatile oil from ginger oleoresin, at 20 ^{0}c are 0.8685 to 0.8803 and 1.4880 to 1.4970.

The steam distilled volatile oil which is responsible for the aroma of ginger is present with the range of 1.0 to 2.5% in dried rhizome. The volatile oil yield of ginger cultivars from Tepi ranges from 1.83 to 2.50%. The specific gravities and refractive indexes of the oils are comparable with those standards.

Table 9. Oleoresin, essential oil yield, volatile oil content of oleoresin, physical characteristics of volatile oil and essential oil of ginger cultivars from Tepi

Cultivar	Yield (%)	Volatile oil (%)	Specific gravity	Refractive index	Yield (%)	Specific gravity	Refractive Index
Sib.36.79	6.9	36.0	0.8398	1.4931	2.2	0.8717	1.4910
Maw.37.79	7.5	37.2	0.8975	1.4924	1.8	0.8527	1.4925
Mar.38.79	8.2	35.7	0.8787	1.4912	2.5	0.8786	1.4910
Mal.39.79	6.0	28.9	0.8686	1.4929	2.1	0.8786	1.4920
Aus.141.79	6.9	33.3	0.8800	1.4920	1.9	0.8805	1.4920
Miz.cu.180.73	7.4	34.3	0.8845	1.4938	1.9	0.8587	1.4922
Miz.wi.190.73	7.1	40.6	0.8825	1.4947	1.9	0.8773	1.4952
Maji.305.72	7.4	41.9	0.8807	1.4960	1.9	0.8675	1.4947
Tepi local	7.0	43.8	0.8861	1.4949	2.0	0.8829	1.4948
Mean	7.2	36.8	0.8776	1.4934	2.0	0.8721	1.4929

Source: Ethiopian Spice Extraction Factory (unpublished)

Planting Date

Farmers in southwestern Ethiopia plant ginger at the beginning of the rainy season or leave it under ground for the next year seed purpose. From there, ginger rhizomes will germinate (ratoon crop) and farmers will harvest the rhizomes irrespective of their yield. Trials were conducted at Tepi from the 1987 to 1990, to examine the effect of ginger planting dates on yield. Seven different planting dates were used at monthly intervals starting from fifth of March to fifth of September. Planting on the fifth of March gave the highest fresh rhizome yield followed by planting on the fifth of April. The yield decreased continuously from March on wards (Table 10).

Land Preparation

Trial was conducted to determine the best method of land preparation for ginger at Tepi. The trials were conducted for five consecutive seasons. The highest yield, 207.7 q ha^{-1} was obtained by planting ginger on raised bed, followed by planting ginger on open ridges after emergence with yield of 195 q ha^{-1}. The lowest yield 173.9 q hà was obtained by planting turmeric on tide ridges (Table 11).

Table 10. Mean fresh yield of ginger planted at different times (average of three seasons)

Planting time	Yield (q ha^{-1})*
5th March	340.9
5th April	303.8
5th May	271.2
5th June	222.5
5th July	160.4
5th September	102.1
5th October	53.9
Mean	207.8

Source: Jima Research Center Progress Reports (1980/81, 1982/83, 1983/84, 1984/85, 1985/86)

Spacing

Trials were conducted at Bebeka for two seasons to determine ginger spacing for maximum rhizome yield. Three levels between rows and three levels between plants were compared. As the distances between rows and plants decrease the average yield tends to increase (Table 12).

Table 11. Fresh rhizome yield of ginger obtained from different land preparation methods at Tepi

Land preparation	Fresh rhizome yield (q ha^{-1})*
Flat land	192.6
Planting on open ridges	148.7
Planting on open ridges after emergence	195.1
Planting on raised bed	207.7
Planting on tide ridges	173.9
Tide ridges after emergence	192.8
Mean	185.2

Source: IAR Jima Research Center Progress Reports (1983/84, 1984/85, 1985/86)

* *Average of five seasons*

Table 12. Fresh rhizome yield of ginger from different plant and row spacings (q ha^{-1}) at Bebeka*

Spacing between plants (cm)	Spacing between rows (cm)				Row
	20	30	40	50	mean
15	200.0	161.8	174.3	193.1	182.3
20	188.8	175.7	159.7	144.5	167.7
25	177.1	175.7	134.0	134.0	155.2
30	189.5	179.7	157.6	133.3	165.1
Mean	188.8	173.2	156.4	151.2	67.4

Source: Jima Research Center Progress Report (1983/84, 1984/85, 1985/86)

* *Average of two years*

Fertilizer Requirement

A factorial combined experiment of coffee husk compost at 0, 45, and 90 t/ha, N at 0, 75 and 150 kg ha^{-1}, P at 0, 33, and 66 kg ha^{-1} were tested on ginger at Tepi. Although the statistical analysis of yield was not significant, the yield increases with increasing N and coffee husk (Table 13).

Table 13. The effect of N and P on the yield of ginger (q ha-1) at Tepi

Coffee husk	N (Kg ha^{-1})	P (Kg ha^{-1})			
(t ha^{-1})		0	33	66	Mean
0	0	410.3	430.5	454.4	431.8
	75	470.8	492.7	480.0	481.1
	150	427.8	442.7	474.2	448.2
	Mean	432.3	455.3	469.6	453.7
45	0	434.0	419.1	462.0	438.4
	75	491.0	480.0	514.6	496.2
	150	468.2	538.2	439.6	481.8
	Mean	464.4	479.1	471.8	471.8
90	0	425.2	403.1	426.8	418.4
	75	433.2	418.4	425.1	458.9
	150	498.4	458.2	500.9	485.8
	Mean	486.5	426.6	450.9	454.4
	Over all mean	426.1	453.6	464.1	459.9

Source: Paulos 1986

Turmeric

Importance

Turmeric `Ird' is a spice from the rhizome of a perennial herb (*Curcuma domestica.*), which is used as a ground spice and in curry powder, mainly as a food coloring agent as well as a coloring material in the textile industry. Before 1972, Ethiopia is one of turmeric importing countries (Manning 1969). The ground spice is obtained from the cured rhizomes called fingers or bulbs, depending on their shapes. The quality of the spice is assessed by its color thus, broken rhizome should be bright yellow or orange yellow and not black. The cultural requirement of turmeric is similar with ginger (Jonson 1981 and Purseglove et al 1981).

Variety Introduction

In 1972, two varieties of turmeric were introduced from abroad for adaptability study (Table 14) at Jima, Metu, Bebeka, Tepi, Wenago, Awasa, Mugi and Bako. At all locations turmeric performs well (Zenebe and Bereke 1987). Purseglove et al 1981 also stated that turmeric can be grown up to an altitude of 2000 m in areas with high rain fall. At present, because of the suitability of southwestern humid regions, the varieties Tu.48.72 is disseminated and adopted by farmers faster than any new and recently introduced crops in all over coffee growing regions. Thus, it has become another cash crop spice.

Table 14. Turmeric varieties available at Jima and Tepi

Variety	Origin
Tu.48.72	India
Tu.51.7	China

Chemical Contents

Chemical analysis was made for both cultivars for their oleoresin yield. The variety Tu.48.72 gave the highest oleoresin yield percentage. The yield, odor and flavor of the oleoresin extracted from the two samples were good (Table 15).

Table 15. Oleoresin yield of turmeric varieties at Jima

Varities	Oleoresin yield (%)
Tu.51.72	13.7
Tu.4.72	18.0
Mean	15.85

Planting Materials

When there is scarcity of turmeric rhizome planting material, the whole rhizome will be cut into pieces each having buds for planting. Trials were conducted at Jima to select the best yielding among the whole cut and finger or lateral rhizomes. Using whole rhizome the highest fresh rhizome yield, 147.5 q ha^{-1} was obtained (Table 16).

Table 16. Fresh rhizome yield of turmeric from different types of planting materials

Planting materials	Mean fresh yield (q ha-1)
Mother rhizome (whole)	147.5
Mother rhizome (cut)	87.7
Primary finger	110.3
Mean	115.2

Source: Jima Research Center Progress Reports (1983/84, 1984/85, 1985/86)

When whole rhizome is used as planting material, it gave highest yield. However, during planting when turmeric rhizomes were stored in pile or in underground produce sprouts due to early rain shower that initiate germination and others were unable to sprout. Due to these variabilities at the time of planting, selection of best yielding planting materials was made. The results showed that

sprouted rhizome gave highest fresh yield of 194.2 q ha^{-1} (Table 17).

Table 17. Fresh rhizome yield of turmeric obtained from different planting materials at Tepi

Planting materials	Mean fresh yield (q ha^{-1})
Unsprouted rhizome	168.2
Sprouted rhizome	194.2
Transplanted rhizome	172.6
Mean	178.3

Source: Jima Research Center Progress Reports (1985/86 and 1986-1991)

Planting Date

Turmeric is rhizomatous crop that produce sprouts when rain shower begins. Studies were made to select optimum turmeric planting date at Tepi for three seasons. Seven planting dates at monthly intervals starting from the fifth of March to the fifth of September were evaluated. The yield highest in the fifth of March (184.8 q ha^{-1}) and lowest in the fifth of September (11.2 q ha^{-1}) (Table 18).

Spacing

An experiment with three different spaces between rows and four different spaces between plants was conducted at Tepi. The highest yield of 305.9 q ha^{-1} was recorded from 30 cm spacing between rows and 15 cm between plants (Table 19).

Table 18. Yield of turmeric rhizome planted at monthly interval

Planting dates	Mean yield (q ha^{-1})
5 March	184.8
5 April	93.5
5 May	61.6
5 June	30.4
5 July	35.4
5 August	21.4
5 Sept.	11.2
Mean	62.6

Table 19. Fresh rhizome yield of Turmeric (q ha^{-1}) spaced at different distances between rows and plants at Tepi

Spacing between plants (cm)	Spacing between rows (cm)			Between plants
	30	40	50	mean
15	305.9	300.9	274.6	293.8
20	277.2	301.2	276.8	285.1
25	287.0	284.6	259.2	276.9
30	286.1	283.1	241.8	270.4
Row mean	289.1	292.5	263.1	281.5

Source: *Jima Research Center Progress Reports (1980/81-1982/83, 1983/84, 1984/85 and 1985/86)*

Land Preparation

Land preparation methods for turmeric were studied at Jima using variety Tu.51.72. Planting turmeric on a raised-bed gave the highest rhizome yield (Table 20).

Table 20. Fresh rhizome yield of turmeric obtained from different land preparation methods

Treatment	Yield (q ha-1)
Flat land	209.7
Open ridge, before planting	312.4
Open ridges, after emergence	302.4
Raised beds	335.5
Tide ridges	267.9
Tide ridge, at interval	284.4
Mean	285.4

Source: Jima Research Center Progress Reports (1983/84, 1984/85 and 1985/86)

Planting Materials and Time of Harvest

Experiment with four different sizes of turmeric planting materials (2, 4, 6 and 8cm) and six different harvesting dates at three month intervals starting from the ninth month after planting upto 24 month after planting were conducted at Jima. The yield increases as the size of planting materials increases. A 301.7 q ha^{-1} rhizome yield was obtained from the largest rhizome (8 cm). The time of harvest also showed significant yield difference. Harvesting after 18 months of planting gave the highest yield, 390.2 q ha^{-1} (Table 21).

Table 21. Use of different sizes of planting material and different harvesting time on turmeric yield at Jima (q ha^{-1})

Time of harvest (month)	Size of planting material (cm)				Time of harvest
	2	4	6	8	mean
9	72.8	83.9	132.1	171.2	115.0
12	75.8	94.4	138.8	177.4	121.6
15	265.5	299.9	344.4	346.8	296.0
18	393.5	335.1	339.1	493.1	390.2
21	276.2	249.6	325.8	286.0	284.4
24	317.1	266.2	397.0	335.3	320.9
Mean	233.5	209.9	279.5	301.7	256.2

*Source: Research Center Progress Reports (1983/84,1984/85 and 1985/86 *)months after planting*

N and P Fertilizer Requirements

A factorial experiment of N X P each at four levels was used at Bebeka to study the response of turmeric to N and P fertilizers. Urea at 0, 50, 100, 150 kg ha^{-1} a DAP levels at 0, 22, 44, and 66

kg ha-[1] were used with the variety Tu.48.72 at plant spacing of 30 X 15 cm. Although there was to be a slight improvement in yield at higher combinations of N and P (Table 22) the result was statistically non significant (Paulos 1986).

Table 22. Effect of fertilizer treatments on the yield of turmeric (q ha-1) at Bebeka

	P (kg ha^{-1})				
N (kg ha^{-1})	0	22	44	66	Mean
0	535	493	478	485	498
50	549	412	469	572	501
100	458	512	647	485	528
150	494	656	640	562	588
Mean	509	521	559	526	

Source: Paulos (1986)

Cardamom

Variety Introduction

Cardamom *(Elleteria cardamomum)* `Heel' or `Yeshaikimam', is a perennial herb, belonging to the Ginger family. It is an expensive spice known as the `Queen of Spices'. It occupies an important foreign exchange commodity in its homeland (Nambiar 1982) and the highest priced spice in world markets (Rijkebuseh 1971).

Even though it was not cultivated in Ethiopia before, the least quality capsule is found in almost all Ethiopian markets, indicating its wide utilization. It is used as a flavoring material. Cardamom plays an important role in a variety of spiced foods, vegetables, meat dishes, for flavoring tea, butter, coffee, bread, cakes, and wet in ground or whole forms as sole or mixed with other spices.

Cardamom starts bearing after three years of planting and continue giving yield for long time if its management is well done. It was introduced to Ethiopia in 1972. The morphological characters of the cultivars first introduced to Ethiopia are described in table 23.

Table 23. Some morphological characteristics of introduced cardamom cultivars

Car.14.79	Car.82.72
Leaves are hairy on the lower surface	Leaves are coarse and are grabous beneath
Panicles are prostrate	Panicles are erect or arching
Fruit are small, globose rounded or ovoid and highly ribbed	Fruits are longer, fusiform three angled and ribbed
Plants are short leafy shoots	Plants are longer leafy shoots

After its introduction to Ethiopia, multiplication of the materials was done at Jima, Bebeka and Tepi, while adaptability and evaluation studies were done Jima, Metu, Mugi, Wonago, Tepi and Bebeka. Results showed that Tepi and Bebeka are ideal for cultivation (Zenebe and Bereke 1987).

Shade Trees Management

Cardamom is a shallow-rooted plant, which thrives best in the shade. It requires similar management with korarima. In order to create suitable microclimate that can conserve soil moisture reserve and

light, optimum shade is required. Cardamom plant needs a rainfall of 2000 to 5000 mm per annum with a uniform distribution and no distinct dry season (Purseglove *et al* 1981).

Although the southwestern part of Ethiopia gets the highest and long rainfall, such a rainfall situation does not occur, where cardamom is adapted. At Bebeka and Tepi December to February are dry periods and more of the rain occur at Bebeka from March to November. During these dry periods associated with high temperature, the available soil moisture becomes below the cardamom requirement, which has negative effect on its growth and performance. When this dry season is prolonged, the vegetative part will die out either partially or completely resulting low or no yield.

Although specific and proper types of shade trees are not yet selected at Bebeka and Tepi, the cardamom plant should be established in partly cleared forest or interplanted with coffee, banana or enset. Where this is not possible, shade trees should preferably be leguminous types such as *Leucanena leucocephala* and *Glricidia maculala*.

Chemical Characteristics

Detailed chemical analysis of the cultivar Car. 82.72 was made by Bahiru and Tigist (1993) for its oleoresin, essential oil, physical characteristics of the oil (Table 24).

Table 24. Quality characteristics (%) of cardamom (var. Car.82.72), sample from Tepi

Characteristics	Content (%)	US Standard
Moisture	8.8	Not > 11.0
Ash	6.7	Not > 7.0
Ash in soluble in HCl	1.10	Not > 3
Crude fiber	16.9	- -
Protein	7.4	- -

Source: Bahiru and Tigist (1993)

Although the oleoresin and volatile oil yields of cardamom depends on many factors like post harvest handling, the raw materials and the solvent used during the analysis, Ethiopian cardamom *(Elleteria cardamomum*) gave low yield of volatile oil for acetone extract as compared to the market (Table 25), but a high value volatile oil (58%) was obtained for hexane extracts which is within the range of commercial cardamom (52 to 58%).

Table 25. Yield and volatile oil contents of cardamom oleoresin with different solvents samples from Tepi

Variety	Solvent	Oleoresin yield (%)	Volatile oil content (%)
Car.14.79	Acetone	6.8	26.8
	Hexane	5.2	55.2
	Ethanol	7.9	36.6
Car.82.72	Acetone	6.9	27.5
	Hexane	6.3	58.0
	Ethanol	8.2	34.4

Source: Bahiru and Tigist (1993)

The whole cardamom usually has the volatile oil yield in the range of 3.5 to 7%. The yield of Car. 14.79 is 5.8% and Car. 82.72 has 6.1% yield of volatile oil cultivars is within the range the highest being that of Car.82.72 cardamom (Table 26).

Table 26. Yield of cardamom essential oil samples from Tepi

Cultivar	Yield (%)	Importing countries volatile content (%)
Car.14.79	5.8	3.5 - 7
Car.82.72	6.1	3.5 - 7

Source: Edossa et al (1995)

The quality of volatile oil of Ethiopian cardamom oleoresin is similar to the Indian cardamom. The major components are 1,8-cineole and x-terpinol acetate, comprising 78% and 63% of the oil (Purseglove et al 1981). This component is the one that indigenous Ethiopian korarima lacks (Nambiar 1982) which plays important role in aroma and flavor. The major component of korarima oil is cineole (35 to 40%). The essential oil yield and physical characteristics of Ethiopian cardamom are comparable with the values of exporting countries.

Balck Pepper

Importance

Black pepper *(Piper nigrum)* `Kundo-berbere' or `Yebahirkimam' is used in all parts of Ethiopia. The dried fruits are thought to be introduced to Ethiopia and are very expensive in local markets.

Dried fruit of *Schinus molle* (pepper tree) is used as a true pepper substitute locally, where true black pepper is not available or very expensive, it also has a bio-pesticidal effect on some insect species. Pepper is a perennial glabrous woody climber that grows to a height of 10m. Under the best cultivation when the height is restricted, the mature vine will have bushy columnar appearance and is about 4m high and 1.5m in diameter (Perseglove et al 1981)

Variety Introduction and Adaptation

Five cultivars were introduced from abroad from 1979 to 1980. These cultivars were planted to test their adaptation at Bebeka, Jima and Tepi for adaptation. At Bebeka the cultivars grew vigorously with excellent performance. While at Tepi they were good, but with lesser performance than Bebeka. At Jima they failed to grow. The varieties Br.32.79, SL.3.8 and Pa.4.80 gave higher yield and a yield of 40 to 70 q ha^{1} fresh red cherry were recorded (Table 27). The picking season starts in December and ends in March. Therefore, in Ethiopia it is possible to cultivate black pepper sucessefully in wider range of altitude than cardamom, from 1250 m at Tepi to extremely lowlands of southwestern Ethiopia where high rainfall is throughout the year. The performance of pepper at Bebeka is very better than at Tepi.

Table 27. Performance of pepper cultivars at Bebeka

Cultivars	Fresh yield* (kg per tree)**	Fresh yield (q ha^{-1})
Br.32.79	1.8	62.5
Sl.3.80	2.12	73.7
Pa.4.80	1.8	62.5
Ku.5.80	1.2	41.6
Mean	1.7	60.1

** Spacing (2.4 x 1.2m), ** Average of three years*

Support and Shade Trees for Pepper Vine

As pepper is a climbing vine, it requires support. Pepper vine could be grown also as a secondary

crop in fruit tree stands for support. It requires a heavy and well distributed rainfall as much as 2500 mm per annum (Puresglove *et al* 1981). Such heavy and well distributed rainfall does not occur in Ethiopia, therefore, shade is needed, although it may have a negative effect on time of maturity and yield.

Quality of Ethiopian Pepper

Black pepper quality is evaluated on the bases of its appearance, pungency, aroma, and flavor. The pungency level is expressed as piperine, which is the major pungent principle of spices. Based on the analysis made by Bahiru and Tigist (1993,) Bebeka's black pepper piperine content is comparable to the international average standard of 4 to 7%. The highest yield and volatile content of oleoresin of Ethiopian pepper was obtained from the variety Ku.5.80 (Table 28). The analysis of oleoresin yield, volatile oil content, physical characteristics of volatile oils, and chemical composition of the volatile oils of oleoresin indicate that the Ethiopian black pepper satisfies international standard quality.

Table 28. Yield, volatile oil and piperine content of black pepper oleoresin with different solvents

Variety	Solvent	Oleoresin (%)	Volatile oil (%)	Piperine (%)
Sl.3.80	Acetone	10.0	15.0	47.8
	Hexane	4.8	51.5	11.5
	Ethanol	8.4	10.3	42.5
Pa.4.80	Acetone	9.1	16.4	47.5
	Hexane	5.0	35.1	20.5
	Ethanol	9.1	6.9	38.1
Ku.5.80	Acetone	10.3	18.0	51.9
	Hexane	4.8	49.7	15.8
	Ethanol	8.3	7.6	50.4
Cr.17.79	Acetone	10.4	12.1	42.7
	Hexane	7.3	33.6	26.4
	Ethanol	9.1	7.1	33.8
Br.32.79	Acetone	10.1	13.2	44.1
	Hexane	7.9	43.3	24.4
	Ethanol	9.5	6.6	37.3

Source: Bahiru and Tigist (1993)

Cinnamon

Eniveronmental Requirements

Cinnamon *(Cinnamomum verum)* `Kerefa' is an evergreen tree. It grows to a height of 8 to 17 m in wild with stem girth of 30 to 50cm. When coppiced from time to time, it could be maintained as a bush from 2 to 2.5 m highst with multiple stems arising from its base (Bavappa *et al* 1981). The dried inner bark and leaves are strongly aromatic. It can grow well in almost all soil types under a wide variety of tropical conditions ranging from semi-dry to wet zone. It requires a warm and wet climate with average temperature of 20 to 30^{0}c high rainfall (Perseglove *et al* 1981 and Bavappa *et al* 1981).

Variety

The cinnamon variety, Cin.5.82 was introduced to Ethiopia in 1975. It is performing well at Tepi and Bebeka but less vigoros at Jima and Metu. In Ethiopia it grows at wider agroecology than black pepper and cardamom.

Quality of Ethiopian Cinnamon

The quality of cinnamon is assessed on the basis of its appearance, oil content, aroma and flavor of the volatile oil (Table 29).

Table 29. Quality characteristics (%) of Ethiopian cinnamon and international standard (IS)

Characteristics	Cin.5.82	IS
Moisture	10.6	Max. 12.0
Ash	3.5	Max. 5.0
Ash Insoluble in HCl	0.03	Max. 1.0
Crude fiber	33.4	-
Protein	4.9	

Source: Berhanu and Tigist 1993

** Variety - Cin. 5.82*

The volatile oil content of commercial cinnamon oleoresin has been reported to range from 16 to 60%. Cin.5.82 yielded high oleoresin when acetone is used as a solvent (12.6%) and the volatile oil content was found to be highest with Hexane (Table 30).

Table 30. Yield and volatile oil content of cinnamon bark oleoresin

Variety	Solvent	Oleoresin yield (%)	Volatile oil content (%)
Cin.5.82	Acetone	12.6	12.6
	Hexane	2.0	38.1
	Ethanol	10.1	5.9

Source: Berhanu and Tigist 1993

Conclusion

The spices research program that was launched two decades back achieved successes in cardamom, turmeric, cinnamon, black pepper and ginger cultivations. Depending of the adaptability study made in different areas of southwestern Ethiopia where there is high rainfall throughout the year, cardamom and blackpepper spices are adapting to the lowlands such as Gimira, Shakicho and Bench. However, ginger, turmeric and cinnamon adapt to more wider ecologies.

At present Korarima grows and available only in wild under forest shade, however, that it is also possible to bring under domestication by providing some optimum requirements.

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Details of the Spices

a. General descriptions

Common name	Cardamom	Cinnamon	Ginger	Korarima	Pepper	Turmeric
Botanical name	*E.cardamomum*	*C. verum*	*Z. officinale*	*A. korarima*	*P. nigrum*	*C.domestica*
Origin	Asia	Asia	Asia	Ethiopia	Asia	Asia
Year of introduction	1972	1975	13th century	Indigenous	1972	1972
Parts used	Seeds	Bark and leaf	Rhizomes	Seeds	Whole fruits and seeds	Rhizome
Type of products (forms)	Green cardamom, Bleached cardamom, Decorticated.	Bark and Quill, Featherings, Chips.	Hands and fingers, Peeled, Scraped, Rough scraped, Unpeeled or coated, Black ginger, Bleached or limed, Splits, Slices and Uncoted		White pepper, Black pepper, Green pepper	Fingers, Hands, Bulbs, Splits
Products prepared	Essential oil, Oleoresin	Essential oil (bark and leaf), Oleoresin	Essential oil, Oleoresin	-	Essential oil, Oleoresin	Oleoresin

b. Bearing and growth habits of some studied spices

Spices	Time between planting and 1st harvest (years)	Time between planting and full production (years)	Average life of the plantation (years)	Propagation	Shade requirement	Support requirment	Yield (ha^{-1})
Korarima	3	5-6	Unlimited	Seed, Cutting	Obligate	No	8q
Ginger	7-10 months	7-10 months	1	Rhizome and finger (or cutting)	Partial or no	No	90-450 q fresh
Turmeric	18-21 months	18-21 months	2	Rhizome and finger (or cutting)	Partial or no	No	220-520 q fresh (pure stand)
Cardamom	3 (Stock) 4 (from seeds)	4-5 6-7	>30 >30	Rhizome cutting Seed	Obligate	No	200 - 300Kg fresh capsules
Cinnamon	4-5	5-6	>25	Seed	No	No	180-220 Kg top grade bark
Pepper	3	5-7	>25	Cutting	Partial or no 1	Obligate [1]	Very variable depending on growing method. 350-3750 kg (India)

1 (E. indica should be used for support and some times for shade)

2 Yields are very variable depending on growing conditions, variety and managements made

Sources: Borget (1993) and Helgason and Storgaard (1987)

C. The most commonly used spacings in some spices plant cultivation (Pure stand)

Spices	Spacings (m)
Korarima	0.5x0.5 (at planting)
Ginger	0.25x0.25(India) 0.3x0.3 (Kerala) 0.3x0.8 (Bangal) 0.3x1.2 (Mysore) 0.35x0.5 (Jamaica)
Turmeric	0.225x0.225 (India) 0.15 to 0.3x0.15 to 0.3 (Srilanka)
Cardamom	2 to 2.5x2 to 2.5 (India) 1.5x1.8, 1.8 x 2.1 (Mysore Variety) 2.1 x 2.4 (Malabar Variety) in Reunion
Pepper	2x2 (Kampuchea) 2.4x2.4 (Sarawak) 2.4 to 3.6x2.4 to 3.6 (Maysore) 2.5x2.5 (Brazil) The density of planting is always greater when nonliving, rather than living supports are used.
Cinnamon	1.75x2.5 (Srilanka)

Source: Borget (1993)

d. Recommended varieties of some spices

Species	Variety [a]	Type [b]	Flowering time	Yield (q ha-1 at research center)	Cuurrent production areas
Korarima	Jima local	EHR	Seasonal	8.0 (dry)	See table 3
Ginger	Miz.c.180/73 Maw. 37/79 Mar. 38/79	AHR	Seldom produce viable seed	374 (fresh rhizome) 357(fresh) 344(fresh)	see table 5
Turmeric	Tu. 48/72	AHR	150 days after planting	350 (fresh)	South and Southwesteren Ethiopia
Cinnamon	Cin. 5/82	EWT	Continious	-	Kefficho-Shekicho, Bench-Maji
Cardamom	Cr. 82/72	EHR	Continious (9 months)	1.3 (Dry)	Keficho-Shekicho and Bench-Maji
Pepper	Sl. 3/80 Br. 32/79 Pan. 4/80	EV	Seasonal [c]	73 (Fresh cherry) 62 (Fresh cherry) 62 (Fresh cherry)	Keficho-Shekicho and Bench-Maji

[a] Recomendation given is based on yield at research center and availability of varieties

[b] E = Evergreen, T = tree, W = woody, V = vine, H = herbaceous, R = Rhzomatous

[c] Dry period checks vegetative growth and brings on floral initiation; subsequent moisture stimulates flowering which usually lasts about 2 months.

e. Chemical composition (g per 100g) of some spices

Spices	H_2O	Proteins	Lipids	Essential oils	Starch + sugars	Cellulose	Ashes	Misellaneious
Ginger	9	8	3	1.8	49	4	4.7	-
Turmeric	10	11	8	2.8	38	9	8.0	curcumin
Cardamom	11	10	2	5.3	33	17	7.5	-
Black pepper	11	13	8	1.5	41	14	4.6	Piperine 8
White pepper	11	13	7	1.6	55	7	2.1	Piperine 7

Source: Borget (1993)

f Lists of spices, herbs, stimulants and medicinal plants collection at Jima Research Center and Tepi sub-Center

Vernacular name	Scientific name	Part used	Uses
Abish(A,O), Sunko(O), Fenugreek(E)	*Trigonella fonumrecum*	Seed	Condiment
Annato(Tr)	*Bixa orellana*	Pulp round the seeds	Cosmetic, Condiments (dye)
Basobila, Kefo (O), Zika Kibe (A), Basil(Tr),	*Ocimum spp.*	Leaf, Flower	Condiment
Cocoa	*Theobroma cacao*	Bean	Stimulant
Capsicum peper (E), Cayene pepper, Red pepper(Tr), Berbere (A,O)	*Capsicum spp.*	Pod	Condiments
Candle nut	*Aleurites spp.*	Seeds	Painting oil
Cardamom(E), `Hell',Yeshai- kimam (A),Y-Hind korarima(A)	*Elleteria cardamomum*	Seed	Condiments
Cenna	*Cassi angustifolia*	Leaf, Fruit	Medicinal
Chive	*Allium spp.*	Leaf	Condiment
Cinnamon(E), Kerefa (A,O,T)	*C.verum*	Bark, Leaf	Condiment
Cinchona(E), Quinine	*Cinchona spp*	Bark	Medicinal
Coconut	*Cocos nucifera*	Seed	Stimulant
Coriander(E), Dinbilal (A,O)	*Coriander sativum*	Seed, Leaf	Condiment

f. cont'd

Vernacular name	Scientific name	Part used	Uses
Dill,Shilan(T)Insilal(A), Kamun, kamuni (O)	*Anethum graveolens*	Leaf, Seed	Condiment
Ginger(E), Zingibel(A), Zingibila(O)	*Zingiber officinale*	Rhizome	Condiments, medicinal
Gesho (A,O), Buckthorn(Tr), Dog wood(E)	*Rhamnus prinoides*	Leaf, Stem, Bark	Condiment, medicinal
Ird(A), Turmeric (E)	*Curcuma domestica*	Rhizome	Condiment, cosmotic
Kai shin-kurt (A), Onion (E)	*Allium spp.*	Bulb, Leaf	Condiment
Koseret(A), Kasey(O), Kusay(T)	*Lippia spp.*	Leaf, Flower	Condiment
Yetibs-kitel(A), Rosemary(E)	*Rosmarinus officinallis*	Leaf	Condiment
Korarima(A), False-cardamom(E)	*Aframomum korarima*	Seed	Condiment
Kundo Berbere/ Ye-baher kimam (A), Black pepper(E)	*Piper nigrum*	Seed	Condiment, medicinal
Laurel leaf, Bay leaf(E)	*Laurrus nobilis*	Leaf	Condiment
Lavender(E)	*Lavandulla spp.*	Leaf	Cosmetic
Leek (E), Baro Shinkurt (A)	*Allium spp.*	Leaf	Condiment
Mint(E), Nana`e (A),	*Mentha spp*	Leaf	Condiment
Marjoram	*Origanum spp*	Leaf	Medicinal cosmetic

f. cont'd

Vernacular name	Scientific name	Part used	Uses
Nech-azmud(A), Camun(T),KamonKamu ni(O), Bishops weed(Tr), Ethiopian Caraway(E)	*Trachyspurmem ammi Sprague* ex Turrill	Seed	Condiment
Nech-shinkurt(A), Garlic(E)	*Allium sp.*	Bulb, Leaf	Condiments medicinal
Periwinkle	*Catarantus spp.*	Leaf	Medicinal
Sage	*Salvia officinalis*	Leaf	Medicinal
Tajsar(A), Lemon grass(E)	*Symbopogon spp.*	Leaf	Medicinal, condiment, cosmetic
Tea	*Camellia sinensis*	Young leaf	Stimulant
Tikurazmud(A), Habasuda(O) Awosetta(T), Black cumin(E)	*Nigella sativa*	Seed	Condiment, medicinal
Tena`Adam'(A), Rue(E)	*Ruta chalepenosis*	Leaf, Seed	Condiment, medicinal
Timiz(A), Long pepper(E)	*Piper spp.*	Seed	Condiment
Tossigne(A,O), Thyme(E)	*Thymus shimperi*	Leaf	condiment, medicinal
Vanilla*	*Vanilla fragrance*	Seed	Condiment
Vetivar grass	*Vetivaria zizanioides*	Rhizome	Cosmetic

A= Amarigna, O = Oromigna, E = English, T = Tigrigna, Tr = Trade name, L = Local Name

** = Species that are not available in Ethiopia, but each single plant has been planted at either Jima or Tepi recently.*

Whether it is for spices production or building up the knowledge-base for profitable research findings, it will be ise to find a documentation that offers details geared to erve the need.

... This Research Report compiles a wide range of spices production and research information as experienced from a long-time efforts of Spices Research Team of the Institute of Agricultural Research of Ethiopia.

... Consulting agricultural research recommendations is nothing new and a number of technologies are finding their way to ULTIMATE USERS✪