The Prominence of

Vicia Faba and Pisum Spp.

in the Ethiopian Farming System

by

Asfaw Tilaye
INSTITUTE OF AGRICULTURAL RESEARCH

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Introduction:

The importance of grain legumes as a major source of protein in the human diet is a well-documented fact. These legumes are still grown extensively today. The cultivated legumes play a large part in the nightmare of primitive man. The cultivated legumes vary greatly in tropical and sub-tropical areas. This is of high importance to the Ethiopian agriculture which has a favourable geographical position, in both plant production and external trade movements.

The purpose of this treatise is to give a description and evaluation of Vicia faba and Pisum Spp., cultivar groups, ecological aspects as well as the vital importance of the two crops in the Ethiopian farming system. The presentation of results of research trials and problems on aspects of diseases, pests and weeds. It should be understood that these data were collected during considerable research progress to date on grain legumes in particular Ethiopia and the present studies are based on these.

Vicia faba and Pisum Spp., Ecological Distribution under Ethiopian Agroclimatic Regions.

In the climate of the tropics, Ethiopia shares both tropical monsoon-desert and desert climates as well as equatorial humid climates with hot summer. Generally few countries in the tropics possess such good natural environment for agricultural development as Ethiopia does. The favourable bio-eco-system is mainly influenced by altitude. The division of Ethiopian climate into four zones is mainly on the basis of the elevations between elevation and temperature. The four zones are:

1. "Quola" or hot zones whose altitude is below 1800 m., with an average temperature above 20°C. In this zone Vicia faba & Pisum Spp. cropping is very much limited because of lodgeer, Botrytis fabae, and mildew of Leveillula spp. diseases.

2. "Weyna Dega" or Temperate zones whose altitude is 1800-2400 m., and average temperature being 15°C. Here the importance of Vicia faba and Pisum Spp. cropping increases with the increase of altitude.

3. "Dega" or cool zones, altitude running from 2400 m. to 3800 m. with average temperature of 10-15°C. At this geographical belt the economic cropping of Vicia faba and Pisum Spp. mostly extends up to 3030 m., at altitudes between 2900 and 3200 m. Botrytis fabae in Vicia faba and Pisum Spp. are the two main limiting factors, which otherwise would have been perfectly fitting into the barley cropping rotatational system in this agro-ecology.

4. "Mountain zones" or the alpine climate, where altitude is above 3800 m., where the biotic habitat is mainly of a kind of alpine vegetation.

Ethiopia lies entirely within the tropics between 3 N. and 18 N. latitude, and between the meridians of 33 E. and 48 E. Undoubtedly topography has a decisive influence on rainfall and temperature. Maps A. and B.
Temperature

At higher altitude with higher rainfall and variable degree of cloudiness, the temperature regime is affected. Therefore, in the highlands (the "Weyna Dega") diurnal variation in temperature during the periods of rainfall is about 6°C. Whereas in dry periods it frequently is as much as 22°C. (21,31). All area between 1800 m-2400 m. above maximum temperatures rarely rising above 24-27°C. In the period between November and the end of January night frost occurs at above 2100 m. and in some sheltered places even at lower elevations some years like four years cycle. The month of November could be critical for both horse beans and field peas, particularly in the regions of altitudes between 2500 m. and 3000 m. where maturation period is relatively longer than those of 1800-2400 m. altitudes (Map A).

The period of March-May is the warmest season; in April most of the high lands (Weyna Dega) are usually surrounded by the 25°C. isotherm which for most part has taken over the place of of the 20°C. isotherm of January. In this period both horse beans and field peas have been threshed: the ground is fallow. The main limiting factor of the two crops growth is lack of adequate moisture where little irrigation is practiced. In large parts of the country minimum temperature could be experienced during June-August due to heavy rainfall and high cloudiness. Here then plants growth rate is relatively slower than month of September or June. The period end of month of September to February is normally lower, but due to cloudiness and high solar radiation, maximum and minimum temperatures could be typical.

The lowland shows normal variation in temperature in both day and night periods, that is, nights cool and days warm, and the month of January is the coldest and May is the hottest.
Rainfall

The main climatic problem is the distribution of rainfall. The highest precipitation is during the months of June to middle of September which is called winter (rainy season). Presumably about 70-80% of the annual rainfalls during this period in most parts of the country. The total rainfall on the average is more than 1000 mm, at altitude above 2000 m. In some of the wet western regions of the country, the rainfall is more than 2000 mm, (21) and Map B. and C. Average annual rainfall decreases from the southwestern margin of the Eritrean lowland region Map D. Rainfall, except the western provinces and in the highlands of Bale in the South-east, is extremely variable for the dry months and should be considered with great care when looking at the annual mean.

The seasonal character of the rainfall must be considered with much care. The rainfall might be high but of a short duration in duration in December and January which is immediately followed by high solar radiation and wind serving no purpose except washing off dust from plants. In summary the following rainfall regimes are considered important in relation to Ethiopian agriculture.

1. Regime with maximum in March-May and June-August. This is a typical for most highland of the country (except the western part) whose average annual rainfall record is 950-1500 mm. A short transitional period marked by a decrease in rainfall occurs around May. This is the last period for "Baye", burning of ploughed soils in the high lands for barley planting in June. The period of June-August experiences the heaviest rainfall, while that of December-February is normally dry with only small amount of precipitation.

February's precipitation in the highlands if lasted for 10-15 days can maintain barley plantation growth but not horse beans and field peas. Nevertheless, the precipitation in the same month at Bale, Sidamo and Gamu Goffa highlands can maintain horse beans and field peas is considered off-season and the period.

2. Regime with Maximum June to August. The high amount of rainfall in Western highlands usually occurs in August. The rain from March-May continue without a notable break into those of June-August. On the other hand the northern part receives 75-80% of the rainfall in the period of June-August and litle is recorded in the period of March-May, while near the southern Margins and in the Western highland the June-August rain account for 50-60% and those in March-May for 15-20% of the yearly total (annual average for western Ethiopia 600-1440 m. (Map D). In southern margins and western highland horse bean and field peas are planted in February and harvested in June. However, June planting and late October-January harvesting is also practiced.
3. Regime with Maximum in March-May and September-November.

It is found in the Horn of Africa, South Ethiopia and North Kenya. The periods of March-May contribute a rainfall of 50-60% and that of September-November 25-35% to the yearly total (being over 1000 mm. in the southern part (31)). There is, however, no part of Ethiopia that receives major rainfall in the months of December. No part of Ethiopia that receives major rainfall in the months of December. Bale highland, being south-east, receives maximum rainfall in the months of Sept.-Oct. and 25-35% of the total in the months of March-May which accounts for the production of two pulses on the off-season period.

SOIL TYPES

The soils are mainly of clay origin of different colours. Red to reddish-brown on the mountains, reddish-brown on the slopes, brown to dark in the rolling country and very dark grey to nearly black in other parts.

Ethiopian soils to this date awaits for full detail study and appropriate classification. Most available information are incomplete and limited. Westphal (1974) adapting Moore (1964) attempts to give the following order of classification, namely:

1. Soils of the 'Costal Plains

In these types of soils arid soils are found, which in a sense are brown soils, desert soils and Sierozens. There is no particular interest in this area region's soil as far as horse bean and fieldpeas culture is concerned.

2. Soils of the Danakil Plains and Rift Valley

The Danakil plains have arid soils with salinity occurring in the Kobar Sink. The Awash River Valley is in the Rift with exceptional soil types of a large plain of alluvial soils. Again because of high temperature, horse beans and field pease production is not common in this rich alluvial soil valley.

3. Soils of the Highlands in General

This dominates Begemdir, Welô, Gojam Shoa and the Chercher highlands in the east. Here it is very common scene to come across fields of horse bean and field peas along the slopes for this is an excellent part of the soil regarding drainage problem. It is interesting to note that the greatest concentration of production of the two pulses is in these parts of the country. Here however, both horse bean and field peas growth is of short stature, less tillering of longer maturation and low in return per hectare.

4. Soils of the Abbay Trough

This is alluvial and colluvial material of Vertisols and incepti-soils found more to the west of the region and enti-soils in association with Verti- soils in topographic depressions. In this region, it is only along slopes and hilly areas that horse bean and field peas are produced mainly due to excessive temperature and rust diseases.
5. Soils of the Southern Highlands.

This region has mainly bushland, with areas of high gypsum content in the extreme south. Five Highland Dairy. In this region, because of topography, temperature, altitude regime, practical horse bean and field pea production is limited (Map E).


This includes northern and some western parts of Tigrai, northern parts of Begemdir, and some lower, stone, shallow, and low in productivity. Nevertheless, these regions are known for their production of horse beans and field peas for the two crops are capable of growing in many areas on rocky soils. Well meadows in the west and Sidamo in the east have a similar soil types with relatively better fertility. Horse beans and field peas are produced.

7. Soils of the Sudanese Highlands.

This is mainly in Illubabor, once more known for Coffaan and rice production even though vast amounts of both horse beans and field peas are produced.

The major soil problem in these Highlands is the lack of drainage in flat areas, while soil erosion is serious on the slopes. In the lower parts, the soils are fertile, resulting in a shortage of available phosphorus.

The lava plateau with its various clay soils is very susceptible to sheet and slightly gully erosion, while it is somewhat resistant to gully erosion. The plateau will tend to increase as more and more mechanized farming goes into scene and small farms are consolidated. Go to all even utilize modern agricultural machinery. (22).

Other aspects of the clay soils' stickiness during the wet season which makes it very difficult for machine operation, resulting in damage of soil structure and drainage systems.

After mentioning the problems and their distribution one can see the Ethiopian horse beans and field peas are produced along the slopes, on the hills, golden areas, around home-stead and undulated land mass of light, black soils, affirming the need of good drainage facilities, good fertility status, minimum of good soil structure and alternating of crop conditions.
Map A: The relationship between altitude and temperature.
Note how as elevation increases, the temperature...
Map 8. Relationship between altitude and rainfall. Note how location in relation to the direction of the moist winds is more important than more elevation above sea level.

Sources: Mesfin, Woldemariam (21)
Map C: Average Annual Rainfall, superimposed of isohyets on the 100 m.s., contour line.

Sources: Meafin Wolde Mariam (21)
Map D
The Average Monthly Distribution of Rainfall for Representative Stations of Each Region Shown Graphically
Map E

Some idea about Ethiopia Soils, seems based on Geology

**Vicia faba in Ethiopian Crops**

**Botany**

*Chromosome:* \(2n = 12, 14\)

*Height:* could be up to 1.8 m.

*Stems:* stout, hollow, square, winged at angles up to 7 branches arising from axiles of cotyledons and basal leaves. Almost all authorities seem to agree that *Vicia faba* has no branch on the upper part of the stem. This has been however, observed at least in some plants both at research stations and under bulk production of individual farmers' field (fig.1). The plant is totally without tendrils.

*Leaves:* pinnated ending in small, round tendrils. Stipules half sagitate dentate, up to 6 sub-opposite or alternate, ovate to elliptic, somewhat glaucous, mucronate, 5-10 cm. long.

*Inflorescence:* Axillary becomes 1-7 flowers per axil, flowers scented up to 3.7 cm. long, standard white with some times faint black streaks on dorsal side sub-erect.

*Stamens:* Short, diadelphous antheres uniform, dark (23,27).

*Ovary:* Sissile or nearly so, very slender. Compressed. 2.5 ovulate, style short bent, hairy near the tip with terminal stigma.

*Pod:* stout, sub-cylindrical or flattend, beaked up to 30 cm. long fleshy when young, with white velvet lining tough and hard at maturity.

*Seeds:* very variable in shape and size strongly compressed to nearly globar with green, buff, brown, purple, black 1-2.5 cm. long, hilum black, colour weight of 100 seeds in 40-186 gm. (3,5,17).

*Roots:* are normally well developed sometimes branched or tap root and an extensively developed lateral system which grow horizontally for some distance and then turn sharply downwards (4). The smaller roots carry large cluster of small lobed nodules.

Anthesis and another dehiscence coincide roughly and self pollination can occur. There is apparently some competitive advantage of introduced pollen from another plant in comparison with that from the same plant. Seed germination is hypogealm. (23).

**Species:** the species are divided into:

1. *V. paniculata* mur
2. *V. eu-faba*
   
   **Var. Minor** Beck  
   e.g. horse bean  
   **Var. major** Herz  
   e.g. broad beans (23)
Westphal (1974) while accepting that several samples from his collections, contained seeds outside the range of the seed length mentioned by Muratova (0.65 - 1.25 cm.) could not confirm if the discrepancy were due to evolutionary segregation resulting in some rare types. Moreover Westphal does not seem to give complete evidence of his own to accept Cv. Giant Dawit as a recent introduction. Nevertheless, investigating into rural areas in countries where the cultivar is cropped did not produce any evidence as recent introduction. Like Ethiopian white coloured field peas called American type, resembling the Indian mohendarfer, cultivated central and north parts of Shoa for centuries, Cv. Giant must have been in the country for centuries. It is also very common cultivar in Bale and Arsi provinces.

Generally the seed size classification is based on seed sizes. The tick beans are the smallest, the broad beans are the largest, and horse beans are intermediate. Horse bean is the most common type in north and western parts of Ethiopia. Because of a very long natural segregations and recombinations processes var. minor and var. major do contribute to the heterogenity of the cultivar.

**GEOGRAPHIC DISTRIBUTION**

There is no obvious conspecific wild form and there are difficulties in connecting the cultivar form with wild species. It is certain however that Vicia faba is a plant of very ancient cultivation. The earliest date remains are those reported by Hopi 1969 from Jericho in pre-pottery neolithic 6250 B.C. Seeds have also been recorded from neolithic sites in Spain and Eastern Europe and from Bronze age sites in Switzerland, Italy and Channel Islands (27). Hectare 1936 believed that V. nar-bonesis was the possible ancestral type (27). Pulse Glove (1974) however, states that V. pliniana Tre is the most closely related wild forms. Cobley (1963), Pulse Glove 1968 and Westphal (1974) all tend to agree that Mediterranean or South-western Asia as a centre of origin of V. faba. Thakur 1975 believes the crop belongs to Asia or Eastern Europe, probably Egypt. All those people don't seem to maintain where either primary or secondary centres of diversity might be, O.H. Frankol (1973) states and indicates S. east and south of Caspian Sea and north of Persian Gulf as centre of diversity. Westphal (1974) states that there is a considerable extent of cultivation in Welo and Begemdir. This is however, far from complete, the greatest concentration is in the provinces of Shoa (central parts) Welo and Tigrai (north) Begemdir and Gojam Western parts of Ethiopia map 4 and 5. Moreover there is no province that does not grow horsebean in rotation with small cereals, map 5.

**Area of Production and Yield**

By and large horse beans are grown in those parts of the tropics where the winters are fairly cool and they are of great local importance as a source of vegetable and pulses. The bulk of world's production is from China (table 1).
**Fig. 1: Vicia faba s. cv. 20DK**

1 stem above ground with leaves, true branch and pods. 2 pod ventral opened up with seeds attached to seed carpel.
Map No. 4: Principal pulse – Distribution Zones compare with map Nos 5 and 6

HORSE BEAN PRODUCTION ZONES

SOURCE: FINAL REPORT OF CROP CONDITION SURVEY FOR THE 1972-73 HARVEST; MINISTRY OF AGRICULTURE; ADDIS ABEBA

1. ERITREA
2. TIGRAY
3. WOLLO
4. BEGEMDIR & SIMEN
5. GOFAM
6. WOLLEGA
7. CHOA
8. ILUBABOB
9. KAFFA
10. GAMUGOA
11. SIDAMO
12. BALE
13. ARSI
14. HARARGIE
### Table 1

**The Area and Production of Horse beans**

<table>
<thead>
<tr>
<th>Location</th>
<th>Area in 1000 ha.</th>
<th>Production in 1000 M Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>The World</td>
<td>4,673</td>
<td>5,213</td>
</tr>
<tr>
<td>China</td>
<td>3,090</td>
<td>3,400</td>
</tr>
<tr>
<td>Italy</td>
<td>321</td>
<td>349</td>
</tr>
<tr>
<td>Morocco</td>
<td>180</td>
<td>190</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>152</td>
<td>143</td>
</tr>
<tr>
<td>Egypt</td>
<td>135</td>
<td>296</td>
</tr>
<tr>
<td>Latin America</td>
<td>308</td>
<td>172</td>
</tr>
<tr>
<td>Near East</td>
<td>204</td>
<td>382</td>
</tr>
</tbody>
</table>

Source, Eugen Card, *Tropical Agric.* 20 points, Uppsala 1973

Ethiopia is also one of the leading nations in world horse bean production as shown in Table 1. Because of the wide variation in climate and soils, there is even off-season production of horse bean in some provinces of the country. In Ethiopian agriculture, the importance of pulse crops always stands next to cereals like wheat, teff (*Eragrostis abyssinica*), sorghum and maize. Therefore, area allotted to major pulse (chick peas, lentil, horse beans and field peas) are subjected to fluctuation according to the need of land to be put under rotation, compare maps 1, 2, 3, 4, 5 and 6.

This is so because:-

1. Agricultural land so far is abundant
2. The natural condition for agriculture is extremely favourable.
3. The Ethiopian plateau has soil with such climatic conditions that allow a wide varieties of pulse production.
4. There is an over increasing demand for pulses both domestically and in the neighbouring countries (1).

**Husbandry.**

In describing the systems of Agriculture of Ethiopia Westphal (1974) divided it into:-

1. The seed farming complex, the characteristics of which is the production nearly all crops by seed.
2. The Enset planting complex, located in the highland zone between 1600-3000 m, south-west Ethiopia.
3. Shifting cultivation is a practice by the lowlanders west of Ethiopia, important implements are the planting stick and the hoe, the crops are sorghum and finger millet (Eleusine coracana).

Sesame (Sesamum orientale), ginger (Zingiber officinale) and yam (Dioscorea spp.).

4. The pastoral complex. This is usually in the lower and drier parts of the country. The main areas are in the north, Harege, the Kia Dale plains, the southern parts of Sidamo and north of Lake Rudolph.

Naturally horsebean husbandry is in the seed farming complex, dominantly central, north-west and all provinces in the geographical ranges of 1800-2800 m. Such a wide and complex distribution of horse bean over the whole country is the result of climatic and soil factor. The Ethiopian highland farmer is in general, well suited to the work involved and knows his job very well. In several ways the cultivation practices he has evolved to suit his environment bear striking resemblance to modern farming methods.

Horse bean is usually considered as the second ranking pulse in importance to chick peas. Like chick peas horse beans are grown over a large part of the Ethiopian highlands. The bulk and exclusively all production of horse bean of the country comes from small farmers using a very old set out of date system of farming. Because nearly 80-90% of the population is engaged in farm occupation this simple and outdated farming system is able to provide the country’s pulse need.

<table>
<thead>
<tr>
<th>Year</th>
<th>Area 1000/ha</th>
<th>Yield q/ha</th>
<th>Total Production 2000 Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966/67</td>
<td>131.4</td>
<td>9.2</td>
<td>120.9</td>
</tr>
<tr>
<td>1967/68</td>
<td>136.0</td>
<td>9.3</td>
<td>125.9</td>
</tr>
<tr>
<td>1968/69</td>
<td>140.2</td>
<td>9.4</td>
<td>137.5</td>
</tr>
<tr>
<td>1969/70</td>
<td>144.0</td>
<td>9.6</td>
<td>137.8</td>
</tr>
<tr>
<td>1970/71</td>
<td>147.3</td>
<td>9.8</td>
<td>144.9</td>
</tr>
<tr>
<td>1971/72</td>
<td>150.0</td>
<td>10.2</td>
<td>152.9</td>
</tr>
<tr>
<td>1972/73</td>
<td>137.0</td>
<td>8.5</td>
<td>118.7</td>
</tr>
<tr>
<td>1973/74</td>
<td>138.0</td>
<td>8.6</td>
<td>294.8</td>
</tr>
<tr>
<td>1975/76</td>
<td>259.0</td>
<td>11.1</td>
<td>304.4</td>
</tr>
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</table>
Pulses in Ethiopia is the second major crop next to cereals. Nevertheless, the total land allotted to the horse bean does not seem to extend beyond 1.5% every year, as the total land under general pulses is not also beyond the range of 7.9-8.2% while cereals command 70.3%. Map 1, 2, 3, and 4 show distributions of most important types of pulses.

Seed Bed Preparation:

Farming practices are still simple and old. A great drain on his working time is his wooden, steel pointed plow which breaks the soil but cannot adequately turn it. Because of such crude implements the Ethiopian farmer plow for horse bean maximum three times, and for field peas at most two times only. The seed sometimes fall deep in the soil and sometimes too near the surface. Most probably its diameter of the seed is the recommended practice. This information is quite true for the field peas too. And yet an adequate return is obtained from such culture, for it is believed that the two crops, as long as the drainage is adequate, can do well on soils where most cereals fail to grow. This however, must be one of the reasons for low yield per hectare of land. However, leaving the land uncropped for a season some organic matter is added to the soil and a reasonably satisfactory rotation have been developed in a good many areas. If land fallow seems not feasible the highland farmer plants his field to one of nitrogen restoring legumes, mainly horse bean or field peas, if the ecology is adaptive.

In any generalities horse beans are mainly grown in regions of the country with an altitude of 1900-3000 in a rotation scheme immediately after cereals or on poor, some times badly eroded soils where other cereals expected to fail. It can be also grown in a mixture of field peas for the latter. The main growing season is June-September but some regions like Velo, north Bale and Sidamo, south, Gamogofa, south-west provinces can produce off-season crops.

At research stations, in Ethiopia, popularly accepted standard spacing in 5 cm. between plants and 40 cm. between the rows, with a rate of 150 kg. 200 kg/ha.

Being a legume, horse beans don't positively respond to nitrogen fertilizer except as initial stimulant because of the capability of the symbiotic relation with Rhizobium bacteria, those fixing nitrogen in the soil. However, whether potash and phosphate fertilizers benefit under Ethiopian soil condition remain still for thorough investigations.
If fertilizer has to be applied, the rate is DAP (18,46). The lower limit rate for planting horse bean is 150 kg/ha. The Ethiopian bulk producer, the farmer, through long experience, knows very well that his broadcast will give him an average rate of 150 kg/ha, with a return of 7-10% o/ha. The yields obtained under trial conditions are also variable between 50 and 100 kg/ha. Therefore, there seems to be much to be done in order to find out the right production methods and to get the farmers to realize the importance of weed- and controlling disease and pestes.

Weed Control

Weed control is necessary for higher yields. Horse bean fields are generally low in weeds. However, more weeds harvested with the beans and picked up from the ground might be included in the seeds and therefore the production of seeds would decrease. If all farmers cleaned the seeds prior to planting, it seems to increase yield when horse bean are sown in rows instead of being broadcast, weeding would then be easier. Weed control could be done by hoeing annually. Any other means of tillage in time, but hoeing encourages tillage of weeds particularly if the space between plants is maintained. Twice weeding and cultivation is quite adequate until harvest time unless weed growth and intensity is too high. After the plants are in full bloom mechanical disturbance is unnecessary for these will be enhance resulting in low yield.

Major pests

Horse bean may be attacked by various insects that can cause serious damage.

American boll worm (Heliothis armigera)

This could be very serious in the highlands in late September and October when there are heavy clouds without much rainfall.

Younger caterpillars eat the flowers and young pods, and the mature pods will show holes where the caterpillars have eaten the developing seeds, if maize is planted near beans, the moth will be attracted, to lay its eggs on it instead of on the beans (26).

Aphis (Aphis fabae)

This can be devastating some times, but easily controlled by heavy rainfall wash-off. This is an insect that may serve as virus vector unless controlled by systematic sprays in areas of threat. In the Ethiopian highland bulk producer zone the insect has never been reported as disastrous but in experimental sites unless controlled could be damaging.
Map No. 2: Principal sorghum, maize, small millet growing region

Source: Mesfin Waide Mariam; An Atlas of Ethiopia
Addis Ababa, 1970
Map No. 3: Principal Tef (Eragrostis abyssinica) Wheat and barley; compare with map No. 1.
Thrips (Taeniothrips aijotei trypom)

This insect attacks the reproductive organs interfering in fertilisation which results in total yield reduction. It has been suspected that these insects might be one of the causes for low yield in the country but this is not confirmed by research so far.

Diseases

There are a number of fungal diseases which cause extensive damages to crop of horse beans in tropical and sub-tropical regions. The most important control measures are:

1. Planting resistant varieties
2. Field sanitation
3. Uses of suitable agronomic practices.

In Ethiopia horse beans growing regions the most serious fungal diseases are:

1. Rust (Uromyces fabae)

   This is a very devastating fungus at altitudes below 1800 m. No resistant variety has been obtained so far.

2. Chocolate spots (Botrytis fabae)

   The Botrytis Spp. is also another single devastating organism, particularly at an altitude greater than 2800 m. This is a number one and a major limiting factor at higher altitudes preventing horse bean from entering into the rotation scheme where barley is grown year after year.

   Between 2000 and 2500 m altitude the rust and chocolate spor infestation is moderate.

3. Powdery Mildew (Erysiphe polygoni)

   The infestation and damages occur at an altitude lower than 1600 m. Off-season growing in the higher altitudes experienced infestation by this pathogens.

   However, infestation normally occurred late in the plant life and caused no considerable reduction in yield. Over all powdery mildew at the bulk production zone, in higher altitudes during normal growing season has never been reported as a serious set back for total yield.

4. Root-Rots (Fusarium Spp. and Rhizoctonia Spp.)

   This might be a serious problem in areas where water and soil relation is an acute one. However, as most crops are grown on hilly to gentle slopy areas drainage problem is naturally minimized and it has never been reported as a serious set back in the bulk producing regions.
5. Virus

Horse bean is also susceptible to a number of virus diseases including broad bean mosaic virus (BBMV), bean yellow mosaic virus (BYMV), pea leaf roll mosaic virus (PIRU) and alfalfa mosaic virus (AMV), normally these viruses are transmitted through insect vector, aphid being one of them. Some of these virus have been noticed at experimental fields though no proper identification is documented so far. At the farmers' fields it has not been reported so far as a serious problem probably aphid population is minimum in these areas.

Harvesting and Threshing

The beans are fully formed by the time pods begin to turn yellow colour, but seeds should dry down to about 10% moisture for safe storage. Standing plants are allowed to dry to ensure 10% moisture level is attained. If the variety is a shattering type, earlier harvesting is better to avoid loss. Most varieties however, should be harvested while some pods are black and some are still green and allowed to ripe after cutting.

The traditional Ethiopian farmer through centuries experience knows when his horse bean has to be harvested. By the time he believes the crop is ready for cutting most of the leaves are shattered, majority of the pods have turned black while the upper parts of the pods are completely or partially yellow.

In most cases he does cutting early 6:30 am. to 11 am. or in late afternoon 4:30 pm. to 6:30 pm. Season for cutting is from late October to early January. At altitudes between 1800–2500 m. cutting is done in late October to early November. At 2000–2800 m. altitudes cutting is started in December and January. The harvested crop is left in the field for nearly 6 weeks in various sizes of stacks. The stacks are arranged in such a way that harvested crop top is in an upright position which allows proper air circulation and direct exposure to solar radiation and are left to dry in a field for nearly 6 weeks. The dried crop wrapped with a coat of smooth leather is transported to the threshing ground by human labour or on the back of donkey. Most of the threshing is done by cattle or horses which trample on the pods until the grain drops out. This might take 3–4 hours depending on the degree of the dryness of the crop. Wooden forks and shovels are then used to separate chaff from the grain by tossing it in the air.
In many parts of Ethiopia pulses are major parts of the daily diet and an important source of protein especially during lent. The bulk of farmers' production is for local consumption but export is also done to various countries like the Middle East, Europe and Asia.

Horse bean culture is dominantly a culture of rotation. It will give fair return even from poor, rocky soils where other crops fail to give adequate yield. The Ethiopian highland farmer has learnt from long experience that when ever his land is depleted either he has to fallow it or plant it to pulses which is normally followed by cereals so that they would benefit from fixed No. 3.

Horse bean is also one of the major pulses exported to the Arabian peninsula, western Europe and south-east Asia for at least more than 30 years. For instance, in September-November 1973 alone horse bean with other pulses constituted 13.1% of Ethiopia's export to various countries. As far back as 1948-1961, the average horse bean exported to various countries was 36% followed by lentil 33% (7).

Table 3, shows the importance of horse bean and other in the export markets.

<table>
<thead>
<tr>
<th>Year</th>
<th>Chick Peas</th>
<th>Horse Bean</th>
<th>Haricot Beans</th>
<th>Lentils Peas</th>
<th>Field Peas</th>
<th>Total (1000 metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>2.2</td>
<td>15.6</td>
<td>17.1</td>
<td>15.8</td>
<td>0.4</td>
<td>51.1</td>
</tr>
<tr>
<td>1970</td>
<td>6.3</td>
<td>16.6</td>
<td>22.6</td>
<td>18.0</td>
<td>0.2</td>
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<tr>
<td>1972</td>
<td>10.7</td>
<td>19.0</td>
<td>25.6</td>
<td>21.9</td>
<td>0.5</td>
<td>77.8</td>
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<tr>
<td>1973</td>
<td>8.1</td>
<td>29.7</td>
<td>19.7</td>
<td>22.2</td>
<td>2.4</td>
<td>141.5</td>
</tr>
<tr>
<td>1974</td>
<td>8.2</td>
<td>28.0</td>
<td>46.0</td>
<td>30.0</td>
<td>10.5</td>
<td>120.7</td>
</tr>
<tr>
<td>1975</td>
<td>10.0</td>
<td>22.0</td>
<td>41.5</td>
<td>37.3</td>
<td>-</td>
<td>102.0</td>
</tr>
<tr>
<td>1976</td>
<td>-</td>
<td>26.7</td>
<td>-</td>
<td>17.6</td>
<td>1.8</td>
<td>46.1</td>
</tr>
<tr>
<td>1977</td>
<td>10.0</td>
<td>26.7</td>
<td>-</td>
<td>17.6</td>
<td>-</td>
<td>54.3</td>
</tr>
</tbody>
</table>

Source:- EPID publication No. 32 (7) and Ethiopian Grain Agency the price movement between 1970-77 reflected in return from 5 major pulses that are also shown in table 4.
Horse beans are consumed as green, as green and roasted, "green and cooked" (dried bean soaked and cooked), "dried bean soaked and roasted", "dried bean soaked and roasted in thick sauce" (in injera form), and in a sauce called "horsebeens" with injera and other seasonings. This is mixed with either barley, wheat, or teff flour. For preparation of local alcoholic beverage. Thick sauce preparation called "feketti". It is mixture of horse bean flour and mustard powder and other flavouring spices. The main source of this sauce is during the lent.

Horsebean as pulse crop provides the major essential food elements. It consists of water 72.2%, protein 25.4%, fat 1.5%, carbohydrate 48.5%, fiber 7.1%, minerals 3.3%. (20). Comparison with other pulses is made in Table 5.

### Table 4. Average Value of Pulse Imports from Ethiopia 1970-77

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Chick peas</td>
<td>235</td>
<td>283</td>
<td>279</td>
<td>305</td>
<td>292</td>
<td>359</td>
<td>600</td>
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<tr>
<td>Horse beans</td>
<td>225</td>
<td>268</td>
<td>269</td>
<td>279</td>
<td>269</td>
<td>404</td>
<td>434</td>
<td>517</td>
</tr>
<tr>
<td>Hardicot beans</td>
<td>396</td>
<td>447</td>
<td>442</td>
<td>447</td>
<td>442</td>
<td>622</td>
<td></td>
<td></td>
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<tr>
<td>Lentils</td>
<td>315</td>
<td>341</td>
<td>345</td>
<td>346</td>
<td>345</td>
<td>832</td>
<td>670</td>
<td>840</td>
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<tr>
<td>Field peas</td>
<td>257</td>
<td>265</td>
<td>268</td>
<td>274</td>
<td>268</td>
<td>520</td>
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<td></td>
</tr>
</tbody>
</table>

Source: EPID publication No. 95 (15). The Ethiopian Grain Agency.

### Table 5. Horsebean food components in comparison with pulses

<table>
<thead>
<tr>
<th>Crop</th>
<th>Water</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrate</th>
<th>Fiber</th>
<th>Ash</th>
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</thead>
<tbody>
<tr>
<td>Chick peas</td>
<td>0.8</td>
<td>17.1</td>
<td>0.3</td>
<td>68.2</td>
<td>3.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Lentils</td>
<td>11.2</td>
<td>25.0</td>
<td>1.0</td>
<td>55.8</td>
<td>3.7</td>
<td>3.3</td>
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<tr>
<td>Hardicot beans</td>
<td>11.0</td>
<td>22.0</td>
<td>1.6</td>
<td>65.8</td>
<td>4.0</td>
<td>3.6</td>
</tr>
<tr>
<td>Field peas</td>
<td>10.6</td>
<td>22.5</td>
<td>1.4</td>
<td>58.5</td>
<td>4.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Horse beans</td>
<td>14.3</td>
<td>25.4</td>
<td>1.5</td>
<td>48.9</td>
<td>7.1</td>
<td>3.2</td>
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<tr>
<td>Groundnut</td>
<td>5.4</td>
<td>30.4</td>
<td>4.7</td>
<td>411.7</td>
<td>2.5</td>
<td>2.3</td>
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<tr>
<td>Soybeans</td>
<td>5.0</td>
<td>29.5</td>
<td>1.5</td>
<td>144.0</td>
<td>2.8</td>
<td>3.3</td>
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<tr>
<td>Horsebeens</td>
<td>9.4</td>
<td>50.3</td>
<td>2.3</td>
<td>231.9</td>
<td>6.3</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Source: R. Sigriald (26)
Horse bean research and development programme in Ethiopia is still at its infant stage, although the crop is one of the major pulses of the country cropped for centuries. The research activities and achievement are far behind the cereals and other pulses like the haricot beans. The major research work on horse bean has been carried out at Kulumsa station. One of the coordinated research programmes was the National Yield Trial on horse bean carried out in 1972.

For instance 1972 National Yield Trial of Horse bean coordinated were run at locations shown below.

<table>
<thead>
<tr>
<th>State Location</th>
<th>Altitude</th>
<th>Location</th>
<th>Soil type</th>
<th>Total Rainfall mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debre-Zeit</td>
<td>1800 m.</td>
<td>Central</td>
<td>Clay loam</td>
<td>567</td>
</tr>
<tr>
<td>Kulumsa (ARDU)</td>
<td>2200 m.</td>
<td>South-East</td>
<td>Dark heavy clay</td>
<td>483</td>
</tr>
<tr>
<td>Holetta (IAR)</td>
<td>2100 m.</td>
<td>Central</td>
<td>Red clay</td>
<td>1050</td>
</tr>
<tr>
<td>WADU</td>
<td>2100 m.</td>
<td>South</td>
<td>Reddish clay loam</td>
<td>358</td>
</tr>
</tbody>
</table>

Areas of Research Emphasis on Horse bean in Ethiopia

The collection and evaluation of indigenous genetic material has been initiated since the end of 1960. The various collections were more or less EPID's and CADU's. It seems that all were nearly market samples in which few necessary information were included. Nevertheless, this has been substantial contribution in screening trials for various agronomic parameters. Limitation of staff and financial constraint have so a restricted thorough coverage of the most concentrated areas of production. Some of the highest yielding lines in 1972 yield trials were from selections of indigenous collections evaluated at several testing sites. Table 7.

In 1977 October-December systematic collection has been effected in which more than 300 samples were collected from major parts of central Shoa and two sub-provinces from Gojam. This would be documented and screening for evaluation at various locations for all agronomic characteristic and will continue in 1978-79 growing season. Collections from all horse bean growing areas in Ethiopia and systematic documentation, characterization and evaluation is a high priority for horse bean improvement and development which is envisaged to continue.

Horse Bean Trials

1. Spacing: A spacing trial was carried out on horse bean in which 40 cm. by 5 cm. gave the highest yield (CADU publication No. 8 p. 49, 1968 results). To determine the correct spacing of horse bean, between 62 and 375 kg/ha, was planted with different spacing and width rows of 20 cm. and 15 cm. in a row gave the best economic result. Broadcasting gave a lower yield than sowing the same amount of seeds in rows (CADU publication No. 63 p. 52).
2. Yield and Variety Trials

In a trial at Kalamas 27 out of 30 horsebean samples collected were tested. The results were rather promising as one third of the tested beans yielded more than 30 Q/ha. There were small differences regarding the length of time from sowing to date of maturity, 109 to 125 days. The late maturing one gave the highest yield (CADU publication No. 63 p. 53). Results of National Yield Trial is shown in Table 6.

In variety trials seven local horsebean selected samples, were planted and compared with seven introduced varieties of horsebeans. The results ranged from 36.8 to 1400 kg/ha. Several of the local lines did better than introduced ones showing that substantial increase could be obtained in yield by selection and finding out appropriate agronomic practices. Outstanding local cultivars and some exotic varieties of horsebean were tested for their adaptable characters like resistance to chocolate spot rusts, earliness high pod sets/plant and yield. Kalamas (ARDU) has a major responsibility for deteriorating this crop's improvement. The endeavor of the 1941-1975 years' yield trial assessments are shown in Table 7.

3. Fertilizer Trials

In 1968, different species of horsebeans were tested with and without fertilizers in the B, O. The phosphate did not increase the yield significantly (K. Biegak 1973).

Table 6. 1972 National Yield Trial Horsebean Yield Data Q/ha.

<table>
<thead>
<tr>
<th>Varities</th>
<th>BSN</th>
<th>D-Zeit</th>
<th>Kalamas</th>
<th>Holetta</th>
<th>Kokate</th>
<th>Total</th>
<th>Mean</th>
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<tr>
<td>20 DK</td>
<td>31.8</td>
<td>27.3</td>
<td>77.9</td>
<td>15.8</td>
<td>102.7</td>
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<tr>
<td>36 BK</td>
<td>22.7</td>
<td>25.3</td>
<td>29.0</td>
<td>18.7</td>
<td>97.7</td>
<td>24.4</td>
<td></td>
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<tr>
<td>Italian Red (D,2)</td>
<td>21.3</td>
<td>26.9</td>
<td>18.7</td>
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<td>93.4</td>
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<td>71.9</td>
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<td>5.9</td>
<td>17.9</td>
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<tr>
<td>11 AK</td>
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<td>-</td>
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<tr>
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<td>14.2</td>
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Table 6 Continued.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>RSU D. Zeit</th>
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<th>WADU Kokate</th>
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<td>3810</td>
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</table>
Continuous research efforts are being exerted to evaluate several hundreds of horsebean lines or varieties for yield, disease resistance, maturity date, and high quality protein content. The germ-plasm material used for the programme in the screening nursery is from both indigenous and international ones. In 1977-78 screening programme for example, the nursery observation trials included varieties or lines from:

- ICARDA 817
- US Collections 81
- UK 50
- Local 232

In 1978-79 screening programme, the indigenous germ-plasm is expected to dominate the lines or varieties in screening, for the need is felt that variability of germ-plasm of the native material is not yet explored and exploited for the characters already mentioned.

Promising lines or varieties are always promoted and included in National Yield Trials Programme for further evaluation, particularly for yield, maturity and disease resistance in different regions of Ethiopia.

Selection of Cultivars:

The selection of high-yielding cultivars such as Kuse 2.27.33, CS 20 DX, CS 11 AK, CS 38 BK is a significant research output. A record yield is being achieved as high as 40-50 q/ha.

Under Chillalo climatic conditions and agronomic practices, all these local cultivars have shown 2-4 times higher yield potential than farmers' cultivars. More serious research efforts in other parts of the country under comparable climatic conditions to that of Chillalo has to be yet extended and publicity campaign for farmers acceptance of the proven cultivars with improved technology has to be emphasised.

FIELD PEAS

Domestication

Old World

Helbaek 1966 reports the occurrence of peas and lentils at Hucilar, Neidha and later Jaricho, which have been dated at 9,500 to 8,000 BC.

Renfrow 1966 reported seeds of pisum, Vicia faba and Lens from Neolithic sites in Greece.

Cultivated peas (Pisum sativum)

There are two forms of cultivated pea.
1. The field pea - Pisum arvense
2. The garden pea - Pisum sativum
both can be crossed very easily and are quite inter-fertile. it
seems probable that the garden peas were derived by selection
from the field peas. Forms fairly closely resembling field peas are found in
the wild state in Georgia (Busch and McPherson 1917).

Zhukovsky, 1950, has suggested that Pisum elatius
Steven, may be the ancestral form from which some recombination
of Pisum elatius germ-plasm may have occurred subsequent to
domestication and establishment of garden peas. This increased
Genetic Variability could perhaps have given a sufficiently
broad genetic base for selection of garden types.

The cultivation of the field peas is apparently as ancient as
that of horse bean, the latter. Archaeological remains of
have been found in the same prehistoric levels in Jericho,
as those of the Horse beans. (Rosen 1936).

Greece, cultivated in Montenegro, Austria and Czechoslo-
Vakia in Bronze age. Switzerland, Austria and Bronze Age.
Germany in Iron Age. As far as cultivation is concerned Pisum
and phaseolus must have abandoned Greece before domestication.

Pisum L.
The genus include 6 spp., in the Mediterranean area
and West Asia of which one is cultivated. P. sativum L.
satinum L. sativum L. ssp. ampelochorum No. 24 = 14

In the present consideration Pisatinum and P. arense are
taken to be conspecific since they are completely inter-fertile.

The Plant

Is short live, herbaceous, usually glaucous and climbing
by means of leaflet tendrils. Dainty, semi-dwarf and tall; cultivars
occur, habit depending on number of nodes and length of inter-

odes.

The Root System

Apart from the tap root, is not strongly developed.

Stems

Weak, slender and circular in section, taller varieties vary.
require support.

Leaves

Pinnate with up to 3 pairs of leaf-like leaflets and
a terminal branched tendrils. stipules large and leaf-like,
avate, lower portion dorso-ventrally up to 5 cm. long, larger
than leaflets, stipules absent, lanceolate, ovate or elliptic,
up to 6 in number, entire or deeply crenate, margin up to 5.5 x 3 cm.
Flowers

Axillary solitary or in racemes up to 3 flowers, bracts very small; calyx oblique, lobes unequal about 1 cm. in length.

Calyx

White, pink or purple, keel short in curved obtuse.

Stamens

Diadelphus, filaments broad and uniform.

Style

Plicate, flattened, bearded on inner surface, stigma minute, terminal.

Pods

Swollen or compressed, straight or curved on short stalks up to 15 x 20 cm. with as many as 10 seeds, dehiscent by two sutures.

Seeds

Angular or globose, smooth or wrinkled on endosperm. Green, gray, or brown sometimes mottled, (Fig. 2).

Weight of 100 seeds is 15-25 gms.

The species includes what are commonly called field peas and garden peas. The growth of garden peas is more luxuriant than that of field peas although the latter are considerably hardier.

The field peas is grown as a dry pulse whereas garden peas can be harvested immature and used as a vegetable. The garden pea lacks the parchment tissue on the inner pod walls and, the whole pod is edible. Depending on the purpose for which they are grown, seed rates vary between 60 and 300 kg/ha, for garden peas. Lower seed rates are used for green vegetable production, higher rates for dry pea production. In subsistence cultivation of the field peas seed rates are probably lower and seeds may be broadcast or sown in rows. Seed yields of about 200 kg/ha. are possible in good conditions with plant populations of the order of 200,000/ha, to obtain satisfactory yields.
The crop is now grown in almost all temperate regions, but has also adapted to cool weather and does not thrive in hot and dry regions, but does well in mountain and tropical areas during the cold season.

Similar to Vicia faba field peas grow in the mountain areas with altitude between 1000-3000 above sea level, during the monsoon rainfall. In some districts, season June 11 to September 17. Extensive and well-concentrated culture areas exist in central, northern, and western highlands of the country, May. In any season, Ethiopia field peas are available all the year round.
Fig. 3: *Pisum sativum* L. - 1 branch with leaves, inflorescence and flowers; 2. staminal sheath and pistil; 3. standard, from view; 4. pod, section opened to show seed attached.
FIELD PEA PRODUCTION ZONES


1. ERITREA
2. TIGRAY
3. WOLLO
4. BEGEMDIR & SIMEN
5. GOKAM
6. WOLLEGA
7. SHOA
8. ILUBABOR
9. KABA
10. GAMUGOFIA
11. SIDAMO
12. Bale
13. ARSI
14. HARARGIE
Peas are best adapted to cool climate with moderate rainfall. They will survive light frosts without injury. Peas are grown in winter period of subtropical zones, or in the cooler season of the true tropics which begins with the onset of the rainy season; however, most important at higher elevations in the true tropics.

Peas prefer soils that are not strongly acid, and are well supplied with calcium. Soils derived from limestone are well-suited for peas. The crop is not well suited to highly leached soils normally found in high rainfall areas of the tropics and sub-tropics. They are not adapted to shallow soils, nor to those that are poorly drained, although the crop is not considered to be a deep rooted one.

In Ethiopia peas equal horse beans in importance after chick peas and lentils with average yields of 7-9 Q/ha. Peas are usually sown at beginning of the big rains between mid-June and first week of July and harvested between mid-October and early part of November. In large areas of central, western and southern west of the country the crop is grown, either in rotation with small cereals or on poor sometimes badly eroded soils and yet fair crop can be produced. Where soil fertility is too low for wheat, barley, field peas can be still cultivated. In fact the crop is usually used as soil stimulant for the following cereals because of its ability to nodulation and soil structure improvement. In red soils, pea can precede as well as follow two consecutive cropping of small cereals, whereas in black soils of central high lands it may succeed small cereals or land has to be fallow.

In Eastern highlands, like the Chercher highlands, peas are of minor culture. The crop is considered as the best crop to sow the first year on fallow land cleared for sorghum or maize production. In south and south-east highlands of the country peas together with home beans, wheat and barley constitute the cereal-pulse zone. This is in an altitude between 2200 m, 2400 m. As a rule the crop is grown as a mono-culture but very common, a mixture of horse bean and field peas grown together but never frequent with chick pea, or barley as Westphal (1974) states it. Among the traditional bulk producers, there invariably is a tendency or producing the crop in relatively well drained but very poor soil because of the conviction that the crop might be given excessive vegetative growth at the expense of maximum grain yield if grown in relatively fertile soil. This is probably one of the horizons where research has to exert its effort of exploration and investigation, for there might be too much high humus ration in relation to mineral soils in areas where the soil is considered fertile.
Seed-Bed Preparation

Field peas seed-bed preparation has to be done well to obtain good yield. It has to be free of growing weeds, all trash removed or ploughed under, and large clods broken up. Early ploughing is done between February and March to make the surface rough for retention of early rainfall moisture, facilitate rapid penetration and retard run off. In the bulk production zone this practice has not yet. Ethiopian farmers infact give little attention to this practice. Field peas or horse beans fields are mostly ploughed only once or twice at most and very little weeding is ever practiced in field peas from planting to harvesting.

Seeding Rate

The bulk produce of the crop is planted by broad-cast. The traditional farmer has learnt through centuries of experience that he almost perfect broad-cast invariably. This rate of broad-cast is estimated to be at the rate between 100 kg/ha, to 150 kg/ha. The upper limit is the most recommended one from the research people, Soon after the broad-cast the oxen plough does the covering of the seed unevenly as the result of which germination is not uniform and sprouting seeds are picked up by birds and insects.

Harvesting and Threshing

Field peas generally would mature between mid-October and early November and this is a very peak harvesting period. Harvesting is done in a similar way to horse bean. The crop is harvested when the top most pods, 1-3 pods are just turning yellow while the bottom ones are almost dried. Harvesting is done with sickles by cutting the whole plant at the ground level. The harvested stuff is put in a stack for 4-5 weeks to dry up completely.

After the stack(s) has been dried for considerable period of time it has to be transported to especially prepared threshing ground. Sometimes threshing could be done at nearby area where the crop has been harvested, but normally for case of transportation it has to be done nearby home-stead. Threshing invariably is done by tramping with cattle for 2-4 hrs. Then the chaff and the seeds are separated with the help of wooden fork. Last winnowing is done with the help of wooden shovel whose blade may be 50-55 cm, in length and 20-25 cm, width, with a handle of 60-70 cm. The grain is stored in a grain storage made of mud plastered wicker work. The average yield is between 5 and 8 Q/ha.
Diseases

Numerous diseases caused by fungi, viruses, and nematodes could affect the leaves, stems, pods, seeds and roots of peas grown resulting in reduced yields and inferior quality seeds. Peas' pathogens could be transmitted by various means, including wind, insects, drainage water, plant refuse and seed.

**Powdery mildew (Erysiphe polygori DC)**

This is the most widely spread and most serious disease of peas. In certain years when there is heavy cloud and some rainfall moisture in the months of September and October infestation of the pathogen could be very high. Mostly the disease sets in later part of the plant growth and it does not seem much in the way of limiting the overall yield. It seems there is no available data on the amount of loss due to this pathogen. The prevalence of the disease is directly associated with temperature.

**Wilt (Fusarium Spp.)**

This is a very serious problem if there is much drainage problem. The whole crop could be lost due to this disease. The Ethiopian highland farmer avoids planting water logged areas used instead plants his peas on gently slopy sites where drainage problem is solved naturally.

**Ascochyta blight**

This could be the most dominant disease in areas with high rainfall. The disease attacks the leaf, stem and pods may result in reduction of both quality and total yield. There seems to be no available information how much crop is lost due to this disease as no assessment has been done so far.

**Insects**

No overall assessment has been done on losses due to various field pests pests. Both in the field and storage losses due to insects could be considerable.

American hollworm (Heliothis armigera). It is probably the most serious insect attack. Large clean holes are formed on the pods. Granules of excreta may also be seen on the plant or soil near the damaged pods. It can be a devastating factor under cloudy and moist conditions. It seems, during heavy rainfall, most eggs are washed-off and destroyed and much crop damage might not be experienced.
Weeds

Several kinds of weeds including perennial grasses could prevail in field peas. Weed competition may seriously reduce yields. Research authorities advocate that band placement of fertilizers avoids undue stimulation of weeds between rows of peas. Weeds should be killed while still young, before there is significant competition with peas for moisture and nutrients. This is by pulling or hoeing of the weeds at early growth stages.

In the bulk producing zone field peas are broadcast. No weeding is practiced even after sowing until the crop is harvested, as the result of this century’s culture Ethiopian field peas are tall and viny in growth prostrating on the ground. So once the crop uniformly covers the ground the weeds are controlled by the prostrating plants. However, this does not suggest that there are no losses due to weeds. So far research has confirmed that a single hand weeding is quite adequate for economical production of Ethiopian field peas.

Uses

What can be mentioned about field peas economics and consumption has already been stated under horse bean uses. See under horse bean and table 3, 4, 5.

Pulses are one of the major food crops for the majority of Ethiopians. Ethiopians eat pulses nearly every day in many different kinds of preparations. Mode of consumption can be enumerated in the order of their magnitude. Therefore, field peas are consumed as:

- Wot, a kind of sauce used in eating injera.
- Roasted
- Soaked and roasted
- Cooked
- Fresh green
- Fresh green roasted or cooked
- Injera (fermented dough baked flat bread) mixed with barley or wheat, or tef (Eragrostis abyssinica) flours
- Porridge.

Field peas provide some of the major essential food elements. The whole dry mature seeds contain:

10.6% water
22.5% protein
1.0% fat
58.5% carbohydrate
4.4% fiber
3.0% ash. However fresh green peas contain:

74.4% water
5.7% protein
0.4% fat
15.5% carbohydrate
2.2% fiber and
0.9% ash (1). Comparison with other important Ethiopian pulses (not soybean is made in table 5).
Indication has already been made that nearly all produced field peas are consumed locally, small portion is exported and in some years there might not be any export at all because of local market demand, Table 4. Table 8 could give some ideas on yearly land allotted to field peas total production and return per unit of land.

Table 8. Ethiopian field peas production status

<table>
<thead>
<tr>
<th>Year</th>
<th>Area 9000 ha</th>
<th>Yield q/ha</th>
<th>Total production 1000/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>130.0</td>
<td>9.2</td>
<td>119.6</td>
</tr>
<tr>
<td>1968</td>
<td>131.8</td>
<td>9.2</td>
<td>121.6</td>
</tr>
<tr>
<td>1969</td>
<td>133.5</td>
<td>9.3</td>
<td>123.9</td>
</tr>
<tr>
<td>1970</td>
<td>135.0</td>
<td>9.4</td>
<td>126.4</td>
</tr>
<tr>
<td>1971</td>
<td>136.2</td>
<td>9.5</td>
<td>129.5</td>
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<tr>
<td>1972</td>
<td>137.1</td>
<td>9.7</td>
<td>132.4</td>
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<tr>
<td>1973</td>
<td>150.0</td>
<td>4.9</td>
<td>73.5</td>
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<tr>
<td>1974</td>
<td>151.4</td>
<td>4.9</td>
<td>74.2</td>
</tr>
<tr>
<td>1975</td>
<td>108.0</td>
<td>4.4</td>
<td>47.5</td>
</tr>
<tr>
<td>1976</td>
<td>107.0</td>
<td>4.8</td>
<td>65.1</td>
</tr>
<tr>
<td>1977</td>
<td>138.4</td>
<td>7.4</td>
<td>51.8</td>
</tr>
</tbody>
</table>

AREAS OF RESEARCH, BREEDING OF FIELD PEAS IN ETHIOPIA

Germ-plasm collections and evaluations

The first step in any research programme is to assemble germ-plasm collections of indigenous and introduced varieties to be used as a source of breeding materials. Introduced varieties may be used for direct selection as a source of germ-plasm for further selection or for further utilization in a hybridization programme. Germ-plasm collection and evaluation and evaluation of indigenous genetic material has been initiated about 8 years ago. However, this initiation in trained

power and financial support, a continuous effort in this line of work has not been serious until 1977 however, a very serious programme of systematic collection has been launched which is expected to go on till all the provinces in the country have been thoroughly covered. Between late October and early December 1977, more than 10 samples of indigenous materials have been collected from our material stock, considerably higher. These would be used in adaptation and performance screening at various regional level in 1978. The next five years collection and introduction of genetic materials, for systematic characterization and evaluation are the highest priority action for the field pea improvement programme in the future.

Varietal Trial Yields

Some annual progress reports of the that of Aressi Rural Development Unit (ARDU) also that of field research programme started since 1967. Different field collections and varieties of field peas in observation program Kossa, ARDU gave 90 kg. to 100 kg/ha. Insect and shrub damage to the seeds, CADU publication No. 19, Amhara (ADU) station 2 pea varieties were tested at few very observations. They yielded in average 2240 kg/ha. The best pea yielded 2200 kg/ha. CADU publication No. 52 (54).

A variety adaptation trial carried out with three varieties at Nazareth Research Station gave poor yields. The incidence of mildew in all varieties indicated that Nazareth is probably too warm for good results of field peas. (Institute of Agricultural Research, National Horticultural Centre, Nazareth Progress Report for the period April 1971–March 1972 page 9).

In Aressi region, central south there has been a serious yield trial screening since 1971. The following table 9 might be an indicative for the on going coordinated work.
Table 9: Yield Assessment Trial Results for 1972-76 in ARDU Kg/ha.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assasa</td>
<td>Bekoje</td>
<td>Kalusa</td>
<td>Assasa</td>
<td>Bekoje</td>
</tr>
<tr>
<td>CS 144</td>
<td>2680</td>
<td>-</td>
<td>-</td>
<td>2190</td>
<td>480</td>
</tr>
<tr>
<td>CS 436</td>
<td>2480</td>
<td>-</td>
<td>-</td>
<td>2680</td>
<td>590</td>
</tr>
<tr>
<td>Local Sheno</td>
<td>2410</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>F. Peas Ex. DZ</td>
<td>2370</td>
<td>-</td>
<td>-</td>
<td>2700</td>
<td>700</td>
</tr>
<tr>
<td>Alaska Express</td>
<td>2240</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Fryssuab Blue</td>
<td>1820</td>
<td>-</td>
<td>-</td>
<td>2990</td>
<td>1670</td>
</tr>
<tr>
<td>Alaska Small Sieve</td>
<td>760</td>
<td>-</td>
<td>-</td>
<td>970</td>
<td>690</td>
</tr>
<tr>
<td>Alaska 14</td>
<td>530</td>
<td>-</td>
<td>-</td>
<td>710</td>
<td>1230</td>
</tr>
<tr>
<td>Zelvedon Wonder</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>640</td>
<td>840</td>
</tr>
<tr>
<td>Holestahiro</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2390</td>
<td>630</td>
</tr>
<tr>
<td>CS 185</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2350</td>
<td>480</td>
</tr>
<tr>
<td>Mahandarfer</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3280</td>
<td>1270</td>
</tr>
<tr>
<td>L 48</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2410</td>
<td>1600</td>
</tr>
<tr>
<td>G 22766</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2850</td>
<td>-</td>
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<tr>
<td>NCI Wajitu</td>
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<td>-</td>
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<td>2360</td>
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<td>NC 3 Arum</td>
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<td>-</td>
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<td>1680</td>
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<td>G 22763</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2540</td>
<td>-</td>
</tr>
</tbody>
</table>

Field Peas Regional and National Nursery Programme

Continuous research programmes are now being launched to evaluate several hundreds of lines of varieties for yield, adaptation, disease resistance and maturity date. The programme consists of lines or varieties of gene-plasmon of international as well as indigenous collections, the main international sources being IOARDA, USA and few introductions from India and Sweden.

Cultural Practice Studies

Plant population, date of planting and weeding methods are also being studied. Date of planting seems to have a definite influence on yield. Mid-June planting on red clay soils is favoured while early July is moderately favourable on black clay soils.

With 2-3 plowing and thorough weed removal, one-time hand weeding or hoeing is quite adequate for Ethiopian field pea varieties. With such cultural practice adaptions the station can make some tentative recommendations for varieties like prussian blue, mahandar for, field pea at D, Z and CS 436 Kulumsa in the climatic condition similar to that of Assel region (ARDU).

Highland Pulse Research Stations in Ethiopia

Ethiopian Agro-eco-system is highly complex in its variability. It is not at all uncommon, particularly in the highlands, to experience different climate and weather conditions within a 10-20 km distance. In such variable and complex eco-system it is both a must and indispensable to have as much as possible representative research locations all over the country. To this effect there are a number of trial sites in the country for both lowland and highland crop improvement studies. The locations where highland pulse (including horse-bean, field pea, grass pea, lentil and fomycrocar) are generally considered highland pulses) work is carried out at the following:

<table>
<thead>
<tr>
<th>Site</th>
<th>Altitude</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holelta</td>
<td>2,600</td>
<td>Central Ethiopia</td>
</tr>
<tr>
<td>Mekelle</td>
<td>2,500</td>
<td>North</td>
</tr>
<tr>
<td>Endidir</td>
<td>1,600</td>
<td>Central</td>
</tr>
<tr>
<td>Nedje</td>
<td>1,800</td>
<td>SWestern</td>
</tr>
<tr>
<td>Debre-Zeit Exp. Station</td>
<td>1,900</td>
<td>Central</td>
</tr>
<tr>
<td>Kulumsa</td>
<td>2,300</td>
<td>S-Central</td>
</tr>
<tr>
<td>Assasa</td>
<td>2,000</td>
<td>WCentral</td>
</tr>
<tr>
<td>Bekoji</td>
<td>2,700</td>
<td>S-Central</td>
</tr>
<tr>
<td>Kokele</td>
<td>2,500</td>
<td>Southern-Ethiopia</td>
</tr>
<tr>
<td>Sheno</td>
<td>2,500</td>
<td>Central</td>
</tr>
<tr>
<td>Chencha</td>
<td>2,800</td>
<td>South-Western Ethiopia</td>
</tr>
</tbody>
</table>

In addition to these sites, various other Extension Project Implementation Departments' sites are also used occasionally. However, it is just a step towards realisation of the need to spread out stations to include more of the various complex eco-system of the country.
Varieties:-

Trial results have shown that the yields vary considerably between the varieties and ecological zones. The yields will probably increase when good and the right varieties for respective ecological zones are more common and when it is possible for the farmers to obtain them.

Variety trials in different parts of Ethiopia are important in order to find out at what altitudes the different varieties of pulses can be grown best. It is important to a farmer to get cultivars and varieties which will suit the area where he lives.

Frost:-

In every fourth year cycle at the high altitudes frost burn is also a setback for good harvest of horse bean. The traditional farmer has no answer to this. Research in the line of frost resistance variety development and date of planting must be intensified to solve the problem. The problem might be quickly answered if seeds from temperate regions particularly spring types are introduced and systematical screening is done.

Summary

The world-known plant breeder and botanist, N. Vavilov describing centres of diversity for some of economic plants puts Ethiopia as a probable secondary Centre for Vicia faba and one of the centres for Horse bean and field peas production occurs all over the country. Of the 900,000 ha. land, total pulse occupies, field peas and horse bean take about 32-35%. The highest concentrated areas of production are in the provinces of Shoa, Welo, Gonder, Gojam, Tigray and Wellega where high diversity of the crops are grown.

Since Ethiopia is located favourably for external trade she can benefit from the ever increasing external demand for the two crops. The sad story of the pulse in general in Ethiopia is that there is still little transference of modern technology to affect the average yield 9-10 Q/ha.

Until very recently all research activities and emphasis were geared towards the improvement and development of:-

1. Cereal
2. Coffee
3. Some horticultural crops
4. Oil and industrial crops

Highland grain legumes including horse bean and field peas research activities and attentions stand at the bottom of the above numerated ones. Therefore, to this date the Ethiopian agro-technology has little to offer to the bulk producing zone for a high return per hectare of cultivated land.
The recent realisation of the need of concentrated effort towards the improvement of the two grain legumes have helped to define research activities priority in the future. Therefore, future research emphasis would be developing desired varieties or lines for the export market as well as local consumption.

The major areas of research emphasis on horse bean and field peas would be:


3. Study of the crops under various Ethiopian ecological zones.

4. Development of resistant varieties to chocolate spots, rusts, powdery mildew, root rot, wilt ascochyta blight and lodging and frost hazards.

5. Creating a working environment with international research organizations for exchange of germ-plasm and technical know-how.

6. Study of the benefit of N fixation of Rhizobium Spp. to fit into Ethiopian cropping pattern.

The sum of all the objectives is to raise the present yield 9-10 Q/ha. to a minimum of 45-55 Q/ha.
Literature Cited:

1. Agriculture in Ethiopia II
   The publication and foreign languages Dept., Ministry
   Information, Addis Ababa.

2. Bengtsson, Bo: Cultivationpractices and weed, pests, and
   Diseases Situation in some parts of the Chillalo Awraja:
   CADU, March 1978.

3. Bland, B.F., Crop Production: cereals and legumes, Academic
   Press London and N.Y. 10003.

4. CADU publication 1970-75


7. EPID publication: Agents H and Book for Agronomy 1975 by
   EPID and IAR Staff, Addis Ababa 1975.

8. EPID publication No. 32, Ethiopian pulse Industry, (Situation

9. Ethiopian statistical publication, Central Statistics
   Office Addis Ababa.

10. Eugen Card, Grain Legumes Tropical Agriculture 20 points

11. Feasibility Study for the proposed seed cleaning, Storage
    and other structure, October 1977 from EPID, stenciled
    paper.

    (Behaviour for 1972-73 planning and programming Dept,

    in Their Centres of Diversity 1st Report, FAO: IBP.


16. ICRISAT - Work Shop on grain legume 1975.


18. Kachroo, P. pulse Crops of India, Indian Council of Agric.
    Research, N. Delhi, 1970.


