PROCEEDINGS OF A WORKSHOP ON

NATIONAL RESEARCH PLANNING FOR BEAN PRODUCTION IN UGANDA

Makerere University, Kampala, Uganda
January 28 to February 1, 1991
CIAT African Workshop Series, No. 9

Edited by W. Grisley

Workshop Sponsors:
Ministry of Agriculture, Uganda
Centro Internacional de Agricultura Tropical (CIAT)

PREFACE

This volume is the ninth in a publication series that documents the findings of researchers on common bean (*Phaseolus vulgaris*) in Africa. This series forms part of the activities of the pan-African bean research network, which serves to stimulate, focus, and co-ordinate research efforts on this crop.

The network is organized by the Centro Internacional de Agricultura Tropical (CIAT) through three interdependent regional projects in eastern Africa, the Great Lakes region of central Africa, and southern Africa (with SADCC).

Publication in this series include the proceedings of workshops held to assess the status, methods, and future needs of research on selected topics that constrain production and productivity of this crop in Africa. Publications in this series currently comprise:

No. 1. Beanfly Workshop, Arusha, Tanzania, November 16-20, 1986.

No. 2. Bean Research in Eastern Africa, Mukono, Uganda, June 22-25, 1986.

No. 3. Soil Fertility Research for Bean Cropping Systems in Africa, Addis Ababa, Ethiopia, September 5-9, 1988.

No. 4. Bean Varietal Improvement in Africa, Maseru, Lesotho, January 30 - February 2, 1989.

No. 5. Troisieme Seminaire Regional sur l'Amelioration du Haricot dans la Region des Grands Lacs, Kigali, Rwanda, 18-21 Novembre 1987.

No. 6. First SADCC/CIAT Regional Bean Research Workshop, Mbabane, Swaziland, October 4-7, 1989.

No. 7. Second Regional Workshop on Bean Research in Eastern Africa, Nairobi, Kenya, March 5-8, 1990.

No. 8. Atelier sur la Fixation Biologique d'Azote du Haricot en Afrique, Rubona, Rwanda, Octobre 27-29, 1888.

No. 9. National Research Planning for Bean Production in Uganda, Makerere University, Kampala, Uganda, January 28 - February 1, 1991.

Financial support for the regional bean projects and for this publication series come from the United States Agency for International Development (USAID), the Canadian International Development Agency (CIDA), and the Swiss Development Co-operation (SDC).

Further information on regional research activities on beans in Africa is available from:

Regional Co-ordinator, CIAT Regional Programme on Beans in Eastern Africa, P.O. Box 67, Debre Zeit, Ethiopia.

Regional Co-ordinator, SADCC/CIAT Regional Programme on Beans in Southern Africa, P.O. Box 2704, Arusha, TZ.

Coordinateur Regional, CIAT Programme Regional pour l'Amelioration du haricot dans la Region des Grands Lacs, B.P. 259, Butare, Rwanda.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The organizers of the National Bean Research Planning Workshop wish to acknowledge the contribution and effort of all individuals and organizations that made the workshop and these proceedings possible. Special thanks and acknowledgements go to:

Professor Joseph Mukiibi, Secretary for research, Ministry of Agriculture, Uganda.

Dr. I. Kibirige-Sebunya, Director of Kawanda Research Station.

Dr. John Mugerwa, Dean, Faculty of Agriculture, Mekerere University.

Staff of the Uganda National Bean Research Programme.

Catherine Namukwaya for typing services for the Uganda National Bean Research Programme.

Staff of Centro Internacional de Agricultura Tropical (CIAT).

The United States Agency for International Development (USAID).

The Canadian International Development Agency (CIDA).

The Swiss Development Cooperation (SDC).

ORGANIZATION OF THE WORKSHOP

The workshop was organized into seven sessions. These sessions are identified as follows:

Session I. Background information on bean production in Uganda. Three formal papers were presented in this session.

Session II. A summary of current and past research on bean production in Uganda. Eight formal papers were presented in this session.

Session III. Bean production problems, their causes and importance by agro-ecological zone.

Session IV. Identification of the causes of bean production problems and analyses of relationships between problems and causes.

Session V. Identification and evaluation of possible solutions to bean production problems.

Session VI. Setting research priorities to solve bean production problems.

Session VII. An open, general discussion on related issues and topics on bean production research.

Sessions III through VI were organized as a series of planning steps. The steps in order of sequence were:

1. To identify farmers' bean production problems.

2. To estimate the importance of the bean production problems and rank their importance.

3. To identify the causes of the bean production problems.

4. To identify and evaluate possible solutions to the bean production problems.

5. To rank the solutions to the bean production problems.

Workshop participants were divided into three working groups for intensive discussions on the topics selected at each planning step.

The results of the planning Sessions III through VI will be presented only in tabular form. Little or no text will accompany the tabulated results as they are self-explanatory.

INTRODUCTION TO THE NATIONAL RESEARCH PLANNING WORKSHOP ON BEANS

by

T. Sengooba
Coordinator, National Bean Research Programme
Kawanda Research Station

Research on beans in Uganda dates from the early 1960s. A significant landmark was achieved in 1968 with the release of the cultivar K 20. This cultivar was immediately successful and was widely adopted by farmers across the country. Since introduction K 20 has continued to dominate bean production in the country.

National average bean yields in the 1970s ranged from 500 to 800 kilograms per hectare. During the 1980s, bean yields were in the 600 to 700 kilogram range, and by the late 1980s yields were approaching the one ton per hectare level. These figures indicate that Uganda bean farmers are increasing their productivity, but farmer yields continue to lag behind the potential yield of currently used cultivars. Potential yield is believed to be in the 1.5 to 2 ton per hectare range. The observed increase in productivity over the past decade is due to a combination of factors, including research efforts and market developments.

Bean researchers in Uganda started collaborating with CIAT in the early 1980s and a formal agreement was signed in 1985. The aim of this collaboration was to increase the productivity of bean production in Uganda, and in eastern Africa generally, through research.

The first phase of co-operation between the Uganda Bean Programme and CIAT's Regional Program has now ended. It is thus appropriate to critically review the results of research emanating from this collaboration and plan for a second five-year phase.

The objectives of the National Research Planning Workshop on beans are:

1. To examine and assess background information on bean production, marketing, and research.

2. To identify bean production problems and their causes.

3. To identify and prioritize opportunities for research in bean production.

4. To develop strategies for bean research and dissemination of research results for the next five year period.

SESSION I. Background Information on Bean Production in Uganda

Background information on bean production by geographical area is presented in this Session. For this purpose, the country was divided into three geographical zones. These zones are the highland, fertile crescent, and other areas.

1. The highland region includes the higher elevation areas surrounding Mount Elgon, the Rwenzori Mountains, and the Kabale District.

2. The fertile crescent region encompasses the districts adjacent to Lake Victoria from the border with Tanzania to the border with Kenya.

3. The remainder of the country is aggregated into the other area category.

40983

BEAN PRODUCTION AND THE CONSTRAINTS TO PRODUCTION IN THE HIGHLANDS AREAS OF UGANDA

by

J. Kisakye
Agronomist, National Bean Research Programme
Kawanda Research Station

Abstract: *The bean producing highlands areas of Uganda include the Kabale Mountains and foothills, Mount Elgon, and the southwestern volcanic mountains and foothills of the Rwenzori range. The major constrains to bean production in the highland areas include land degradation, crop diseases and pests, weeds, unavailability of labour, and poor marketing facilities.*

Introduction

The purpose of this paper is to review the cropping systems of the highland areas of Uganda and to identify the production constraints with particular reference to beans.

The principal bean producing highland areas of Uganda include the Kabale Mountains and foothills, Mount Elgon, the southwestern volcanic mountains (Rwenzori range), and the southwestern volcanic foothills. The agricultural systems practiced in these highland areas are influenced by climatic conditions, altitude, physiography, and human population densities.

Atmospheric climatic conditions are a good indicator of the agricultural potential of an area. The highland areas in Uganda tend to have cool temperatures and an adequate level and distribution of rainfall. The soil moisture and temperature regimes of the highland areas indicate that the area is suitable for many crops, including coffee, tea, bananas, beans, sorghum, and potatoes. Steep and highly erodible slopes are one of the major limitations to agricultural land use in these areas.

In addition to the identified environmental characteristics, high rainfall areas tend to have high population densities. These high population densities often result in intensive land use which can lead to a break down in soil structure and result in the promotion of soil erosion.

Kabale Mountains

The distribution of the Major Land Resource Areas (MLRA) of Uganda is shown in Figure 1. The establishment of the MLRAs is based on the soil, landscape, climate, vegetation, and water resource characteristics of an area (Yost and Eswaran). The Kabale Mountains fall into MLRA unit 1 classification.

The topography of the Kabale Mountain area is characterized by steep hills with incised streams and small lakes. Elevations range from about 1,830 to 2,500 m. The lowlands in the valley bottoms are level to gently sloping, while the uplands are characterized by the steep slopes on the mountain sides.

Average annual precipitation is about 1000 mm. The area has two wet seasons extending from February to May and August to December. June and July are the driest months. Average annual temperature is 17° C with June and July being the coolest months with an average temperature of 16° C. Because of the cool temperatures, beans require a long growing season. It is estimated that beans require a growing season of 87, 95, 96 and 109 days in the Northern, Central, Eastern and Western regions of Uganda, respectively (Mukasa).

The dominant soil types in the Kabale Mountains are haplohumults, kandiudults and sombrihumults. In general, these soils are fine textured. Narrow ridges of sandstone outcrops are common on some of the steeper slopes. Residual and colluvial soils are on uplands with alluvium and marshes in lowlands and along streams.

The natural vegetation consists of a grass savanna with some of the medium-altitude moist areas in evergreen forest and thickets. Most of the area is, however, under intensive crop cultivation. The main crop grown during the first wet season is sorghum. Other important crops include beans, bananas, sweet and Irish potatoes, peas, maize, tobacco, coffee, millet, and wheat.

Mixed cropping is a common practice in this area. Bean cultivars with a bush type structure are generally preferred for intercropping because they do not intertwine with associated crops. When intercropped with Irish potatoes, beans are sown in the inter-ridge spaces. Intercropping with sweet potatoes differs in that both crops are planted on top of mounds. Where beans are intercropped with maize, sorghum, pumpkins, or bananas they are sown as a ground cover crop.

Most sorghum is sown in the January to February period as a relay crop in maize.

Many farmers stagger the sowing of beans because they want to avoid the heavy rains and resulting disease infestations which can reduce yields. Some beans are sown at the onset of the rains, while others are sown after the rains have decreased in intensity. The staggered sowing may also be related to a household labour availability.

An increase in the land area sown to beans was found over the period 1981-88 (Table 1). Most of the cultivars sown are bush types, but climbers are dominant in the higher elevations around Kisoro. The names of the major cultivars sown are shown in Table 2. Beans are consumed in both the fresh and dry form and a few farmers eat snap beans. Consumption of bean leaves is also common in selected areas.

Kabale Foothills

The Kabale foothills are labelled as Unit 2 in Figure 1. The area consists of the moderately steep foothills adjoining the Kabale Mountains. Average annual precipitation is about 950 mm and is evenly distributed throughout the year except for June and July which are the driest months. Average annual temperature is 19° C with the highest temperature in February and March at an average of 21° C.

Dominant soils are residual with rock outcrops and very stony areas on steeper slopes in the uplands. Colluvial soils are at the base of hills and in sloping concave areas. The dominant soils types are kandiudults, sombrihumults, and lithic dystrochrepts. These soils are medium to fine textured. The mean annual soil temperature is over 22° C. There is a probability of soil moisture stress for about two months in two out of ten years (Yost and Eswaran).

The native vegetation is predominantly grass savanna. Steep slopes are in grass and are used for rangeland. Homes are found on the less steeply sloped areas.

Most of the area is under crops. Bananas are grown on the slopes and are typically mulched with banana leaves and stems. Beans are interplanted with sorghum and maize on the slopes and with Irish potatoes in the valleys. Farming practices are generally similar to those practiced in the Kabale Mountains.

Southwestern Volcanic Mountains

The volcanic mountains of the Rwenzori range fall into this MLRA unit. Elevation ranges from 1,500 to 5,100 m.a.s.l.

Rainfall is evenly distributed throughout the year with average annual precipitation about 1,500 mm. This rainfall pattern allows for continuous production of beans. The driest month is January. Average annual temperature is 19° C with the coolest months dropping to 18° C.

The soils at the highest elevations are rich in organic matter. At lower elevations, residual and colluvial mineral soils are found. Dominant soils at the highest elevations are umbrepts, udolls, and udands with a medium to fine texture. The mean annual soil temperature is between 15-22° C. Soils of the lower elevations are dominated by hapludalfs and kandiudalfs.

Most of the Rwenzori area is forested, but large areas have been cleared for food crop production. Bananas, maize, cassava, sweet potatoes, beans, and groundnuts are the main food crops. Commercial crops include arabica coffee and tea. Beans are mainly intercropped with maize.

Southwestern Volcanic Foothills

This area has moderately steeped foothills as part of the Rwenzori Mountain system. Elevation ranges from 1,700 to 4,000 m.a.s.l. Average annual precipitation is 1,322 mm. with a distinct dry period from December to March. The average temperature is about 25° C with the warmest month being February with a mean temperature of 27° C.

Soils developed from volcanic ash adjoin the mountain range. The nearby hilly areas comprise of residual and colluvial soils.

The natural vegetation is medium altitude, moist evergreen and semi-deciduous forest. Moist areas are in mixed forest and savanna. Crops grown include bananas, sweet potatoes, coffee, cotton, beans, maize, sorghum, and millet.

Mount Elgon

The slopes of Mt. Elgon range from steep to very steep. Elevations range from 1,500 to 4,300 masl. Annual precipitation is 1,100 to 1,500 mm with January to March being the driest months. The average annual temperature is 22° C with a cool period from July through September.

The dominant soil types are umbrepts, haplohumults, udolls, udands, and kandiudults. The soils vary depending upon elevation. The mean annual soil temperature is between 8-15° C at the higher elevations while the lower slopes are at 15-22° C.

Large areas are covered with bananas which are the main food crop, but are also used for brewing beer. Finger millet is also grown at high altitudes, primarily for making beer (Parsons). Beans are the major pulse produced and are often intercropped with maize. Beans are also relay-cropped into maize in August. When beans are sown as a relay crop, the lower leaves of the maize plant are removed.

Production Constraints

Land degradation

As indicated in Figure 2, population pressure in the highland area is directly related to the level of rainfall. The high population density results in little cultivated land per household. Thus land is cultivated continuously with either a short or no fallow period. Soil fertility is thus declining with the continuous cultivation. In many cases, terraces have been removed and cultivated because farmers do not have enough cropland. After many years of rest the terraces are found to be more productive than the neighbouring plots of land. Cropland parcels are highly fragmented in the Kabale area. This presents problems in land management use because farmers are not willing to construct and/or to maintain existing terraces.

Due to a land shortage in the highland areas, some farmers cultivate slopes steeper than 20° which should otherwise be under forest or permanent pasture. Cultivation of steep slopes enhances soil erosion which is serious in the Rwenzori and in Kabale Districts. Erosion is also common on communal grazing land, especially when rain falls in heavy showers on shallow and silty or sandy soils. Land slides occur on the permeable soils of Mt. Elgon and in areas of Kabale. Indiscriminate burning during the dry season also encourages erosion.

Methods of erosion control aim principally at reducing run-off by increasing the proportion of rainfall percolating into the soil (Webster and Wilson). In the 1960s, it was recommended that on the steep slopes of Mt. Elgon long continuous bunds of 0.9 m wide be constructed at 4-8 m intervals and planted with *Paspalum notatum* for the purpose of controlling soil erosion (Stephens). In Kabale, 3.2 m wide terraces were separated by grass bunds. Mulching coffee and banana plantations is also effective in reducing soil run-off. The use of cover crops, such as beans, also acts to control soil erosion while at the same time suppresses weeds.

Hail

Hail frequently occurs in the highlands, especially in the vicinity of the Rwenzoris and Mt. Elgon. The most likely time for hail is at the beginning of the wet season, after a long dry spell. At altitudes above 1,200 m.a.s.l., crop damage caused by hail can be extensive (Jameson and McCallum).

Diseases and pests

Diseases that reduce bean yields in the highlands are halo blight, ascochyta, anthracnose, bean common mosaic virus, and angular leaf spot. The most economical means of

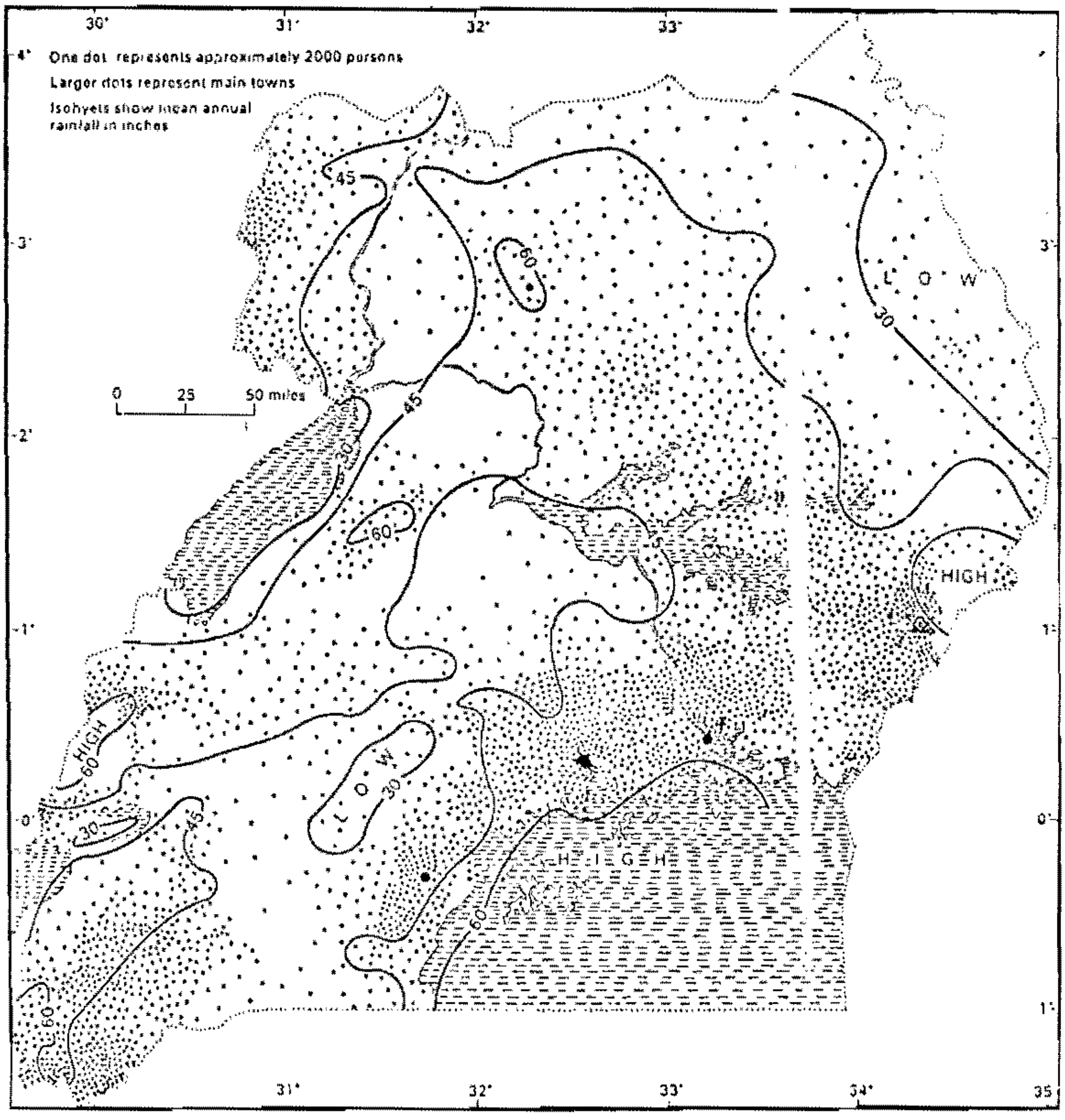


Fig. 2. Mean annual rainfall of Uganda

Table 1. Area and Production of Beans in the Highland Areas of Uganda, 1981 to 1988[a]

District	1981-84	1985-88
Kabale		
Hectares	15,300	18,666
Tons	11,325	16,602
Kabarole		
Hectares	17,044	15,711
Tons	12,635	12,277
Kasese		
Hectares	2,964	1,694
Tons	2,189	1,325
Mbale		
Hectares	19,962	23,904
Tons	14,719	18,465
Rukungiri		
Hectares	7,936	4,560
Tons	5,892	3,589
Country Total		
Hectares	367,956	382,453
Tons	271,460	300,328

[a] Ministry of Agriculture, Entebbe, Uganda.

40984

BACKGROUND INFORMATION ON BEAN PRODUCTION IN THE FERTILE CRESCENT ZONE OF UGANDA

by

T. Sengooba
Pathologist and Coordinator, National Bean Programme
Kawanda Research Station

Abstract: *The fertile crescent zone lies within the first 100 km of lake Victoria. It has medium to high fertility soils. The total annual rainfall is around 1000 mm with peak periods from March to June and from September to December. The area is classified as the robusta coffee/banana farming system zone. Beans are largely produced in association with other crops, with maize and bananas being the most important. Bean production in this zone is 14-17 percent of national production. Beans are used primarily for home consumption, but sales are common. Large to medium size grain types are preferred. The major production problems range from biotic and abiotic to social economical factors.*

Introduction

The fertile crescent zone of Uganda includes the districts of Rakai, Masaka, Mpigi, Mukono and Jinja. This zone lies largely within 100 km of the shores of Lake Victoria. The soils are fertile, with sandy clay loams and sandy loams of medium fertility covering most of the area. The soils of the Nakabango area through to the Mabira Forest are heavier and more fertile than the rest of the zone due to the presence of basic rock amphiborlites in the parent rock material (Harrop).

Annual rainfall in the fertile crescent zone ranges from 1,000-1,200 mm with two peak period extending from March to June and from September to December. Mean monthly maximum temperatures range from 25° to 29° C with an overall annual mean maximum temperature of 27° C.

Farming System

The farming system practiced in the fertile crescent zone has been classified as the robusta coffee/banana system by the ministry of agriculture. Robusta coffee is the principle cash crop, but it has recently been declining in importance. Bananas occupy more land in this zone than any other crop and are the main food staple. Other important crops are beans, maize, sweet potato, cassava, groundnuts, sorghum, sugar cane, tea, and fruits and vegetables (Kisakye; Nabacwa; Ugen).

Intercropping is the norm in the fertile crescent zone with the maize and beans association as probably the most widely practiced foodcrop production system. In a recent survey in Mpigi District, 93 percent of farmers were reported to be producing beans in association with maize (Kisakye). A similar percentage of farmers are expected to grow maize and beans in an intercropped system in the Mukono and Jinja Districts. A slightly smaller percentage of farmers are expected to be using the system in the districts of Masaka and Rakai.

The banana-bean intercropping system is also important in the fertile crescent zone. In the Rakai district, it is the most important system as beans are frequently produced underneath bananas. Beans can be produced in this system on young as well as old, mulched plantations. In other districts of the fertile crescent zone, the banana-bean association is primarily with young, unmulched bananas (Ugen).

Beans are also intercropped with cassava before the cassava canopy closes and on the top and in between the mounds of sweet potatoes. Other crops commonly intercropped with beans include Irish potatoes and groundnuts.

Production

Bean hectarage and production statistics for the fertile crescent zone over the decade of the 1980s are reported in Table 1. The annual increase in hectarage and production over the seven year period examined was 1.6 and 5.2 percent, respectively. These growth rates were less than the national average which had an area expansion of 2.4 percent and an increase in production of 5.5 percent over the 1980s.

The districts of Rakai and Masaka had the highest growth rates in both area expansion and production in the fertile crescent zone. The annual area expansion growth rates were greater than 3.5 percent and the production growth rates were approximately 9 percent. In these two districts, productivity increases were thus responsible for more of the growth in production than growth in area expansion.

In the districts of Mpigi and Mukono, area expansion in bean production was less than one percent annually, while total production increased in the 2 to 4 percent range. Productivity increases were thus responsible for most of the increase in production. In the Jinja District, the bean production area decreased by -1.2 percent annually while the overall increase in production was 0.5 percent.

Table 1. Bean Hectarage and Production in the Fertile Crescent Zone of Uganda

District	1981-83 area	1981-83 prod.	1987-89 area	1987-89 prod.	Annual % increase area	Annual % increase prod.
Rakai	11,618	8,687	14,806	14,125	3.9	8.9
Masaka	13,750	10,274	17,146	16,749	3.5	9.0
Mpigi	6,073	4,536	6,151	5,312	0.2	2.4
Mukono	10,557	7,882	11,138	9,941	0.8	3.7
Jinja	13,411	9,988	12,305	10,373	-1.2	0.5
Total	55,409	41,367	61,546	56,500	1.6	5.2
National production totals						
	352,000	263,439	410,867	364,363	2.4	5.5
Zone as percent of national production						
	17.3	15.7	15.0	15.5	0.66	0.95

Source: Ministry of Agriculture, Uganda

Bean Utilization

Beans are primarily produced for home consumption . They form an important component of the diet and are a major source of protein. Farmers harvest and consume both fresh and dry beans. The harvesting of fresh (mature, whole grain) beans allows farmers to extend the period in which households can secure food from bean plantings. Fresh, as well as dry beans, have a ready local market and it is not uncommon to see women selling fresh beans at informal roadside markets.

Even though farmers market beans, they are primarily targeted for home consumption by the vast majority of households. Purely commercial bean producers are not common.

Bean Cultivar Types

The type of bean cultivars found in the fertile crescent zone indicates that farmers prefer large and medium sized grain. Surveys conducted in the area in 1987 revealed that cultivars like Nambale, Kayinja, Kanyebwa, Mutike, Kampulike and White Haricot are widely popular (Kisakye). The colour range of these cultivars are red, brown, purple, and white.

Grain size ranges from a high of 0.45 gram for Nambale to a low of 0.20 gram for White Haricot.

Farmers in this zone indicate a strong preference for cultivars with grain that is large with red or red mottled seed type. If farmers are asked the question "why do you prefer specific cultivars," responses range from high yield, good taste, tolerance to pests and diseases, quick maturity, and short cooking time to favourable market price. However, there is considerable variation in farmers' preferences both across and within the same cultivar.

Bean Production Problems

The major bean production problems as expressed by farmers in the Rakai, Masaka and Mpigi Districts include:

1. A range of pests including leaf eaters, aphids, weevils and cutworms. Beanfly are not mentioned by farmers but they are widespread on farmers plots.

2. A range of diseases including angular leaf spot, common bacterial blight, bean common mosaic virus, rust, anthracnose and floury leaf spot.

3. Shortage of labour and lack of mechanical power.

4. Lack of inputs such as good quality seed, pesticides, fertilizers.

5. Poor yields.

6. Declining soil fertility and lack of manure to improve the soil.

7. Unreliable rainfall.

8. Lack of contact with extension staff and hence poor knowledge of improved technologies.

9. Low bean prices and a poor marketing system.

References

Harrop, J. F. (1970). Soils. In *Agriculture in Uganda*, ed. J.D. Jameson, pp. 43-71.

Kisakye, J., T. Sengooba, and W. Tushemereirwe (1987). A Diagnostic Survey of Rakai District. In National Bean Programme Annual Report, 1987, Department of Agriculture, pp. 27-32.

Kisakye, J. and W. Tushemereirwe (1987). Report on Survey of Mpigi District. In National Bean Programme Annual Report, 1987, Department of Agriculture, pp. 18-26.

Ministry of Agriculture and Forestry (1973). Potential Agricultural Development Zones in Uganda, pp. 60

Nabacwa, P. and J. Nabawanuka (1988). Survey of the Bean-Banana Intercropping Association in Rakai and Mpigi Districts. In National Bean Programme Annual Report, 1988, Department of Agriculture, pp.43-43.

Ugen, M.A. (1988). Survey of Bean Production in Masaka District. In National Bean Programme Annual Report, 1988, Department of Agriculture, pp. 51-54.

40985

REVIEW OF BEAN PRODUCTION IN UGANDA OUTSIDE THE HIGHLAND AND FERTILE CRESCENT ZONES

by

B.S. Male-Kayiwa
Breeder, National Bean Programme, Kawanda Research Station

Abstract: *Beans are grown and consumed in all of the 34 districts of Uganda. Areas outside the highland and fertile crescent zones account for over 60% of the country's production. Increased production over the past 10 years has been through area expansion rather than increased yield. Production constraints include diseases and pests, poor yielding varieties, land limitations, soil fertility, water stress, and poor marketing system. Beans are consumed both in the fresh and dry states as a sauce accompanying the staple food. The most common bean dish is cooked in a mixture with either bananas or cassava. In the central and eastern regions, beans are consumed in a mashed form with sweet potatoes, while in the northern region they are mixed as a sauce with other grains such as simsim and groundnuts*

Introduction

Bean production in the northern, eastern, western and central regions of Uganda is investigated in this paper. Districts included in the northern region are Arua, Moyo, Nebbi, Apach, Kitgum, Gulu and Lira. The eastern region districts are Kotido, Moroto, Kapchorwa, Kumi, Soroti, Tororo, Kamuli, and Iganga. Districts in the western region are Hoima, Masindi, Bushenyi, and Mbarara. The two central region districts are Luwero and Mubende.

Beans are consumed almost in every home in Uganda. Production, both in acreage and yield terms, fluctuates from year to year depending upon weather conditions, social and economical factors, and general civil security. As has been the trend in the rest of Africa and Latin America over the past decade, increased production has been due to area expansion rather than increases in yield (Janssen).

There is a similarity in the cropping systems and the production constraints for beans in the areas under review. However, there is a noticeable variability in seed types preferred and the utilization of grain. Because all production is generally consumed within the country, the relative importance of beans in any one district depends upon the diet of the people and the environmental adaptation of other grain legumes. Over the past decade, and generally since the early days of this century, the acreage of beans had always exceeded that of other grain legumes (Rubaihayo).

Cropping Systems

Beans are found intercropped with maize, cassava, bananas, sweet potatoes, cotton, and other legumes. In the districts of Kamuli, Bushenyi, and Mbarara intercropping practices are said to be influenced by the scarcity of land, while in other districts where land availability is not a problem intercropping is looked upon as a means to maximize diversity of crops on a limited plot of land. Beans are also found in pure stands in variable proportions in most districts.

Bean seedbed preparation, planting, and weeding are mainly done with a hoe. Plant populations are variable, depending upon whether the crop is planted in pure stand or intercropped. Beans are grown in both rainy seasons, while limited acreages are grown off-season. This is particularly true in the case of cleared swamps in the Bushenyi District and in the Nile River valley in Arua District.

In Apach and the neighbouring districts about 50 percent of beans are grown in pure stand. Planting in pure stand is less the norm in Arua District. Fertilizers are rarely used and, even where animals are kept, manure is not utilized on the bean crop.

Production Statistics

Increased production was due to area expansion over the period 1981-89. Beans consistently had the largest acreage among the grain legumes and was only exceeded in total acreage by the staple food crops of bananas and sweet potatoes and occasionally maize and millet. Security problems affected production in some districts during the 1980s, but production has continued to rise both in acreage planted and tonnes produced (Table 1). Yields ranged from 698 to 1,000 kg/ha.

Utilization

Beans are mainly consumed as a sauce accompanying the staple food. In Luwero and Kamuli Districts it was estimated that over 50 percent of all beans are consumed in the boiled fresh form. The remainder is marketed or retained for consumption as dry beans or for seed. In Arua and other districts of Northern Uganda, beans are mainly eaten when dry. They are prepared in a variety of methods. In the most popular dish, beans are mixed with pounded groundnuts or simsim to make a sauce. In this preparation, beans would either have the testa removed or left intact. In areas of central, western and eastern Uganda, boiled beans are mashed to make a thick soup (magera) or are mashed with sweet potatoes to make a soft dough (mugoyo). Beans are also commonly eaten as katogo, which is a mix with either bananas or cassava. Beans which provide the dark red soup are preferred for the katogo dish. In some areas of western, eastern and central Uganda, steamed bean leaves are consumed. However, this practice is becoming less common.

Seed Types

The most common cultivars in the districts of central, western and eastern Uganda are the red mottled K 20, or Nambale, the brown coloured Kanyebwa, and Mutike which is of various colours. These cultivars are mainly large or medium in grain size. In the northern region, the most common cultivars are the small seeded cream or black types. However, in Arua there is a predominance of white seeded types with grain size ranging between medium to small.

Farmers maintain genetic variation in landraces. Common grain colours found include black, purple, red, brown, pink, yellow, cream and white. A rare green coloured grain was recently collected from the Arua District. Some grain colour types are preferred for home consumption while others are grown primarily for marketing. Consumer preferences seem to play an important role in the grain types grown for marketing purposes.

Production Constraints

Diseases are a serious concern in bean production, especially when there is excessive rains. Common bacterial blight is the most widespread disease. The frequent occurrence of this disease has significantly reduced bean production in Masindi District. Seed sorting control methods practiced by some farmers may not effectively control the disease. Other common bean diseases include angular leaf spot and bean common mosaic virus.

Variation in soil fertility across the areas studied has an important impact on bean yields. Land tenure laws restrict farmers to their plots, thus limiting expansion to less exhausted soils. Soil fertility is rarely enhanced with animal manure or composts and inorganic fertilizers are generally unavailable and when available are uneconomical to use in bean production.

Farmers have claimed that weather patterns have changed in the recent past, adding to the uncertainty as to when beans should be planted. This has led to losses due to water stress or too much rain. Beans are particularly susceptible to seed rot when rains are heavy. These and other factors make large scale bean production unattractive when planted in pure stands.

The bean cultivars grown by farmers have low yield potential, but they are in high demand because consumers have strong preferences for their culinary characteristics. High yielding cultivars of acceptable grain types would be a major boast to bean farmers. Drought resistance would have to be incorporated into cultivars for the Tororo District. Disease resistant cultivars need to be developed for other areas of the country.

A major pest concern in all districts is the storage weevil. The flower eating beetle is also a major problem in the Tororo District and leaf eating caterpillars and beanfly are generally problems throughout the northern districts.

The poor marketing system acts to deter farmers from producing greater quantities of bean as they lack sufficient storage facilities. Lack of easy access to markets often leads farmers to sell their produce at low prices during the harvesting period. Political insecurity has also decreased production in the Kumi, Arua, and Luwero Districts during various years of the past decade.

Conclusion

Beans have become a common constituent in the diet of the people of all districts of Uganda regardless of whether the area is good for bean production or not. The government target for increased bean exports has to be met with increased production. Unless there is improvement in varieties and infusion of better management practices whereby fertilizers and other inputs are utilized, increased bean production can only be continued to be met through increased area expansion.

References

Janssen. W. (1989). Dry Bean Production and Consumption in the Year 2000: Projections, Thoughts and Guesses with Emphasis on Latin America and Africa. Proceedings of the International Bean Breeding Workshop on Common Beans, CIAT Working Document No. 47, pp. 329-50.

Rubaihayo P.R., D. Mulindwa, T. Sengooba, and F. Kamugira (1980). Bean production in Uganda. in Regional Workshop on Potential for Field Beans in Eastern Africa, Lilongwe, Malawi, 1980. Centro Internacional de Agricultura Tropical, 1981, pp. 155-186.

Wortmann C.S, and M.A Ugen (1988). A brief Survey of Tororo and Mbale Districts and Report on a Brief Survey of Bean Production in the Masindi District. in Uganda National Bean Programme Annual Report, 1988.

Table 1. Hectares and Production of Beans in Selected Districts of Uganda, 1981-82 and 1988-89

District	1981-82 hectares	1981-82 production	1988-89 hectares	1988-89 production
Luwero	-	-	5,907	5,466
Mubende	3,579	2,581	4,207	12,927
Hoima	10,730	7,730	13,064	11,896
Masindi	17,182	12,526	15,761	14,349
Bushenyi	10,701	7,787	8,608	8,204
Mbarara	19,220	14,023	45,615	44,662
Kotido	549	383	335	258
Moroto	1,416	1,001	1,085	-
Arua	12,072	8,769	12,176	9,545
Moyo	121	89	295	248
Nebbi	5,841	4,267	6,928	6,278
Apach	17,582	12,775	36,365	33,061
Gulu	14,895	10,831	12,723	10,984
Kitgum	17,096	12,419	12,922	11,374
Lira	19,362	14,039	24,126	21,221
Kapchorwa	18,168	13,252	17,976	14,581
Kumi	8,559	6,150	6,626	9,393
Soroti	9,127	6,393	6,118	4,647
Tororo	8,659	6,066	19,920	17,019
Iganga	2,097	1,481	9,293	8,883
Kamuli	8,751	6,294	16,390	15,578
	205,706	148,855	285,071	256,742
As % of total country	63	63	66	66

Source: Ministry of Agriculture, Uganda

SESSION II. Summaries of Research Progress on Bean Production

The purpose of the Session is to present all relevant information on past bean research in Uganda. The research fields reported upon include breeding, pathology, entomology, agronomy, soil science and plant nutrition, and socio-economics.

40986

BEAN BREEDING IN UGANDA

by

M.S. Musaana and H. Gridley
Breeder, National Bean Programme and Breeder,
Centro Internacional de Agricultura Tropical
Kawanda Research Station

Abstract: *The history of bean breeding in Uganda from 1960-90 is reviewed, covering production constraints, germplasm collections, introductions, and cultivar release. Note is made of the restructuring of the breeding programme in 1989 and the resulting large increase in breeding material handled. Yield results from the 1990b season are presented, showing that breeding lines have been identified with yields over double that of the local cultivar K 20.*

Introduction

Research work aimed at breeding new bean cultivars with improved disease resistance, heavier seed yield and acceptable seed quality has been underway for 30 years in Uganda, and started in 1962 with the appointment of a plant breeder and pathologist. At this time few Ugandans were using beans as a major food source and campaigns were launched to popularize the crop as a cheap source of protein, especially in the banana/cassava growing areas where child malnutrition was high.

By 1968 a new cultivar, named K 20, a large seeded Rose Coco type, had been released that had the following parentage, viz; (Banja x No 15) x No 77 x No 78. No 77 (Diacol Nima) had the 'ARE' gene for resistance to anthracnose and No 78 (Mexico 11) resistance to *Isariopsis*. Both Banja and No 15 were local landraces widely accepted in many areas in Uganda and Kenya. After the release of K 20, the breeder was promoted to an administrative position and subsequent research was reduced due to civil unrest.

In 1983 the Ministry of Agriculture decided to create a centrally coordinated, bean research programme with the present programme starting in 1985. In 1984 a local collection of bean germplasm was initiated in the central and western parts of the country. In 1985 another collection was carried out in the eastern parts of Uganda. These two collections plus introductions from Rwanda, Kenya, Tanzania, Ethiopia and from other bean producing countries and later from CIAT (Centro International de Agricultura Tropical) to form the present germplasm resource collection used by breeders in the crop improvement programme (Anon.).

During the germplasm collections the breeders interviewed farmers to ascertain the constraints to increased bean production. Among the many enumerated the following were found to be the more important: Yield, especially of non infected seed; availability of a 'good' variety; taste of cooked beans and the colour of the broth; cooking time; seed colour; seed size and ability of the seed to keep overnight after cooking. Variations in growth habit could be tolerated provided the other variables were favourable. Low soil fertility, poor soil conservation techniques and disease susceptibility were identified as major constraints to increased production.

Agriculture production accounts for a significant proportion of Uganda's GDP and 90 percent of this comes from small farmers. These farmers lack the capital to buy fertilizer or other chemical inputs, and cannot even afford to buy certified seed from the Uganda seed's project. Hence, farmers usually keep their own seed for planting, and in such a situation the development of cultivars with resistance to seed transmitted diseases is of considerable importance. As traditional breeding techniques take a long time to produce results, introductions were seen as the quickest means of obtaining high yielding, disease resistant cultivars for release in Uganda in the shortest possible time. The programme was therefore initiated with the following objectives.

1. Introduce and evaluate diverse sources of bean material (both exotic and local) for disease resistance and seed yield.

2. Identify promising lines for release and use in hybridization programmes.

Materials and Methods

Locations

Research work on beans is mainly conducted at Kawanda Research Station with two other locations at Kachwekano and Serere, with different ecological conditions from those at Kawanda, acting as sub-stations. Work at Serere stopped in 1987 due to security problems. Kachwekano is at an elevation of 2,300 m, about 1,000 m higher than Kawanda.

Yield trials are regularly conducted each season at Kawanda, Kachwekano and a further six to eight locations covering different agro-ecological regions.

Source of Genetic Material

At the start of the present programme local germplasm collections were the main source of genetic variation available to the breeding programme. Later, introductions from CIAT and other bean producing countries within the region and world wide were made to widen the genetic base of available variation.

Screening and Testing Procedures

In the southern part of Uganda where most of the trial locations are situated, there are two annual growing seasons (termed 'a' and 'b'), with breeding and disease nurseries and trials planted in one or both seasons. The replicated breeding trials are commonly grown in randomized complete block or lattice designs. In the disease nurseries spreader rows of susceptible genotypes are included and planted two weeks before the test lines. The reaction of entries to prevalent diseases in all experiments and nurseries are rated on a 1 - 9 scale (developed at CIAT) were 1 = no disease (resistant) and 9 = very susceptible. Disease ratings on yield trials are usually taken at flowering and at pod filling. Days to flowering and maturity, plant vigour and pod load are also normally recorded.

Diseases

The five most prevalent and serious diseases rated are: angular leaf spot (*Isariopsis griseola*), rust (*Uromyces phaseoli*), anthracnose (*Colletotrichum lindemuthianum*), common bacterial blight (*Xanthomonas compestris* pv. *phaseoli*) and bean common mosaic virus (BCMV). Other diseases usually rated are ramuralia, ascochyta blight and halo blight.

Results and Discussion

Prior to 1989.

Breeding and selection work prior to the second season of 1987 (1987b) had identified twenty-four superior genotypes, comprising local land races and introduced breeding lines, for further evaluation. Accordingly, these genotypes and the local cultivar K 20 were tested over the three seasons 1987b, 1988a and 1988b in advanced yield trials conducted at five, five and eight sites respectively. Although overall seed yields were light and a proportion of these trials had relatively high coefficients of variation (CV) due a combination of few resources and poor management, a number of genotypes significantly ($P < 0.05$) out yielded K 20 at individual sites. The three heaviest yielding lines, with acceptable seed and other consumer characteristics (determined from on-farm testing), were G 13671, Rubona 5 and White Haricot (a selection from a landrace) and showed across site mean yield increases over K 20 of 75, 32, and 66 percent, respectively (Figure 1). These lines also showed considerable yield improvement over local landraces and were released as new cultivars in 1989.

1989 to 1990

With the arrival and additional help of a CIAT breeder (based at Kawanda) from mid-1989 it was possible to markedly increase the amount of genetic material being handled. The breeding programme was re-structured to allow for an orderly flow of an increased number of breeding lines through an extensive evaluation and testing system. This involves initial screening in non-replicated observation nurseries (OBN), followed by selected lines being advanced through preliminary (PYT), intermediate (IYT) and advanced (AYT) multilocation yield trials. Each of the first three stages involve one season of testing, with superior lines retained in the AYTs for three seasons, whilst entering on-farm trials to determine their farmer and consumer acceptability. The number of lines and populations were tested in the second season of 1989 (1989b) and the first season of 1990 (1990a) are shown in Table 1.

After 1990a the breeding programme was divided with the National Breeding Programme taking responsibility for handling all the breeding lines without the I gene for resistance to BCMV and the CIAT breeder for all the lines with the I gene. (Lines with the I gene produce a hypersensitive reaction (black root) when infected with a necrotic strain of BCMV, usually resulting in premature death.) Trials testing solely lines with the I gene have 'Regional' in front of the trial title (RAYT, RIYT, RPYT) to distinguish them from trials testing I gene lines.

With the flow of material from breeding activities in the two previous seasons, over 500 breeding lines and segregating populations, the majority of which were introductions from CIAT, were tested in the second season of 1990 (1990b) (Tables 2 and 3). Considering information from both Tables, the number of lines and segregating populations tested at the different stages is shown in Table 4.

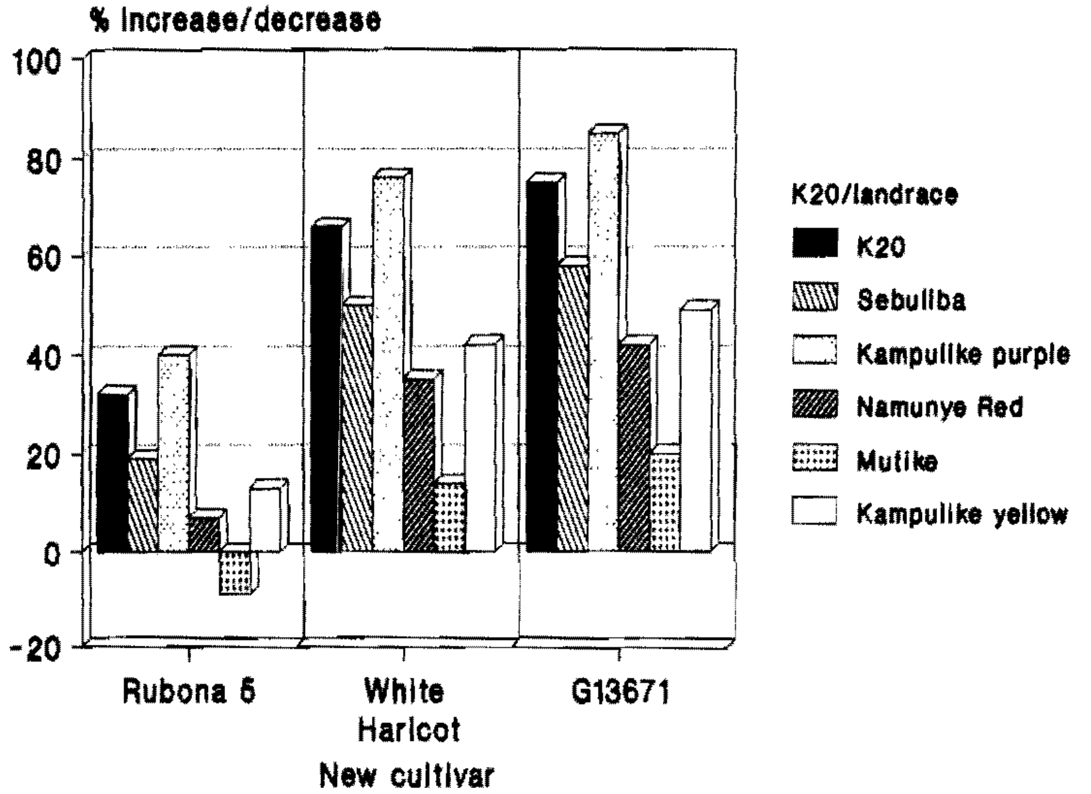
A summary of the yield results from the different replicated yield trials is shown in Tables 2 and 3. In the AYTs and IYTs, 88 to 95 percent of the breeding lines exceeded the mean yield of K 20 across sites in the range of 1 to 104 percent. Amongst the I gene lines a substantial number also showed significant seed yield increases over K 20 at more than one site (Table 3). Similar data are not yet available for the non I gene lines. The high proportion of lines exceeding K 20 across sites suggest that multilocation testing of PYTs in the previous seasons had successfully identified heavy yielding lines for advancement to these trials.

Compared to the AYTs and IYTs, a smaller percentage of lines in the PYTs exceeded the mean yield of K 20 across sites, although the increases, particularly amongst the I gene lines, were of the same magnitude (Table 3). As the PYTs are the first stage of replicated yield testing such a difference between the stages is not unexpected. However, and perhaps surprisingly, of all the lines tested in replicated trials, one I gene and one non I gene line in different PYTs recorded the heaviest across site yield increase over K 20 at 162 and 182 percent, respectively (Tables 2 and 3).

It is well known, and confirmed by the yield results from the three seasons, that medium to small seeded lines are inherently heavier yielding than large seeded lines which tend to be preferred by consumers. Thus to prevent smaller seeded lines dominating the later stages of testing (AYTs and ITYs) as a result of selection favouring heavy yield, trials are now divided medium/small (<0.4 g/seed) and large seeded (>0.4 g/seed) types at the PYT stage, the best of each type then being advanced to the IYTs and AYTs. Figure 2 shows the considerable difference in yield potential between large and medium/small seeded lines in the Regional PYTs for 1990b. It was encouraging, however, that the five heaviest yielding large seeded I gene lines in RPTY-LS exceeded the mean of K 20 across sites in the range of 34 to 71 percent (Table 2 and Figure 2).

Figure 1 shows that the three new cultivars released in 1989 had mean yield increases over K 20 of 32 to 75 percent over 18 sites and three seasons. The yield results from 1990b, although based on fewer sites and seasons, strongly indicate that there is now available advanced lines with markedly superior yield to K 20 and these new cultivars; the best four I and non I gene lines are now being evaluated in on-farm trials at fifteen sites in southern Uganda.

Figure 1. Seed yield of new cultivars relative to K20 and five local landraces in Uganda (1987-1989).



Data mean of 18 sites over 3 seasons.

Figure 2. Yield increase (%) over K20 of five superior lines in two PYTs in 1990b in Uganda.

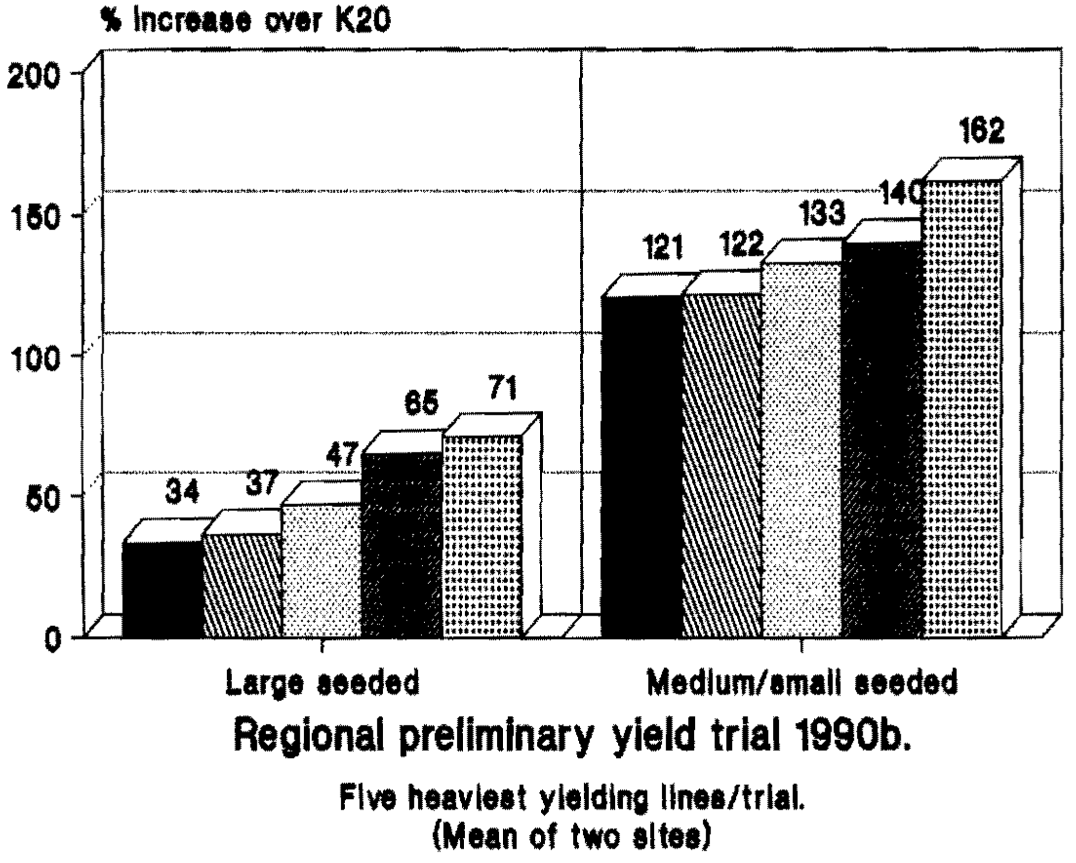


Table 1. Bean Breeding Lines and Populations Tested in 1989 and 1990[a]

Testing stage	Season 1989b Site[b]	Season 1989b Genotype	Season 1990a Site	Season 1990a Genotype
Observation nurseries	1	711 lines	1	673 lines
	1	185 SP[c]	1	151 SP
Preliminary yield trial	2/3	478 lines	1/3	389 lines
Intermediate yield trial	3	20 lines	4	128 lines
Advanced yield trial	5	20 lines	7	21 lines

[a] In addition, in 1990a 1,881 single plant selections were made for 17 F^1 populations segregating for BCMV resistance.
[b] Preliminary yield trials grown at one to three sites.
[c] SP is segregating populations.

Table 2. Statistics for Trials with Non I Gene Lines Conducted During the Second Season of 1990 (1990b), Uganda

Trial[b]	Number of: test entries	Number of: sites	Number of: entries exceeding mean yield of K 20 across sites%[c]	Range (%) yield increase of lines over mean yield of K20 across sites[a]
AYT	22	7	21 (95)	101-232
IYT	15	3	14 (93)	102-147
PYT1	79	3	43 (54)	101-136
PYT2	48	3	29 (60)	103-282
POP-YT	46	3	34 (74)	103-143

[a] Control mean taken as 100. Percent equal no. of lines exceeding mean of K 20 over sites/total number of test entries.
[b] AYT is advanced yield trial, IYT is intermediate yield trial, PYT is preliminary yield trial, and POP-YT is population (F_4,F_5) yield trial.
[c] For mean yield calculations one PYT and POP-YT site were dropped due to high CVs.

Table 3. Statistics for Trials and Nurseries with I Gene Lines Conducted in the Second Season of 1990 (1990b), Uganda

Trial[a]	Number of: test entries	sites	entries exceeding mean K 20 across sites (%)[b]	Range (%) increase of entries over mean K 20 across sites[c]	Number of lines with significant increases over K20 at: 4 sites[c]	3	2	1
RAYT	32	5	28 (88)	104-205	12	5	4	4
RIYT	43	4	40 (93)	101-204		2	10	20
RPYT-LS	45	4	20 (47)	103-171			6	11
MS1	45	4	20 (44)	104-210			2	4
MS2	45	4	41 (91)	108-262			23	14
RPYT-1	11	2	9 (91)	102-196			2	5
MCM-YT	12	4	3 (25)	104-131				1
SN-1[d]	281	1						
BRN-F_3	1881[e] F_3	1						

[a] RAYT is regional advanced yield trial, RIYT is regional intermediate yield trial, RPYT-LS is regional preliminary large seeded yield trial, RPYT-MS1 is regional preliminary medium seeded yield trial 1, RPYT-MS2 is regional preliminary medium seeded yield trial 2, RPYT-1 is regional preliminary yield trial 1, MCM-YT is yield trial evaluating BCMV resistant lines, SN-1 is screening nursery of lines from the VEF 89, and BRN-F_3 is black root screening nursery of F_2 derived F_3 progenies.

[b] Yield of K 20 taken as 100. Percent equal no. of lines exceeding mean of K 20 over sites/total no. test entries.

[c] The mean yield calculations and number of significant increases for one IYT and two PYT sites were dropped due to high CV's.

[d] SN-1 and BRN-F_3 are non-replicated nurseries.

[e] Seven-hundred and four of the 1,881 progenies showed no symptoms of black root infection.

Table 4. Total Number of Bean Breeding Lines Tested in Season 1990b, Uganda

Testing stage	Site[a]	Genotype
Observation nurseries	1	281 breeding lines, 1881 F_3 single plant progenies (704 progenies showed no symptoms of virus infection).
Preliminary yield trial	3/4	127 breeding lines, 46 $F_{4/5}$ segregating populations, 12 BCMV resistant lines.
Intermediate yield trial	3/4	150 breeding lines.
Advanced yield trial	5/7	54 breeding lines.

[a] Replicated yield trials grown at varying number of sites.

40987

PROGRESS ON BEAN PATHOLOGY RESEARCH IN UGANDA

by

A.F. Opio and T. Sengooba
Pathologists, National Bean Research Programme
Kawanda Research Station

Abstract: *Diseases were identified as the most important factor limiting bean production as early as 1960. Research on these diseases in Uganda focused on the important ones as identified by pathologists. The progress presented here summarizes the work carried out on these diseases since 1960. Between 1960-1984 races of colletotrichum lindemuthianum and Uromyces appendiculatus were identified. The survival mechanism and transmission of angular leaf spot was established and the use of fungicides in the control of diseases was studied. Benlate gave control to angular leaf spot while rust was best controlled by dithane M45. Breeders' materials were evaluated for diseases in different areas. Since 1985 more diversification in pathology research has occurred. Work has been done on ascochyta blight, CBB, BCMV, halo blight as well as on effect of intercropping on diseases and crop loss assessment. Evaluation of breeders' materials and disease nurseries is also being carried out.*

Introduction

The purpose of this paper is to report on bean pathology research that has been undertaken in Uganda since 1960. When research on beans started in 1960, intensive effort was directed toward discovering the causes of low yield. It was observed that diseases were the most important factor limiting production (Mukasa). In 1961, a pathologist was appointed to work with breeders to undertake research on bean disease problems.

Research Progress in the 1960-85 Period

The initial work carried out by pathologists was a survey to identify important bean diseases and their causal organisms. The most important diseases found were anthracnose (*Colletotrichum lindemuthianum* (Sacc. and magn.) Scribner), rust (*Uromyces appendiculatus* (pers) unger), angular leaf spot (*Phaeoisariopsis griseoli* (Sacc.), and the bacterial blights, i.e., *Xanthomonas campestris* pv. *phaseoli* (XCP) and its fuscous variant, and *Pseudomonas syringae* pv. *phaseolicola*.

Twenty diseases had previously been identified on beans in Uganda by Hansford in 1943. During this period, pathologists periodically evaluated useful cultivars as determined by breeders in different parts of the country. The purpose of using different areas was to study and keep watch on the changes on both the incidence and severity of diseases. In particular, these cultivars were used to detect new anthracnose races.

Research in pathology centered on anthracnose. Two major groups of races of *Colletotrichum lindemuthianum* were identified by Leakey and Simbwa-Bunya in 1972 from isolates of anthracnose pathogen collected from all over the country. These pathogens were; 1) a group comprising of alpha and related delta races and 2) Beta and related more virulent Gama races.

Later work was carried out on the control of bean diseases. Simbwa-Bunya evaluated four fungicides in 1972. Dithane M45 (Zineb + maneb) was found to be the most effective in controlling diseases when a rate of 3.4 kg/ha was used. Sengooba tried dithane M45, brestan 60 and benlate using the bean cultivar Banja 2. Angular leaf spot (ALS) was effectively controlled by all three fungicides with benlate giving the best control at a rate of 1 kg/ha. Rust was controlled only by dithane M45 and brestan, but not benlate. The resulting yield data, however, revealed no significant differences in plots under different treatments. It thus was concluded that it was not economical to use fungicides on Banja 2 under the environmental conditions prevailing at Kawanda.

Work on the epidemiology of ALS was carried out by Sengooba in 1980. Her results indicated that there was considerable variation in the pathogenicity of a number of *Phaeoisariopsis griseola* isolates. The stability of this variation was, however, not confirmed. The fungus was found to be both seed and straw borne, but the main source of inoculum appeared to be from volunteer and off-season crops. The development of ALS was favored by both high relative humidity and high rainfall. The optimum temperature for ALS in both the laboratory and field was between 23-27° C. Temperatures of 30° C and above were too high for the disease to thrive.

Race identification of rust isolates collected from Uganda, Kenya, and Tanzania was carried out by Howland and MaCartney. Of the eight races identified, six occurred in all three countries.

During the 1960-85 period no research was carried out on the bacterial blights other than selections.

Research Progress in the Period 1985 to Date

Since 1985 research in various pathological aspects have been initiated with emphasis being put on the more important diseases. The most important diseases were ALS, common bacterial blight (CBB), bean common mosaic virus (BCMV), rust, anthracnose, halo blight and ascochyta blight. The last three being important only in the higher altitude zones. A summary on the progress of each project follows.

1. Effect of Intercropping on Bean Diseases.

Research to determine the level of important diseases in intercropping situations as compared to monocrop situations was initiated in 1987. This research was carried out at Kawanda, Bukalasa, Rakai and Kachwekano stations. The intercrops considered were beans/maize, beans/potatoes, beans/bananas. It was found that the incidence of CBB, BCMV and rust were less in intercropping situations while the incidence of ALS, anthracnose, and ascochyta blight were greater in intercropping (Sengooba 1987, 1988, and 1989).

2. Crop Yield Loss in Beans from Disease.

Sengooba (1987 and 1988) studied the effect of diseases on yield of beans using the three chemical treatments benomyl + streptomycin, macozeb 70, and M70 + streptomycin on ten bean genotypes. Although the fungicidal treatments reduced the level of infection, there was no significant increase in yield. This result suggests that diseases do not significantly affect yield. However, during the period of this trial the disease pressure was very low. Additional research is needed using varied disease pressures.

3. Ascochyta blight

Sengooba (1988 and 1989) studied the control of ascochyta blight using two chemical treatments; dress seed with benomyl and spray with dithane M45 (or macozeb) and dress seed with benomyl only and pull out infected seedlings from emergence to second trifoliate leaf stage (V4). The cultivars Carioca, K 20, and Rushare were used. Seed dressing combined with fungicidal application significantly reduced the ascochyta infection and an increased yield was found. The other two treatments were not effective in controlling the disease.

Recent research has been initiated on producing seed clean of ascochyta blight by using production sites in warmer, lowland areas where the disease does not occur.

4. Common Bacterial Blight (CBB).

Research on CBB has focused on control, variation in pathogenicity of XCP, survival of the pathogen, and crop loss (Opio 1987a, 1988a, and 1989a).

Seven chemicals (cupric carbonate, cuprous oxide, cupric sulphate, cupric chloride, cupric nitrate, copper oxychloride and streptomycin) were evaluated for their control of CBB.

Cupric carbonate and cupric sulphate proved the best of the chemicals tested. They reduced the disease level on leaves and pods and significantly increased yield as compared to other treatments and the control. The other treatments also significantly reduced CBB when compared to the control, but significant increases in yield were not found.

Attempts to combine cupric carbonate and cupric sulphate with seed disinfectants did not yield better results. The two chemicals were therefore recommended if it was absolutely necessary to spray as a control measure for CBB. It was noted that although the chemicals reduced the level of infection, they did not completely eliminate it. Thus they could not be used in seed production.

The potential of using dry areas for the production of disease free seed was investigated at Mobuku in 1988 and 1989. In the off seasons that were dry (November 1988 and November 1989) the crop was very clean. Almost no CBB and even other diseases were found to be present. This suggests that under proper environmental conditions seed production could be a solution to the CBB problem. The off seasons in June of 1988 and 1989 were wet and the CBB disease scores were high.

Studies on variation in pathogenicity of *Xanthomonas compestrisa pv. phaseoli* indicate that about three quarters of CBB infection in the areas surveyed in Uganda is actually caused by the fuscous variant. In Ethiopia, most of the isolates were found to be fuscous. In Uganda, it was found that both the common blight pathogen and its fuscous variant could be isolates from the same plant and from even the same lesion* To date, seven phage types have been obtained from forty-five isolates.

Research on the survival of the pathogen XCP indicates that several weeds and non-host crops may be important in the survival. The pathogen has been isolated from six weed species (*Commelian, Benghalensis, Digitaria scalarium, Oxalis latisoha, Bidens pilosa, Cassia hirsuta, and Amarathus sp*) and a non-host (maize) growing in a heavily infected bean crop. Whether the pathogen survives in weeds after the crop has been harvested is being investigated. The length of time XCP survives in the soil without a bean crop is also being investigated.

Investigations as to whether CBB causes economical loss in bean production in Uganda was initiated in 1990. this research is still in progress.

5. Halo Blight.

The halo blight international nursery was used to study the variation in *Pseudomonas syriange pv. phaseolicola*. The results indicate the presence of Race 3 (Opio 1987 and 1988). More detailed work is needed to confirm the races in Uganda.

6. Bean Common Mosaic Virus.

In 1989, Owera identified isolates of BCMV collected from different parts of Uganda. His work revealed that the NL3 (necrotic) strain was predominant in Uganda. A study on the host range of the virus has been started.

Disease Nurseries

Two types of nurseries have been evaluated in Uganda. These are; 1) the international disease nurseries from CIAT and 2) regional disease nurseries which are formed within eastern Africa.

1. International disease nurseries

The international nurseries evaluated to date in Uganda include rust, CBB, halo blight, ALS, ascochyta, anthracnose, and BCMV (black root nursery). Several resistant lines have been selected from these nurseries to feed into the regional nurseries. Lines which are well adapted and have other good characteristics have been selected by breeders to feed into the preliminary yield trials for further advancement.

2. Regional nurseries

The purpose of these nurseries is to identify and put together entries that are resistant to the relevant diseases in eastern Africa. These resistant entries can be used by breeders in the whole region as sources of resistance to various diseases. The regional nurseries so far formed and grown in Uganda include rust, CBB and ascochyta.

Other Diseases

Diseases frequently encountered in bean fields, but for which no research work has been started, include floury leaf spot, bacterial brown spot, web blight, and the root rots.

References

Hansford, C.G. (1938). Annotated Host List of Uganda Parasitic Fungi and Plant Diseases. *East African Agriculture and Forestry Journal*, 33:319-324.

Howland, A.K., and J. MacCartney (1966). Eastern Africa Bean Rust Studies. *East African Agricultural Journal*, 32:209-210.

Leakey, C.L.A., and M. Simbwa-Bunya (1972). Races of *Colletotrichum lindermuthianum* and Implications for Bean in Uganda. *Annals of Applied Biology*, 70:25-35.

Simbwa-Bunya, M. (1972). Fungicidal Control of Bean Diseases at Kawanda. Uganda Plant Disease Report 56, pp. 901-903.

Mukasa, S.K. (1961). The Improvement of Beans in Uganda.

Sengooba, T. (1979). Seed Transmission of Angular Leaf Spot in Beans (*Phaseolus vulgaris*). In Proceedings of 2nd Symposium of the Uganda Society of Agronomy, Kampala, pp. 140-143.

Sengooba, T. (1980). Angular Leaf Spot of Beans (*Phaseolus vulgaris*) Caused by *Phaeoisariopsis griseola* (Sacc.) Ferr. in Uganda. MSc. thesis, Makerere University.

Sengooba, T. (1987 and 1988). Crop Yield Loss in Beans from Diseases. In Uganda National Bean Programme Annual Reports 1987, pp. 52-55, and 1988, pp. 63-66.

Sengooba, T. (1987, 1988, and 1989. Diseases in Bean Intercrops. In Uganda National Bean Programme Annual Reports 1987, pp. 66-63, 1988, pp. 70-79, 1989, pp. 81-84.

Sengooba, T. (1988 and 1989). Control of Ascochyta Blight. In Uganda National Bean Programme Annual Reports 1988, pp. 67-69, 1989, pp. 85-86.

Simbwa-Bunya, M. (1972). Fungicidal Control of Bean Diseases at Kawanda, Uganda. *Plant Disease Reporter*, 56:901-903.

Opio, A.F. (1987a, 1988a, and 1989a). Control of Common Bacterial Blight of Beans in Uganda. In Uganda National Bean Programme Annual Report 1987, pp. 42-43, 1988, pp. 84-89, 1989, pp. 74-78.

Opio, A.F. (1987b, 1988b, and 1989b). Variation in Pathogenicity of *Xanthomonas campestris pv. phaseoli*. In Uganda National Bean Programme Annual Reports 1987, pp. 40-41, 1988, pp. 80-84, 1989, pp. 73-74.

Opio, A.F. (1987 and 1988). Studies on Variation of *Psedoudomonas syringae pv. phaseolicola*, a Causal Organism of Halo Blight Beans. In Uganda National Bean Programme Annual Report 1987, pp. 48-51, and 1988, pp. 90-91.

Owera, S.A.P. (1989). Analysis of Serotypes and Strains of Bean Common Mosaic Virus in Countries within CIAT's Eastern Africa Regional Programme on Beans. In, Uganda National Bean Programme Annual Report 1989 pp. 94-99.

40988

SURVEY OF BEANFLY (*OPHIOMYIA* SPP) IN KABALE DISTRICT

by

E.B. Karamura
Entomologist, Kawanda Research Station

Abstract: *Beanfly (Ophiomyia spp.) incidence was investigated at the farm field level to determine losses at successive plant ages over varying altitudes in the Kabale District of Uganda. A higher beanfly population was found at the 1,860-2,110 m altitude range than at both lower and higher ranges. Both beanfly species were found, but the dominant species was O. spencerella. Future research will analyze for crop loss due to beanfly damage and sampling dates will be increased to determine the onset of beanfly infestation.*

Introduction

The Beanfly (*Ophiomyia spp.*) was first described by Tryon in 1895 from specimens collected near Brisbane, Australia in 1888. Since then the pest has been reported in most tropical and subtropical regions of the old world. In East Africa, three species (*O. phaseoli, O. spencerella, and O. centrosematis* (Tryon; Greathead; and de Meiji, respectively)) have been reported to attack beans. In this region beanfly can cause losses up to 100 percent. The damage is largely caused by the larva, especially the third instar larva which destroys the medullary tissue of the stem at ground level (Oree and Hallman). The area around the pupa dies, dries up and frequently splits. Infested plants are stunted and yellow and may die. The role of adult beanfly in transmitting diseases has yet to be verified.

A number of control measures have been adopted for beanfly. Chemicals have been reported to be effective. These include organochlorides (DDT, dieldrin, aldrin, and endrin), organophosphate, and carbamates. From these groups, the systemic members are reported to be more effective when applied on the soil or directly on the seed. However, systemic materials are normally toxic to mammals. This could be a serious drawback to their use in Uganda as bean leaves are consumed in selected areas. Residual levels of phorate, disulfoton, and carbofuran in soybean foliage and pods were found to be unsafe up to 80 days after treatment with 1.5, 1.25 and 1.65 kg ai/ha, respectively (Handa *et al*).

Other control methods include cultural control, plant breeding for resistance, and biological control. Cultural practices can be effective in reducing beanfly damage. Early planting to avoid peak infestation, removal of alternate hosts and volunteer crops, and the rotation of beans with non-host crops have been advocated (Allen and Smithson). In the case of plant breeding for resistance, many varieties have been reported possessing resistant or tolerant traits. The common mechanism being the ability of the plant to produce adventitious roots upon attack. However, the method can only be viewed as a long term strategy.

With regard to biological control, most of the work carried out in East Africa is reported by Greathead. He studied and identified natural enemies of the beanfly. However, their effectiveness in controlling the pest remains to be demonstrated.

Problem Definition

Even with the various control measures prescribed for control of beanfly, damage levels in some seasons and areas remain high. Apart from the problems posed by pollutant chemicals, farmers find chemicals uneconomical and thus only a few use chemical pesticides. Without dramatic changes in the relative price of chemicals, their use will likely remain restricted.

The possibility of using cultural measures to control pests holds promising prospects for resource poor farmers. However, these methods, such as early planting and rotations, are largely affected by land use competition and availability.

Similarly, biological control measures offer a possibility for resource poor farmers because, once established, natural enemies will not require additional purchased inputs. However, in ephemeral systems inundative releasing of natural enemies is usually thought appropriate. This involves mass-rearing of the natural enemies which can be expensive.

In circumstances where resources are limited and the economic value of the crop is low, it is necessary to assess the losses at the subsistence farmer level in order to justify research costs. It is also necessary to identify the causes of the losses in the farming system and, where possible, to analyze and prioritize the losses.

The study reported upon here was carried out to assess beanfly incidence, damage, and losses in fields of small farmers in the Kabale District. It complements similar studies being conducted in Kenya and Ethiopia. An important hypothesis to be tested is that beanfly species composition is affected by altitude.

The overall objective of the study was to obtain quantitative data on the beanfly and the losses incurred at successive plant ages at varying altitudes.

Research Methods

The study was carried out at altitude ranges of 1,600-1,850 m, 1,860-2,110 m, and 2,120-2,370 m. The 1,600-1,850 m range site is located at the village of Nyabugando, Kyobwe sub-parish and Kayonza sub-county of Bushenyi District. The village is located in the Kabale foothills. The soil is a black, sandy loam with good drainage properties.

The 1,860-2,110 m range site is located at 20 km on the Kabale-Katuna road to the south of Kabale town at Nyakarindi village. The surveyed farms are located in the Kabale-Katuna swamp. The mean altitude of the swamp is 1,900 m. The black alluvial soils are poorly drained and are wet the year round even though continuous cultivation is the norm.

The 2,120-2,370 m range site is located in Mwendo village to the West of Kabale on hills flanking Lake Bunyonyi. The brown, sandy loam soils are well drained but are believed to be exhausted and heavily leached of many nutrients.

Both Nyakarindi and Mwendo villages are high rainfall areas, whereas Nyabugando is generally dry. Both Mwendo and Nyabugando villages grow beans primarily during the short rains of September and October.

Data taken on farmers' bean fields at the following plant growth stages include:

1. At seedling emergence
   a. Bean plant stand per 4 x 4 m, repeated three times.
2. At three to six weeks after seedling emergence.
   a. Plant stand per plot.
   b. Plant height in cm for mean of 5 plants.
   c. Plant canopy width in cm for mean of 5 plants.
   d. Number of dead plants and causes of death.
   e. Number of beanfly larvae and puparia.
   f. Incidence of other pests.
3. At eight to nine weeks after seedling emergence.
   a. Number of beanfly larvae and puparia.
   b. Incidence of other insect pests.
   c. Number of pods bored per plant for 10 plants.
   d. Incidence of diseases.
4. At harvest.
   a. Plant stand per unit area.
   b. Number of pods bored per plant for 10 plants.
   c. Weight of bean seed for ten plants.

Results

Farmer management practices

In all survey study areas, climatic variability was minimal except that temperatures decreased for increases in altitude. It was not possible to obtain actual records of the climatic factors in each of the three altitude ranges.

Management practices engaged in by farmers varied with regard to bean cultivar and farming system. Most farmers planted bean mixtures, resulting in different plant growth habits and attendant yield levels. There was also variability in farming systems. At the 1,860-2,110 m range sites bean cultivation was continuous from the previous season while at the other altitude ranges sites the seasons were completely closed. The intensity of intercropping varied during the season, even within the same locality. Farmers intercropped beans with Irish potatoes (*Solanum* spp.), maize, field peas, sorghum, and bananas. Weed control methods also varied. Bean diseases were most common in the 2,120-2,370 m range site while podborers were mostly recorded in the 1,600-1,850 m range site. Fertilizers and pesticides were rarely used.

Beanfly infestation

An analysis of variance was carried out for beanfly infestation across the three altitude ranges and for the two sampling dates. In all cases there was higher beanfly infestation at the 1,860-2,110 m range than at the other two ranges. Notably, this was the area with continuous bean cultivation. An important characteristic of the area is that the soil is continuously moist. The nutrient rich and moist soil may contribute to the incidence of beanfly.

Speciation

The distribution of the two species *O. phaseoli* (brown) and *O. spencerella* (black) are shown in Figures 1 and 2. Both species were infesting the crop six weeks after emergency at all altitudes, although *O. spencerella* was found in higher densities than *O. phaseoli*. However, at 9WAE the *O. spencerella* populations at the 1,860-2,110 m range increased tenfold, but remained roughly in similar proportions at both the 1,600-1,850 m and 2,120-2,370 m ranges; The population of *O. phaseoli* did not change significantly at 9WAE.

Duncan's Multiple Range Test was carried out on the beanfly population means (brown and black pupae) at both sampling dates and for the three altitude ranges. The results indicate that there was significantly ($p < 0.05$) more beanfly at the 1,860-2,110 m range than the remaining two ranges. The dominant species was *O. spencerella*. At Nyakalindi (1,900 m), the root mealy bug is a commonly found pest.

Future Research Proposals

1. Increasing the number of altitude ranges studied to include sites lower than 1,600 m. This is not possible in the Kabale District because altitudes range above 1,600 m. Alternative, lower altitude sites will have to be selected elsewhere.

2. Crop loss assessment studies: The large variability in farmer practices makes beanfly crop loss assessment difficult. It may be necessary to undertake preliminary crop loss assessment work at research stations in order to reduce the level of variability.

3. Increasing sampling dates: From the completed survey it was not possible to know when beanfly infestation commenced. To determine the timing of beanfly incidence it will be necessary to increase both the earliness and the frequency of sampling dates.

4. Biological factors influencing beanfly populations: There was considerable variation found in beanfly populations on the farms studied. Apart from abiotic factors, which are not selective, there may be selective biotic factors selecting one species against the other. Additional research will be required to determine the impact that biological factors have on beanfly species and population.

5. Farmer Management: As noted above, there was large variability in intercropping practices, weed control, plant densities, and bean cultivars sown. To reduce this unmanageable variability it may be necessary to standardize cultivars, inputs, and practices used.

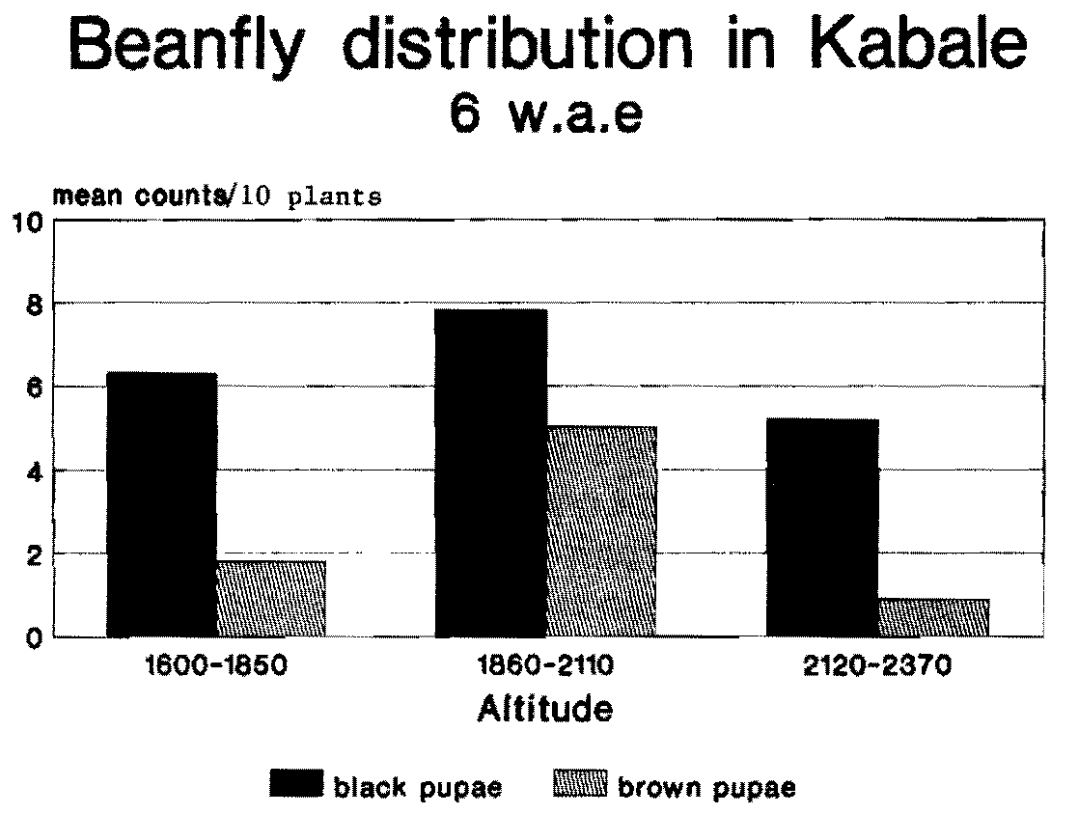
References

Allen, D.J., and B.J. Smithson (1986). Proceedings of the Beanfly Workshop, November 16-20, 1986, Arusha, Tanzania. Pan African Workshop Series No. 1, CIAT, Cali, Colombia.

Greathead, D.J. (1969). A Study of Beanfly (*Diptera agromyzidae*) Affecting *Phaseolus Vulgaris* and Their Natural Enemies with a Description of a New Species *Melanagromyza*. Hend. Bull. Ent. Res., 59:541-561.

Oree, A., and G.J. Hallman (1984). Agromyzid Stem Flies Attacking *Phaseolus vulgaris* L. Beans. Unpublished bibliography. CIAT, Cali, Colombia, p. 47.

Handa, S.K., A.K. Dikshit, M.D. Awasthi, and N.S. Bhattacharjee (1977). Residues of Phorate, Disulfoton, and Carbofuran in Soybean Crop. *Indian J. Entomol.* 39:354-56.



Beanfly distribution in Kabale
6 w.a.e
mean counts/10 plants
10
8
6
4
2
0
1600-1850
1860-2110
2120-2370
Altitude
black pupae
brown pupae

Figure 1

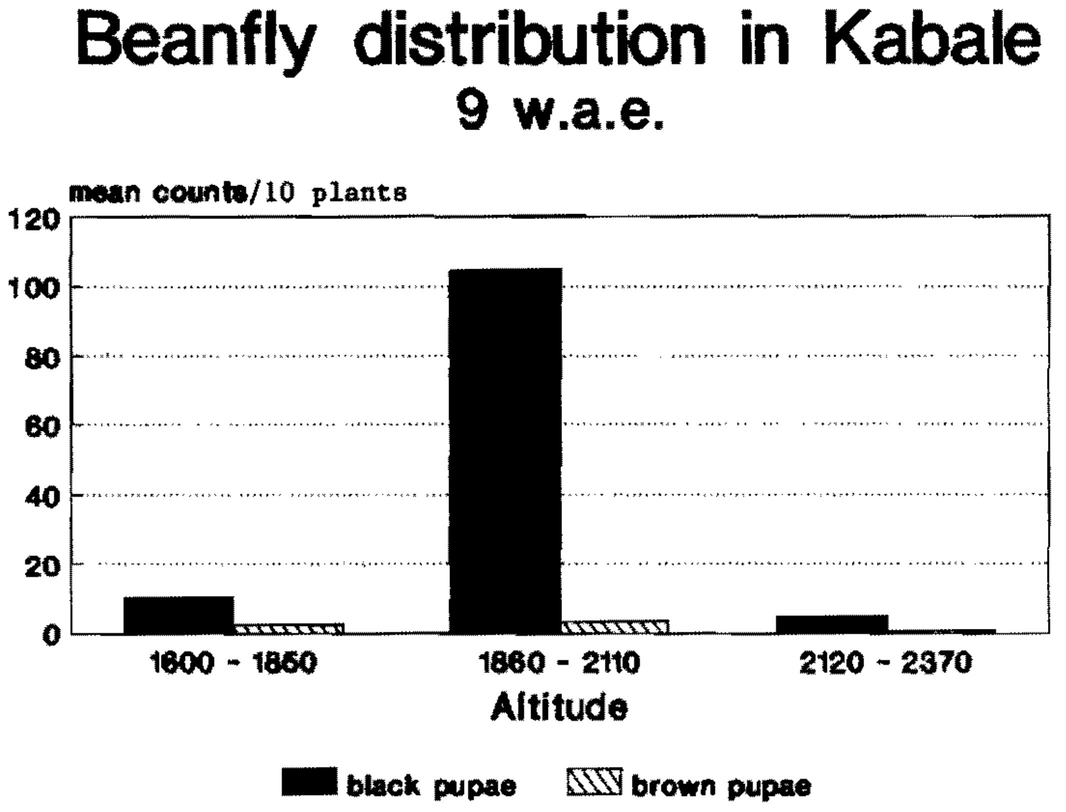

Beanfly distribution in Kabale
9 w.a.e.
mean counts/10 plants
120
100
80
60
40
20
0
1600 - 1850
1860 - 2110
2120 - 2370
Altitude
black pupae
brown pupae

Figure 2

40989

CURRENT RESEARCH ON BRUCHIDS IN UGANDA

by

M.N. Silim
Entomologist, Kawanda Research Station

Abstract: *Zabrotes subfasciatus and Acanthoscelides obtectus are widely distributed in Uganda. A. obtectus is the predominant species in the cooler zones, while Z. subfasciatus is predominant in warmer areas. The former species is more common in grain warehouses while the latter is more common in on-farm storage. Examining the four bean lines EMP 175, K 20, White Haricot, and RAZ 2 in storage trials, it was found that RAZ 2 was resistant to Zabrotes. The remaining lines were susceptible. RAZ 2 contains arcelin, a seed protein, which confers resistance to Zabrotes. Results on farmers' perceptions, practices, and control of bruchids remains to be studied. Research on the efficiency of solar heat disinfestation of bruchids has been initiated.*

Introduction

Research on bruchid problems in Uganda was undertaken in four parts. The four studies undertaken to date are:

1. Storage trial for the *Zabrotes* resistant bean line RAZ 2.

2. Bean storage survey to determine the distribution patterns of *Zabrotes subfasciatus* and *Acanthoscelides obtectus*.

3. Surveys on farmers' perceptions, practices, and control of bruchids.

4. Research on solar heat treatment to control bruchids.

The first two studies have been completed and results are now available. The third study has been completed, but the results have yet to be analyzed. Study number 4 is underway. The completed studies are briefly reported upon below.

Storage Trial on the *Zabrotes* Resistant Bean Line RAZ 2

Arcelin, a major seed protein discovered in wild beans (*Phaseolus vulgaris*) in central Mexico, has antibiosis effects on the bean bruchid *Z. zubfasciatus*. Transfer of purified arcelin to artificial seeds has been shown to result in high levels of insect resistance (Osborn, *et al*). To date, these highly successful trials on arcelin have been confined to the South American strain of *Zabrotes*.

Research on arcelin in Uganda was undertaken on *Zabrotes* strains that were collected from commercial stores of beans in Kampala. These strains were bred at Kawanda Research Station. The tests were conducted under simulated storage conditions. The performance of the *Zabrotes* resistant bean line RAZ 2 from CIAT was compared with the susceptible recurrent line EMP 175 and the locally grown cultivars K 20 and White Haricot.

Beans were stored in tightly woven cotton bags (20 x 43 cm) and kept at ambient environmental conditions. Five replicates of two kilogram of seed each were used in a complete randomized block design. Four sexed pairs of newly emerged *Zabrote* insects were introduced into each replication. The control was one replication with no *Zabrote* insect infestation.

Four months after the introduction of the *Zabrote* insects, the bags were opened for inspection. The contents were sieved and the insects, both those alive and dead, were counted and the percent grain damage and weight loss were determined.

All grain and live insects were then returned to their respective bags. The contents of the bags will be reexamined in 8 months time.

The results of the experiment are as follows: Four months after infestation, high levels of *Zabrote* insects were found in bags containing the lines EMP 175, K 20, and white haricot. For the RAZ 2 variety, the only *Zabrote* insects found were the initial ones placed into the bags at the start of the experiment. These insects were dead when the bags were opened. The damage and weigh loss were significant for the three lines EMP 175, K20 and white haricot. No damage was observed on the RAZ 2 line.

Before the end of the eight month time period a reinspection of the bags revealed that the *Zabrote* insect population was high in bags with the three lines EMP 175, K20 and white haricot. In some cases, the grain had been completely destroyed. No new emergence of *Zabrote* insects were noted in the RAZ 2 line. The experiment was therefore discontinued.

High levels of antibiosis, which is resistant to the Ugandan strain of *Zabrotes*, was detected in the RAZ 2 bean cultivar. The cultivars EMP 175, K20 and White Haricot were found to be susceptible to *Zabrotes*.

Research at Cento Internacional de Agricultura Tropical headquarters in Colombia is concentrating on producing resistant bean lines that are resistant to *Zabrotes* and that will be acceptable to bean producers and consumers in Uganda.

Distribution Pattern of Bean Bruchids

A knowledge of the occurrence and distribution patterns of each of the bruchid species is essential in research on bean storage problems. The bruchid problem was studied by surveying both on-farm and grain warehouse storage facilities. Grain samples were taken from both types of storage facilities to analyze for the presence of bruchid species.

The districts studied were Kapchorwa, Kabale, Nebbi, and Mbale in the high altitude zone, Masindi, Masaka, Hoima, Bundibugyo, Mukono, and Mpigi in the tall grassland zone, and Luwero, Tororo-Palisa, Lira-Apac, and Arua in the short grassland zone. Both species of bruchids were found in all zones. The species *Z. subfasciatus* was more common in urban bean storage warehouses, while *A. obtectus* was more common in farmers' storage containers.

Climatic factors appear to affect the occurrence and pattern of distribution of both bruchid species. *Z. subfasciatus* was more common in the high altitude zone, while the other species was predominant in the short and tall grassland zones. *A. obtectus* appears to have been introduced into the country much earlier than *Z. subfasciatus*.

Farmers' Perceptions, Practices, and Control of Bruchids

A survey was conducted to determine farmers' perceptions, practices, control methods for bean storage pests. The damage levels were also assessed. Farmers were selected from representative areas of the four agro-ecological zones of Uganda. The farmers were selected using a multi-stage, stratified random sampling method. Bean grain samples were collected for analyses on grain damage and weight loss.

A total of 120 farmers were surveyed in nine representative districts of the 4 agro-ecological zones. Districts in the high altitude zone were Kabale, Nebbi, Kapchorwa, and Mbale. The northern and eastern zones included the districts of Lira, Apac, and Tororo, southern and western zones included Mukono district, and the district of Luwero comprised the pastoral dry to semi-arid range land zone.

The survey has been successfully completed, but the data have yet to be analyzed.

Solar Heat Treatment of Bruchids

Among the practices commonly associated with bruchid control by farmers is solar heat treatment method. The efficiency of this method has, however, yet to be assessed in Uganda.

The solar heat study was designed for three phases. Phase one is to determine bruchid mortality at different temperature levels and different exposure time lengths. Phase two examines different solar treatment methods. The third phase will involve farmer participation. Both bruchid species with be used in the solar heat treatment study.

The first and second phases of the study will involve artificial infestation while third phase will be natural infestation. In the first and second phases, mortality at all bruchid development stages will be investigated through a two stage infestation at different times.

Temperature levels to be investigated in phase one will be 35°, 40°, 45°, 50°, 55°, and 60° centigrade. Exposure times studied will be 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5 and 6 hours, respectively. There will be four replication for each treatment and a control.

Variable parameters to be investigated will be adult mortality, adult emergence, and percentage damaged seeds. Cooking time of cultivars will also be investigated.

Future Work Plans

Future work plans include:

1. Continuation of breeding for resistance in local cultivars against *Z. subfasciatus* and assessment of their consumer acceptability.

2. Initiate *A. obtectus* resistance research by screening for in-field resistance on bean pod infestations. This in-field work will be undertaken because infestations of *A. obtectus* begins primarily in the field through pod penetrations.

3. Initiate biological studies on both species with special emphasis on field studies. Carry out ecological investigations under field conditions on *A. obtectus*.

References

Osborn T.C., C. A. Danny, S.S. Sun, C. Cardon C, and F. A. Bliss (1988). *Science*, Vol. 240:207-210.

40990

WEED SCIENCE RESEARCH IN UGANDA

by

E. Kikoba
Weed scientist, National Bean Research Programme
Kawanda Research Station

Abstract: *Strategies adopted by weed researchers centers on two aspects; cultural methods and chemical use. Cultural methods are intended to reduce weed competition through multiple and intercropping and high plant populations while herbicides reduce weed competition through the direct elimination of weeds. Weed control practices that use a combination of both methods may prove to be the most efficient in the control of annual and perennial weeds in Uganda.*

Introduction

The purpose of this paper is to provide readers with a general outline of the research that has been conducted on the control of weeds in crop production in Uganda and make suggestions for further research in this area.

Current bean research programme priorities in weed management are conditioned by weed problems associated with prevailing crop production situations. Long term weed control should involve a management strategy that will integrate two or more weed control measures in order to reduce weed competition. These weed control measures must be low input cost and not labour intensive in order to make them economically attractive to farmers.

Because of the need to preserve light textured soils from erosion due to intense rainfall and associated frequent weeding, weed management through conservation tillage is receiving additional attention.

More emphasis is being put on cultural practices that tend to influence the dynamics of weed populations in a given cropping system. Research carried out by Koch and others has shown that weed species are adoptable to specific environmental conditions and that weed flora will respond to changes in the type of cropping systems employed (Koch *et al.*).

Current Research

An exploratory survey was carried out by the author in 1989 on the effects of bean based cropping systems on weed composition and populations (Kikoba). The survey confirmed the existence of a link between the dynamics of weed populations and the nature of the cropping systems.

As a result of these findings, a preliminary experiment was initiated in the second season of 1990 on crop combinations involving beans, maize, and soybeans and the same crops in pure stands. Various crop planting densities were explored. The results of this experiment are now being assessed.

This research effort is intended to be an on-going experiment whereby crop densities and intercropping combinations are varied to conform to actual production situations in the major agro-ecological zones in the country. The purpose of the research is to ascertain the extent of natural weed suppression that can be achieved by the various intercropping treatments.

Shetty and Rao reported that inter-sowing of cowpea and mungbean into a sorghum or pea crop minimized weed growth after only one hand weeding (FAO). The weed suppression due to the smother effect of intercropping was equivalent to that obtained from two hand weedings. In contrast to chemical and physical means of weed control, the biological factors that promote intercrop dominance over weeds in intercrop systems are complex and have not been adequately studied.

The underlying strategy of utilizing a multiple or intercropping approach against weeds is to capture soil nutrients and moisture by a crop that would otherwise be captured by weeds. In essence, the intercropped crop is substituted for the weed(s). The two or more crops which are intercropped together would capture a greater share of available resources than would be the case in a monoculture situation with high weed competition. In addition, the intercropped crops often have structural characteristics that allow them to occupy different niches both above and below the ground (Francis).

In the chemical control of weeds, the threat posed by perennial weeds such as Couch Grass (*Digitaria abyssinica*) and Nutsedge (*Cyperus spp.*) is substantial because most herbicides are specific to broad leafed weeds and annual grasses. The perennial weeds noted above are more difficult to control with either a pre- or post-emergence herbicide. The broad spectrum herbicide Glyphosate (Roundup) is currently uneconomic for most resource poor farmers.

Research on herbicides has shown that no single contact or pre-emergence chemical can continuously be applied without evoking a vigorous upsurge of the more dreaded perennial weeds. If a broad spectrum translocated herbicide is applied over even short periods of time, the emergence of perennial weeds is enhanced. Farmers should be forewarned of this problem if a continued use of herbicides is practiced.

Because herbicides can be more effective when used in combinations, additional research is required to identify the economically optimal combinations and application levels. Both pre- and post-emergence herbicides may be required in the development of these optimal combinations.

Screening trials with five pre-emergence herbicides on pure stand beans and a bean-maize intercrop were conducted in 1990. The results indicate that even when herbicides effectively controlled the weed problem, the hand hoe weeded treatments tended to give consistently higher yield. As expected, these results imply that the use of the herbicides does not lead to an increase in crop yield per se. However, considering that one of the main reasons for having a wider spacing of crops is to ensure ease of hand hoe weeding, a herbicide application may effectively contribute to yield increases only if used as part of an integrated package that also involves higher seeding rates.

Where labour costs are exceptionally high (e.g., in the control of couchgrass), the use of herbicides is intended to reduce production costs and therefore increase net profits. Further herbicide screening trials are needed to investigate higher seeding rates as well as the economics of herbicide treatments.

References

W. Koch *et al*. (1986). Food and Agriculture Organization. Plant Protection Bulletin No. 3, Vol. 34.

Francis, C.A. (1986). *Multiple Cropping Systems*, Macmillan Publishing Co., New York, NY.

Kikoba, E. (1989). National Bean Programme Annual Report 1989.

40991

BEAN AGRONOMY AND ON-FARM RESEARCH IN UGANDA: A REVIEW AND FUTURE RESEARCH NEEDS

by

Charles S. Wortmann and J. Kisakye
Agronomist, Centro Internacional de Agricultura Tropical
and Agronomist, Uganda National Bean Research Programme

Abstract: *Results of agronomic research are reviewed and suggestions for further research are given. Research is needed to derive methods that will enable farmers to integrate climbing beans into their current crop production systems. The wide gap between genetic yield potential and actual results on farmers' fields suggest the need for research on the physiology of bean yields. Computerized simulation and expert system models appropriate for research on beans need to be identified, validated, and improved. The involvement of farmers in research planning and criteria for selecting farmers for different research situation needs, farmer information elicitation methods, farmer identification of research problems and solutions, and farmer evaluation of alternative technologies needs more research emphases.*

Introduction

Bean yields on both research station and farm trials in Uganda are often below the inherent genetic potential of cultivars used. Technology exists to relieve most production constraints encountered by farmers, but the application of this technology is often not economically or socially feasible. The challenge in research is to develop alternative technologies to eliminate these constraints that are both economically viable and acceptable to farmers. The long-term maintenance of soil productivity in low input systems also presents a challenge to researchers.

The purpose of this paper is to provide background information on agronomic research that may be of use in bean research planning. Past and current agronomic research findings in Uganda are reviewed and future research needs are suggested.

Land Preparation

Farmers, extensionists and researchers appear to be in agreement that good seed bed preparation is important for optimal bean growth, especially to minimize the need for subsequent weed control measures. There is little published research information on the topic for either Uganda or east Africa.

Results of research on minimum and zero tillage are inconclusive in sub-Saharan Africa. Beans are, however, successfully produced under minimum and zero tillage systems in the Central Province of Kenya, suggesting that these practices may be economically feasible. These practices should be investigated to determine their feasibility in other areas, including Uganda.

Planting

In monoculture, the recommended spacing for Uganda is one bean plant at 30 cm x 30 cm (11.1 plants per m^2), or 1 plant at 60 x 10 cm (16.6 plants per m^2) (Anonymous). The first recommendation is obsolete and needs to be revised. Research by Mukasa (1965) and Leakey indicate that the marginal product of seed is positive up to 30 plants per m^2, but that 18-20 plants per m^2 may be the most profitable level. This is supported by the results of recent work at Kawanda and it agrees, in general, with farmers' practice in central Uganda. Higher plant densities do, however, occur in the Kabale District of Uganda and in parts of Rwanda (>30 plants per m^2). In parts of Ethiopia, farmers plant at even higher densities (>50 plants per m^2), presumably for weed suppression purposes. Recommendations in Kenya and Tanzania are for 20 plants per m^2, but for Ethiopia higher densities are recommended.

Mukasa (1965) and Leakey varied plant density, but held row spacing constant at 61 cm. Recommendations in neighboring countries call for a closer row spacing (45-50 cm). Results of recent work at Kawanda show a linear increase in yield as row spacing is decreased from 60 to 45 to 30 cm. For mechanized bean production, an alternative may be to alternate spacings of 30 and 60 cm to allow tractor wheels to pass in the 60 cm space.

In intercropping, optimal plant densities and planting patterns are difficult to determine for two reasons: 1) The relative competitiveness of the associated crops varies by environmental conditions, suggesting the optimal proportion of each species varies over both time and space and 2) farmers' objectives often vary due to variation in the economics of production and marketing of the associated crops and result in variation in relative crop preferences over both time and space.

In the maize-bean intercropping system in Uganda, bean plant densities are often at monoculture levels, while maize plant densities are at 30 to 50 percent of the optimum. In parts of Kenya where farmers are reluctant to sacrifice maize production for additional bean production, maize densities are near monoculture levels, but bean stands remain low. Willey and Osiru and Osiru and Willey found that intercropping beans with sorghum or maize requires a higher total population than under monoculture. Further, they found that the proportion that each crop makes up of the total can be varied. These findings are in general agreement with farmers' practices in Uganda.

When intercropping bananas and beans, farmers often have a full stand of bananas, while bean densities are normally 50 to 60 percent of monoculture densities. Optimal bean density in the banana-bean system is probably above 15 plants per m^2 (Wortmann and Sengooba). When intercropping sweet potatoes and beans in Uganda, farmers give preference to sweet potatoes, while beans are sown at a low density. The plant density of the cassava-bean intercropping system in Uganda is variable, depending upon the relative importance of the two crops.

Farmers are capable in adjusting plant populations to fit their particular situation. No further bean plant population research is needed at this time.

Weed Control

Mukasa (1970) recommended that the bean seedbed should be well prepared and weeding should be kept to a minimum to avoid damage to shoots and roots. This is in line with farmers' practice where a single timely weeding is the norm. In selected cases, the weeding is followed by a hand pulling of taller weeds.

In southwest Uganda, farmers indicate that they sow both beans and sorghum at high plant densities for the purpose of suppressing weed growth. Weed growth is a function of the cropping system practiced. Relatively few weeds are normally found in the banana-bean system, whereas an intermediate number are found in the maize-bean system and the most are usually found in the bean monoculture system (Wortmann and Sengooba).

Current research is finding substantial differences between bean cultivars regarding their ability to suppress weeds; with leafy, high yielding Type II's giving the best weed suppression control. Herbicides are useful in weed control, but their use may now be uneconomical given their impact on yield and current relative input and output prices.

At Kawanda, application of pre-emergence herbicides reduce labor requirements, but a hand weeding is still needed to prevent the spread of couch grass. Fallowing cultivated land is an important practice for the control of some perennial weeds such as couch grass. Declining prices of suitable herbicides may result in an improved feasibility of chemical control of such weeds.

A possible research topic on weed control in beans is:

1. The economics of perennial weed control in high value bean production systems with the herbicide glyphosate.

Climbing Bean Management

Climbing beans are an important traditional crop in the Kisoro area, but are not of importance in other parts of Uganda. The potential for their adoption elsewhere, especially in the highlands, is high due to their greater productivity on fertile soils. Recent efforts to introduce climbing beans to farmers in Kabale and to involve farmers in variety evaluation and production system development have shown promising results. The availability of suitable staking material remains a major production constraint in the promotion of climbing beans.

The intercropping of climbing beans with maize, which affords a suitable support structure for climbing beans, has been found to be a productive system in central Uganda (Wortmann and Ugen-Adrogu) However, farmers have expressed reservations about the system due to difficulties in the harvesting of beans.

Several topics need the attention of agronomists and socio-economists with regard to climbing bean production.

1. Stake support for climbing beans.

   a. The production and use of Pennisetum and bamboo for stakes.
   b. Agro-forestry for stake production.
   c. Relay cropping of beans with maize.
   d. Intercropping of beans and maize in areas where maize is an important crop.

2. Soil fertility and plant nutrition.

   a. Agro-forestry.
   b. Efficient use of farmyard manure.
   c. Use of rock phosphate and chemical fertilizers.
   d. Sustainability of production.

Research on High Yield Potential

Research on high yield potential has a role to play in gaining a better understanding of factors affecting yield and resource utilization. For example, the role of the harvest (crop) index and the nitrogen harvest index on bean yields and how these can be manipulated to achieve a higher yield are not fully understood. There is a further need for collaboration in research by agronomists and breeders with physiologists in this important area.

Use of Simulation Models

Agricultural production systems are complex and optimal management levels require the successful integration of information on many factors. Beans in Uganda are grown in a number of production systems in many different environments. Experiments to examine all important factors and their interactions that affect productivity and sustainability in these different systems and environments would require a significant amount of resources.

Simulation models are now available to integrate many sources of information and to interpolate and extend research finding over a wide range of environmental conditions. Cole *et al.*) reviewed the progress on simulation models in the United States that are used in predicting short- and long-term effects of environmental and cultural practices on productivity and soil characteristics. The BeanGro (Hoogenboom *et al.*) and other crop growth simulation models are being improved for further research.

Future research needs on simulation models include:

1. The identification and validation of appropriate models.

2. Collaboration with model developers to improve their use under Uganda conditions.

3. Model use to pre-screen technologies and extend results.

On-Farm and Farmer Participatory Research

The application of on-farm and participatory research in bean research in Uganda was reviewed by Wortmann *et al.*). Involvement of farmers in research planning was found to be on the increase. Methodologies for diagnosis, experimentation, technology evaluation and transfer aspects of on-farm research have received much attention in many countries. However, methodologies designed for better involvement of farmers in research remain in the embryonic state.

Topics needing further attention to develop or fine-tune farmer participatory research methodologies are:

1. Farmer selection.

   a. When to use random and non-random selection of farmers.
   b. When to collaborate with the "best managers" or with the typical or representative farmers.
   c. Factors affecting the sex ratio of farmer samples.

2. Elicitation of information from farmers for identifying research topics, designing experimentation, and evaluating technologies.

   a. Systems of communication between farmers and researchers.
   b. Carefully selected versus typical farmers.
   c. Contact with individuals versus groups.
   d. Improvement of farmers' analytical skills.
   e. Sex roles and ratios.
   f. Increasing involvement of extensionists.

References

Anonymous (1985). Crop Production Handbook. Ministry of Agriculture and Forestry, Entebbe, Uganda.

Cole, C.V., J. Williams, M. Shaffer, and J. Hanson (1987). Nutrient and Organic Matter Dynamics as Components of Agricultural Production Systems Models. In *Soil Fertility and Organic Matter as Critical Components of Production Systems*, ed. J.J. Mortvedt, The Soil Science Society of America, Inc. pp. 147-166.

Hoogenboom, G., T.W. Jones, J.W. White, and K.J. Boote (1990). BEANGRO Version 1.0. A *Phaseolus* Computer Simulation Model. Annual Report of the Bean Improvement Cooperative, 33:39-40.

Leakey, C.L.A. (1972). The Effect of Plant Population and Fertility Level on Yield and Its Components in Two Determinate Cultivars of *Phaseolus vulgaris* L. *Journal of Agricultural Science*, Cambridge University, 79:250-267.

Mukasa, S.K. (1965). Bean Spacing Trials in Uganda. Contributed paper to 11th Meeting of the East African Specialist Committee for Agricultural Botany, Arusha, Tanzania (mimeo).

Mukasa, S.K. (1970). Beans--*Phaseolus vulgaris* L. In *Agriculture in Uganda*, ed. J.D. Jameson, Oxford University Press, Cambridge, U.K.

Osiru, D.S.O. and R.W. Willey (1972). Studies on Mixtures of Dwarf Sorghum and Beans (*Phaseolus vulgaris*) with Particular Reference to Plant Population. *Journal of Agriculture Science*, 79:531-540.

Willey, R.W. and D.S.O. Osiru (1972). Studies on Mixtures of Dwarf Maize and Beans (*Phaseolus vulgaris*) with Particular Reference to Plant Population. *Journal of Agriculture Science*, 79:517-529.

Wortmann, C.S., J. Kisakye, M.A. Ugen, and T. Sengooba, (1989). Farmers' Participation in Bean Research in Uganda. Paper presented at the National On-Farm Research Program Review/Orientation Workshop, Mukono, Uganda, November 12-17, 1989.

Wortmann, C.S., and T. Sengooba (1990). Investigations of Banana-Bean Intercropping in Uganda. Paper presented at the First Uganda National Scientific Conference, Kampala, Uganda, December 10-15, 1990.

Wortmann, C.S., and M. Ugen-Adrogu (1990). The Development of a Maize-Climbing Bean Intercropping System for Central Uganda. 1990 Annual Report, Uganda National Bean Programme, pp 5-10.

40992

SOIL FERTILITY AND BEAN NUTRITION IN UGANDA: A REVIEW AND FUTURE RESEARCH NEEDS

by

Victor A. Ochwoh and Charles S. Wortmann
Soil Science Department, Faculty of Agriculture, Makerere University and Centro Internacional de Agricultura Tropical, Uganda

Abstract: *Results of research on soil fertility management for bean production in Uganda are explored. The occurrence and severity of soil fertility problems as constraints to bean production are examined and additional research needs are suggested. Results of trials conducted on research station and farmers' fields show that soil nutrition problems are major constraints in bean production. Yield response to applied N and P frequently occur. Application of K and lime result in increased yield in selected sites, but response to applied micro-elements are rare. Crop production in Uganda is concentrated on the more productive soils. Much of the potentially arable land is not in cultivation because of low soil fertility problems. Other areas are extensively cultivated, but with frequent fallow periods. Soil fertility problems can be expected to increase as crop production encroaches into marginal areas.*

Introduction

The commonly held view that Uganda soils are fertile and that most crops can be successfully produced is misdirected and can be misleading. Over 70 percent of the arable land in the country consists mainly of ferralsols (oxisols) and acrisols (ultisols) (Chenery). These are highly weathered and leached soils which generally have low pH, P, bases and sometimes fix high proportions of P. In addition, they also have low soil organic matter and thus low N, especially under continuous cultivation. These two soil groups are estimated to make up 40-50 percent of the soils in the bean growing areas of Uganda.

Bean yields in Uganda are low in general and are far below the genetic potential of the genotypes sown. Most research in Uganda on soil fertility and bean nutrition was conducted from the mid 1940s and was reported upon in the 1960s and early 1970s. This research was confined largely to research stations and district farm institutes. It is clear from these reports that soil nutrient deficiency is an important factor affecting the production potential of beans.

Therefore to increase bean production there is urgent need to carry out research on alternatives methods to increase or maintain soil productivity in areas currently under bean production and in the more marginal areas by either amending the soils or the introduction of tolerant bean genotypes.

The purpose of this paper is to provide background information on soil fertility relative to bean plant nutrition for research planning purposes. Research on soil fertility and bean nutrition is reviewed and estimates of the relative importance of various constraints are made. Finally, additional research needs are suggested.

Soil Productivity

Soil productivity depends upon the availability and balance of water and soil nutrients. Most soils in Uganda are able to meet the demands of extensive farming systems, but when subjected to more intensive continuous cropping they fail to meet crop demands within a short period of time.

Research work at Namulonge showed that from the late 1940s, when land clearing was started, until the mid 1950s crop yields were satisfactory. However, during the following decade they dropped markedly. Although fertility was declining, field trials failed to show that fertilizers were effective in either raising or maintaining crop yields. By 1972, however, yields were significantly improved through a continued application of fertilizers.

Jones (1975) concluded that the consequent decline in yield served a useful research purpose. It emphasized the need for studies on soil productivity to encompass the whole farming system rather than restricting the research to an investigation of nutrient identification that limits the yield of individual crops.

Soil Fertility Research in Uganda

Prior to 1940 most work on soil fertility was aimed at improving crop management with a special emphasis on the development of appropriate rotations. After 1940 the need to raise the general level of productivity was accepted and the use of inorganic fertilizers on an experimental basis was introduced. This resulted in a number of experiments in Serere, Namulonge, Kawanda, and the associated upcountry stations (Manning and Griffith; Le Mare; Mills; Jameson and Kerkham; Stephens; and Foster (1970, 1972, 1979, and 1980)).

Conclusions drawn from these experiments were that for the area of the Fertile Crescent Zone no consistent increase in arable crop yield could be expected from the application of fertilizers, except from N applied to cereal crops in unusually wet seasons and from fertilizers applied to old arable land. Despite these conclusions, the general yield levels of all crops were low in relation to the potential yield. It was then accepted that the only certain means of maintaining fertility was to rest the land in some form of long-term vegetation or to use animal manure (Foster, 1969; Stephens, 1967; Jones, 1968).

Given these results, Le Mare initiated a research program on the rhythm of fertility that occurs within a 3:3 rotation. The quantity of nutrients involved in the cycle provided a basis for formulating a mixture of fertilizer for supplying five major nutrients. When tested over a period of six seasons, the yield of maize, beans, and cotton consistently increased (Table 1). Thus the inorganic fertilizers tested in the 1950s gave inconsistent results, but when used in the late 1960s they consistently increased yields of the same crops.

Bean Responses to Soil Amendments

Bean response to applied fertilizers in Africa was reviewed by Wortmann and Zake. Selected pertinent points emphasized in that review should be noted here. Organic manures have been more successful than any combination of inorganic fertilizers in increasing bean yields on Uganda soils (Stephens 1969); Jameson and Kerkham). Response of beans to fertilizers and other soil amendments have been observed, but are less than that for some other crops. The response for beans has also been less consistent. Farmers have noted this result and are more likely to fertilize other crops rather than beans.

Beans are often grown in rotation with other crops or in intercropped systems. Organic and inorganic fertilizers are often applied to benefit grain crops, which preceed beans in rotation, or to benefit banana, coffee, or maize when intercropped with beans. Little information is available on fertilization of these crop associations for Uganda soils.

A greater response to fertilizers can be expected when management levels are high (Foster, 1979). Wortmann and Zake's review concluded that deficiencies of N, P, and K frequently constrain bean yields in Uganda. Liming was found to be important in selected cases (Stephens (1969); Foster (1970, 1972, 1979, 1980). Stephens reviewed work done in Uganda and other African countries between 1924 and 1934 and concluded that green manures failed to maintain soil fertility. Fallowing with elephant grass was, however, effective in restoring productivity.

Results of recent diagnostic on-farm trials conducted in the Luwero, Mpigi, Rakai, and Kabale Districts showed that beans responded to low levels of applied N and P in all districts except of Mpigi (Ugen-Adrogu and Wortmann).

The average yield increase across all the on-farm trials was 62 percent. In nutritional screening trials conducted to identify the most limiting nutrients, both N and P were found to be important in Mpigi District while N was found to be especially important in Luwero District. In this set of on-farm trials, no response to applied fertilizers was observed in fields near Kachwekano in the Kabale District.

The Relative Importance of Different Soils Constraints

Bean production data for the periods 1963-1964 and 1976-1988 show that the area under beans, bean production, and bean yield have remained relatively constant. The area under production ranged from 300,000 to 350,000 hectares with average yields in the range of 500 to 700 kg. Total production ranged from 230,000 to 260,000 tons. The consistency in these figures could be a result of bean production being confined within soil groups which are basically fertile. These include:

1. The deep, red or brown, loam or clay loam, pediment soils occurring in the "fertile crescent" zone which is located in a 40-50 km wide belt around Lake Victoria from Jinja to Rakai, a rectangular block of land about 500 km wide extending north-east from Kabarole into north Mubende, and smaller areas of land lying between Hoima and Masindi.

2. The Nakabango soil series formed from basic amphibolite rocks extending from Mabira to Kakira with small patches in the Tororo District, around Sunga in Hoima District, and in the north-west corners of Nebbi and Arua Districts.

3. Soils formed on volcanic ash on the lower slopes of Mt. Elgon, Kadam, Moroto and Iriri, on the triangle south of Lake George and north of Lake Edward, around and south of Kabarole, and around Kisoro in the south-west of Kabale District.

4. The deep sedimentary soils occurring around Bundibugyo, in the neighborhood of Lira and around Dokolo in Lira District, Panyimuri in Nebbi District, and Laropi in Moyo districts.

5. The hydromorphic soils along river valleys.

Within these fertile soil groups there are pockets or patches of infertility called "Lunyu" in the Luganda language. The causes and characteristics of "Lunyu" have not been adequately researched.

The general distribution of the bean growing area coincides with the distribution of fertile land (Figure 1).

Using available secondary sources of soil information and soil maps the hectares of beans produced in the major soil type areas was estimated. The estimates and some general characteristics of the soil groups are shown in Table 2. Phosphate deficiency was estimated to be a major constraint on 40, 80, 53, and 22 percent of the bean producing areas in eastern, central, western, and northern Uganda, respectively. Low base availability was estimated to be a problem on 40, 80, 40, and 20 percent of the bean producing areas in eastern, central, western, and northern Uganda, respectively.

Aluminum toxicity was estimated to be a problem on 12-38, 0, 14, and 0 percent of the soils of eastern, central, . western, and northern Uganda, respectively. Using organic carbon as an indicator of N availability, 41, 20, 0, and 29 percent of land in eastern, central, western, and northern Uganda, respectively, have low N as a major constraint.

Because farmers will use the more productive soils in the heterogenous soil groups, the above estimates may exaggerate actual soil nutrition problems. These estimates, however, are based on soil information that is now 30 to 40 years old. Current soil nutrient levels are probably lower.

The major soil groups found south of latitude 2° north that are now unsuited or marginal for bean production, but which have suitable climatic conditions, are shown in Table 3. Low P availability stands out as the most serious constraint in most cases. The soil bases, especially K, are frequently found to be low. In some soils Al toxicity may also be a problem. Sandy textured soils with low fertility and low water holding capacity have low levels of productivity. However, these soils generally have an adequate depth. In central and western Uganda, Mn toxicity could be a serious problem, although it is not indicated as such here.

Research Needs

Further research is needed on the following topics:

1. Diagnosis to better define the problems, their causes, and the extent of their distribution.

    a. Computerized handling of results of soil chemical analyses to increase their utility.
    b. Determination of the relationships of soil physical and chemical characteristics to productivity.
    c. Determination of the occurrence, character, and management of some problem soils.
    d. Improvement of foliar tissue analysis as a diagnostic tool.
    e. Use of nutritional screening trials.

2. Chemical fertilizer use in the high value production systems of coffee-beans, banana-beans, and climbing beans.

   a. Input-output studies for responses and efficiencies of use.
   b. Production sustainability studies.

3. Evaluation of agro-minerals in high value production systems.

   a. Rock phosphate from Tororo (research underway).
   b. Lime.

4. Organic manures.

   a. Limited, cautious work on high potential green manures crops.
   b. Cover crops.
   c. Agro-forestry (research underway).
   d. Use of organic matter or ash harvested from swamps as mulch or amendments.
   e. Alternative crop residue management practices for improved soil, nutrient, and water management.
   f. Synchrony of nutrient release from decomposing organic matter and nutrient demand by crops to minimize losses.

5. Nutrient fluxes and losses in important production systems.

   a. Quantification of important fluxes in nutrient cycles.
   b. Use and improvement of simulation models.

6. Soil and water conservation.

   a. Understanding farmers' knowledge and perceptions.
   b. Investigating alternative management practices in collaboration with farmers.

7. N-fixation.

8. Genetic improvement for adaptation to nutritional disorders.

Figure 1: Soils with Productivity Greater than Moderate

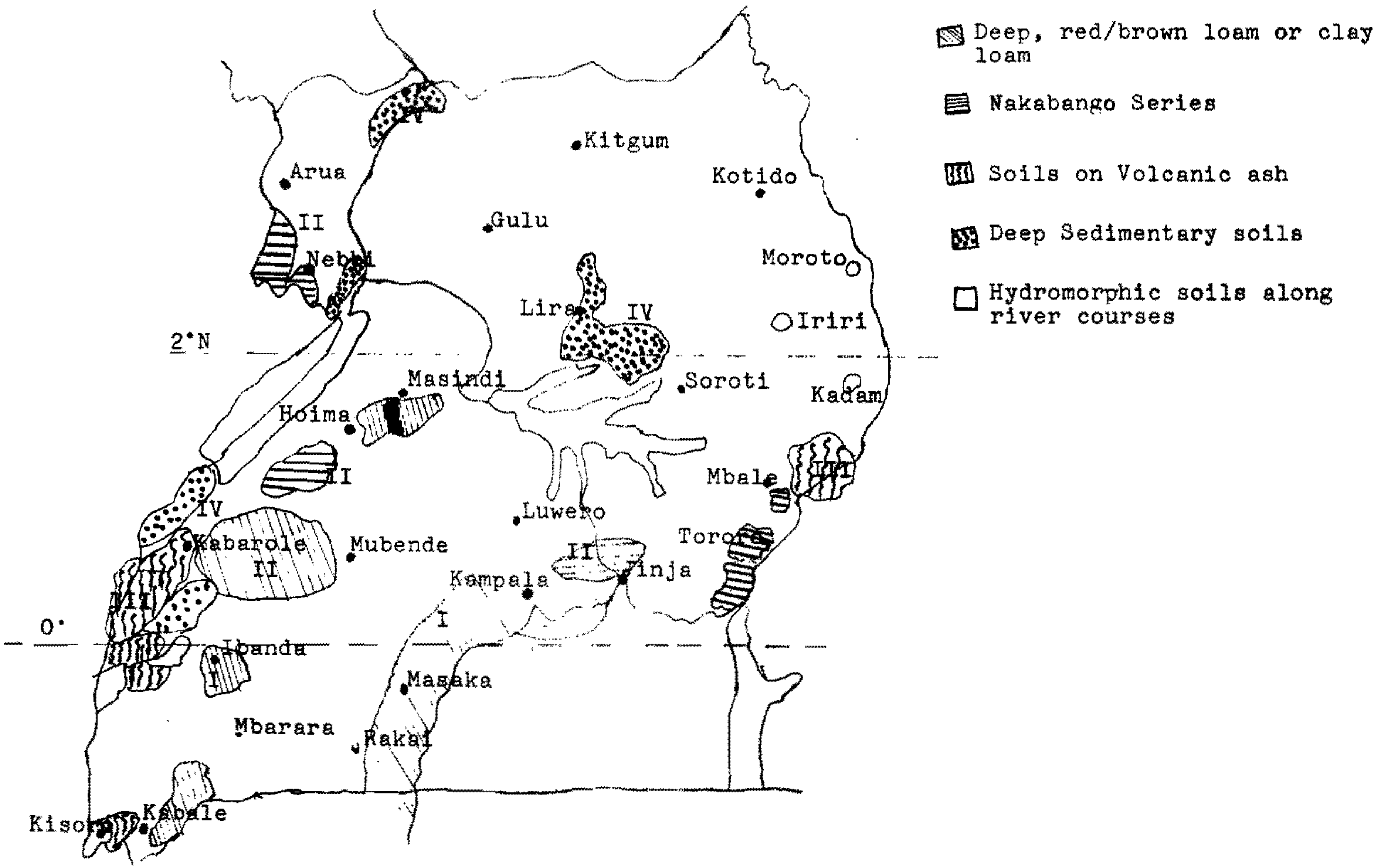


Table 1. Estimates of Soil Nutrient Contents at Namulonge Research Station in Uganda[a]

Item	Soil nutrients N	P	S	K	Ca	Mg
Quantities[b]						
0-30 cm	3,800	1,580	580	880	5,420	1,540
30-90 cm	4,200	2,850	800	900	4,040	1,710
Total	8,000	4,430	1,380	1,780	9,460	3,250
Crop requirements						
Arable crop[c]	150	30	20	150	30	15
Grass[d]	200	30	25	200	70	50
Fertilizer mixture						
Composition(%)	8.2	3.5	5.0	10.0	12.5	-
Nutrient (kg) in 752 kg mixture	62.0	26.0	37.6	75.2	94.0	-

[a] Source: Jones, E. (1975).
[b] The quantities of major nutrients (kg/ha) in the 0-30 cm and 30-90 cm depths of soil compared with the requirements of arable and grass crops and the fertilizer mixture.
[c] Based on the average requirements of good maize and cotton crops.
[d] Requirements of grass for a six-month period.

Table 2. Major Bean Producing Soil Groups in Uganda, Estimated Hectarage by Group and some Generalized Characteristics of the Soils.

Location Group	Hectare	Texture	P	pH	Base	%OC	Productivity
Eastern							
Nakabango	15,000	lc[a]	a[b]	m[c]	a[d]	a[e]	h[f]
Sipi	15,000	cl	a	ma	a	-	h
Bugusege	5,000	c-cl	a	m	a	a	m-h
Siroko	5,000	c	a	n	a	a	m-h
Buruli	10,000	sl-l	l	m-l	l	l	m-l
Buyanga	7,500	cl	-	-	-	-	m
Bubulu	7,500	l-cl	l	m-l	l-k	l	m
Bubutu	7,500	csl	l	m	l	l	m
Bukedea	10,000	cl	l	l	l	m	m
Amuria	5,000	sl	a	m	a	l	l
Usuku	5,000	s-sl	a	m-l	a	l	l
Central							
Buganda	16,000	cl-c	l	m	l	a	m
Mirimbi	4,000	sl	a	m	m	m	m
Western							
Mbarara	7,500	l	l	m	a	a	m-l
Bufumbira	5,500	l	l	m	a	a	m-h
Sabino	2,500	l	l	l	l	a	m
Kabale	7,500	cl	a	m	a	a	m-h
Koki	2,500	si-cl	-	-	-	-	l-m
Buruli	25,000	l	l	m	l	a	m-l
Mulemba	20,000	s-sl	a	l	a	-	l-m
Bukora	7,500	l	l	l	a	a	l
Kifu	7,500	-	-	-	-	-	-
Saka	5,500	l-sl	a	m	a	a	h-m
Kiamara	3,000	cl	m	m	a	a	m-h
Fort Portal	4,000	l-cl	a	m	a	a	h-m
Northern							
Yumbe	5,000	sl	-	m	a	a	m-l
Pagor	15,000	cl	a	m	a	a	l-m
Buruli	7,000	cl-l	l	m	l	l	m-l
Metu	5,000	sl	a	m	a	l	l
Arua	5,000	sl	a	m	a	m-l	h-l

[a] The letters c, l, and s indicate clay, loan and sand, respectively.
[b] The letters a, l, and m indicated adequate, low, and medium soil P.
[c] The letters m, l, and n indicate medium, low and neutral soil pH where low <=5.3, medium 5.3-6.5.
[d] The letters a, l, and m indicate adequate, low, and medium soil base where low P < 10 ppm.
[e] The letters a, l, and m indicate adequate, low, and medium percent soil organic content where low OC < 1 percent.
[f] The letters l, m, and h indicate low, medium, and high soil productivity.

Table 3. Some Major Soil Groups in Uganda on which Expansion of Bean Production is Likely to Occur and Their Possible Limitations

Location Soil group	Texture	% Organic content	pH	% Base saturate	Other
Buganda					
Mawogola catena	g-l[a]	1-1.5	l[b]	30-60	low P & bases
Lukaya series	l	1.5-2	m-l	30-40	low P & bases
Buruli	l	0.5-1	l	30-40	low P, C, bases
Buruli	l-s	0.5-1	l	40-50	-
Mubende	g-l	1.5-2	l	25-30	-
Buwekula catena	g-l/cl	-	-	-	-
Western					
Buruli catena	l	1-3	m-l	55-60	low P & bases
Buwekula catena	g-l/cl	1-2	vl	50-50	v low bases & P
Mawogola	g-l	2	m-l	50-60	low P & bases
Kazo series	si-l	-	-	-	-
Anaka complex	-	-	-	-	-
Kiamara[c]	c-l	2	l	60-70	low K, P
Eastern					
Kabira catena	s-l	<2	m	60-80	low P
Bukedea	l	<1.3	l	30-40	low P & bases
Buruli	s-l	<1	m	40-90	low P & K
Amuria	l	1	m	50-70	low P & K
Mazimasa	s	<1	n	high	low P, n, mg

[a] The letters g, s, si, l, and c indicate gravel, sand, silt, loam, and clay soil textures, respectively.
[b] The letters l, m, and n indicate low, medium, and neutral soil pH where low <=5.3 and medium is 5.3 to 6.5.
[c] The Kiamara soil series is heterogeneous and contains fertile soils.

References

Chenery, E.M. (1960). An Introduction to the Soils of Uganda Protectorate. Memoirs of the Research Division, Series I, Soils No. 1, Entebbe, Department of Agriculture.

Foster, H.L. (1969). The Dominating Influence of Soil Organic Matter and Soil Reaction on the Fertility of Ferrallitic Soils. In Uganda Proceedings of the East Africa 11th Special Committee on Soil Fertility, Arusha, Tanzania.

Foster, H.L. (1970). Liming Continuously Cultivated Soils in Uganda. *East Africa Forestry Journal* 36:58-69.

Foster, H.L. (1972). The Identification of Potentially Potassium Deficient Soils in Uganda. *East Africa Forestry Journal*, 38:224-233.

Foster, H.L. (1979). Yield Responses to Lime and Potassium Fertilizer in Different Cropping Years in Uganda. *Experimental Agriculture*, 13:193-201.

Foster, H.L. 1980. The Influence of Soil Fertility on Crop Performance in Uganda - II. Groundnuts. *Tropical Agriculture* Agricultural (Trinidad), 57:29-42.

Jameson, J.D., and R.K. Kerkham (1960. The Maintenance of Soil Fertility in Uganda. I. Soil fertility experiment at Serere. *Emp. Journal of Exp. Agriculture*, 28:179-192.

Jones, E. (1968). Nutrient Cycle and Soil Fertility in Red Ferrallitic Soils. Progress Reports from Experiment Stations: Uganda, 1966-67. Cotton Research Corporation, London, England, p. 41.

Jones, E. (1975). Soil Productivity. In Arnold, M.H. (Ed.) *The Namulonge Experience*. Le Mare, P.H. (1963). Progress Reports from Experiment Stations: Uganda, 1961-62. The Emp. Cotton Growers Corporation, London, p. 23.

Mills, W.R. (1954). A Review of Recent Trials with Fertilizers in Uganda. 2nd Inter-African Soils Conference Document 89, Section III B.C., pp. 1133-42.

Manning, A.P., and G. Griffith (1949). Fertilizer Studies on Uganda Soils. *East African Agriculture Journal*, 15:87-97.

Stephens, D. (1967). Effects of Grass Fallow Treatments in Restoring Fertility of Buganda Clay Loam in South Uganda. *Journal of Agriculture Science*, Cambridge University, England, 68:391-403.

Stephens, D. (1969). The Effects of Fertilizers, Manure, and Trace Elements in Continuous Cropping Rotations in Southern and Western Uganda. *East Africa Agriculture Journal*, 34: 401-417.

Ugen-Adrogu, M., and C.S. Wortmann (1989). Results of Plus - One Exploratory Trials for Bean Yield Loss Assessment. Annual Report, Uganda National Bean Programme, 1988, pp. 35-38.

Wortmann, C.S., and J.Y.K. Zake (1988). Review of Bean Responses to Applied Fertilizers. In proceedings of a Workshop on Soil Fertility Research for Bean Cropping Systems in Africa. ed., Wortmann, C.S., Centro Internacional de Agricultura Tropical African Workshop Series, No.3.

40993

A REPORT ON THE SOCIO-ECONOMICS OF BEAN PRODUCTION AND MARKETING IN UGANDA: INFORMATION FOR RESEARCH PLANNING

by

W. Grisley and D. Mwesigwa
Economist and Technical Assistant for CIAT Bean Program in Africa, Kawanda Research Station

Abstract: *Socio-economic research on bean production in Uganda is reviewed. Uganda was the third largest bean producer in Africa in the late 1980s with production at 272,000 tons. Beans were increasingly competitive with maize and all pulses, but were decreasingly competitive with cassava, sweet potatoes, and bananas. The most popular cultivars are Kanyebwa, Nambale, Mutike, and Ebyeru. The market for both fresh and dry beans is competitive and efficient. Grain size and color are not important characteristics in explaining consumers' preferences for beans. The lack of a seed industry will be a major constraint in getting seed of newly released cultivars to farmers.*

Introduction

The purpose of this paper is to review and summarize available information relative to the socio-economics of bean production and marketing in Uganda. The objective of the paper is to provide information for the Uganda Bean Program to use in setting research priorities. As such, only information that is highly relevant to the research planning process will be reported. Space limitations preclude a more extensive reporting. In addition, important areas in which little or no information exits, but which would be useful in the research planning process, will be identified.

Bean Production

Uganda was the third largest producer of beans in sub-Saharan Africa during the 1986-88 period with 272,000 tons being produced from 368,620 ha (Grisley, 1990a). Only Kenya with nearly 400,000 tons and Burundi with 300,000 tons were larger producers. Uganda's production during this period accounted for approximately 15 percent of all beans produced in sub-Saharan Africa, excluding supplies from Cameroon and S. Africa. Per capita supply averaged 17.3 kg compared to 7.6 kg for sub-Saharan Africa as a whole. Average yield in Uganda was 741 kg per ha, 11 percent greater than the sub-Saharan Africa wide average yield of 669 kilogram.

Over the 1970-89 period bean production in the aggregate grew at an annual rate of 1.6 percent, or 4,036 tons. This growth was achieved primarily through an increase in productivity as no significant growth in area expansion was found. Using upwardly adjusted yields in 1989 and 1990 and an exponential relationship in estimation, the Ministry of Agriculture (MOA) estimated a growth rate of production of 2.5 percent over the 1970-90 period with most of the growth resulting from an increase in productivity of 2.1 percent per year. To realize this growth rate the MOA estimated average yield to be 1 ton per ha in 1989 and 1990.

During the 1980-89 period Grisley (1990a) estimated that production growth was flat. The MOA estimated production growth to be 8.3 percent during the 1980-1990 period, with growth in area expansion at 5.2 percent while the remainder was due to growth in productivity.

Growth in bean production during the 1980s was a positive contributor to the Uganda agricultural sector, which overall had a negative growth of -0.5 percent over the period 1980-87 (World Bank). However, Growth in bean production lagged behind the population growth rate of 3.1 percent when using Grisley's figures, but greater than population growth when using MOA estimates.

Beans are produced in all 34 districts in the country. The districts of Bugisu, Busoga, Masaka, Kigezi, and Lango accounted for more than one-half of production by the late 1980s according to MOA estimates. Except for Busoga, growth in production in these districts were negative over the period 1970-80. Decrease in area was the most important reason for the decline in production. During the 1980s, however, production growth was positive, ranging from a low of 7.4 percent in Busoga to a high of 18.7 percent in Masaka. Again, this growth was largely due to growth in area expansion.

Competitive Position of Beans in Production

Beans are produced in a variety of circumstances from pure stand to intercropping with maize, bananas, or other crops. In production, the competitive position of beans was analyzed relative to that of maize, sweet potato, cassava, all pulses, and bananas over the period 1961-64 to 1984-86 using ratio analysis (Grisley, 1989). Beans were found to be increasingly competitive relative to maize and all pulses in production. That is, in the aggregate, bean production was increasing (or not decreasing) at a faster rate than both maize and all pulses. Beans were increasingly competitive in both area planted and yield relative to maize and area planted relative to all pulses.

Beans were decreasingly competitive relative to sweet potato, cassava, and bananas. To a large extent, this was due to faster growth in area expansion of these crops. Beans were also decreasingly competitive in production with a combined category of beef and veal.

The competitive position of beans relative to that of other crops is a function of the production technology used and relative output prices. From the results of Grisley's (1989) study it can not be determined why beans were increasingly competitive for some crops and decreasingly competitive for others. However, an overriding factor was almost certainly relative changes in output prices. Output prices were probably moving in favor of beans relative to that of maize and all pulses and against beans relative to sweet potatoes, cassava, bananas, and beef and veal. However, beans may, in the future, realize a favorable relationship in output prices when compared to sweet potatoes, cassava, and bananas if the overall economy improves.

Producer Preferences for Cultivars

Farmers select among bean cultivars to produce using a complex set of production, consumption, and marketing criteria. Using data supplied by district agricultural officers, Grisley and Sengooba investigated for bean cultivars commonly planted. Data were received on 264 cultivars in 29 districts. About 40 cultivars were named in more than one district. The most common cultivars were Kanyebwa, Mutike, Nambale, and Ebyeru. In terms of grain size, 37 percent were large seeded, while 28 and 35 percent were medium and small seeded. Sixty-four percent were found to be bush types while 21 percent were semi-climbers. Many of the semi-climbers are, however, expected to be trailing types and not true semi-climbers.

By color category, the most common colors were white (51 cultivars), red (50), brown (48), black (25), and purple/maroon (22). The intended use of the grain was home consumption 22 percent, marketing 4 percent, and both home and marketing 72 percent.

Forty cultivars were listed in the top 5 cultivars in the 19 district reporting data. Both Nambale (K20) and Kanyebwa were in the top 5 in 68 percent of the districts. They were also the most frequent cultivars listed in the first and second rank positions. Other cultivars frequently in the top 5 where Mutike-large (37 percent), White (26 percent), and Kayinja (16 percent).

The most common colors in the top 5 rank were brown, white, red molted and red in that order. By size of grain, the top 5 were rated large 45 percent of the time and medium and small 29 and 26 percent of the time. By plant structure type, 73 percent of the top 5 cultivars were bush, followed by semi-climbers at 19 percent and climbers at 8 percent. Semi-climbers only occupied the first rank in 3 of the 19 districts. Sixty-nine percent of the top 5 cultivars were used for both home consumption and marketing.

The Market for Beans

Beans are marketed at the farm, wholesale, and retail levels in a highly competitive environment. The large number of participants at each marketing level insures the competitive nature of the market. At the wholesale level, the major buyers are merchants, cooperatives, and the government produce marketing board. From the wholesale level, grain is usually treated with chemical additives and then moved to urban centers.

Most bean grain goes into retail markets, but increasing quantities are being targeted for the export market. In 1989, over 20,000 tons of beans were exported (MOA). Even larger quantities are believed to be exported to Kenya and Rwanda through informal channels. Barter trade has been used by government, while private sector traders normally engage in cash payment transactions. The export market is expected to improve as the private sector gains experience in processing, transporting, and financing large stocks of grain.

There is limited information on the number of farmers that normally sell on the open market and the quantities sold. A recent survey of 50 farmers in 4 districts showed that 39 percent of the farmers sold beans with average sales of 335 kg (Kisakye). The median volume of sales was 250 kg.

Over the period 1970-89 the growth rate of producer bean prices in real terms has decreased by -3.3 percent annually (MOA). At the rural wholesale level, growth in prices was 0.1 percent and at the retail level prices rose by an annual average of 0.2 percent. Growth in the farmgate-to-retail price spread was 3.5 percent annually, which is about equal to the rate of decrease in the farmgate price. The widening of the farmgate-to-retail price spread in most likely due to increasing transportation costs.

Differences in prices paid for both fresh and dry beans was investigated in 12 major markets in 1990 (Grisley and Mwesigwa). For fresh beans, prices in markets distance to Kampala were lower than Kampala market prices by an average of Ush 39 to 97 per 500cc tin. These results were expected because Kampala is a deficit fresh bean area and the transport costs and associated spoilage risks are high when moving fresh beans from outlying districts.

However, for dry beans, no significant difference in retail prices were found. Because there is little spoilage risks during transportation, bean storage costs are low and traders have found it profitable to store and move dry beans from lower to higher priced areas. Traders have evidently arbitraged across market locations such that further movement of beans is unprofitable. Thus the market for dry beans is believed to be efficient.

Consumer Preferences for Bean Grain Characteristics

Two important issues relating to consumer preferences of beans are whether they are consumed in the freshly hulled or dry state and the color and size characteristics of the grain. Kisakye found that 98 percent of farmers harvested beans in the fresh state. Forty-seven percent of the farmers harvested less than 25 percent of their beans in the fresh state, while 38 percent harvested 25 to 50 percent of their beans in the fresh state. These results indicated that farmers, as consumers, have strong preferences for beans in the fresh state.

Grisley and Mwesigwa found that significant quantities of beans were sold in the fresh state. While not determined, the percentage was estimated in the 30-50 percent range. Fresh beans commanded a revenue advantage of 210 percent over the equivalent number of dry beans. If some of this revenue is passed back to farmers through market forces, then fresh beans are probably more profitable than dry beans.

Size of grain was not found to be an important factor in explaining prices paid for either fresh or dry beans. In contradiction to conventional wisdom, beans with larger grain size was not bringing significantly different prices than smaller sized grain, holding constant other factors that influence market prices.

Of the 11 color grain categories studied, only the color pink and mixture of colors were significant in explaining prices paid for fresh beans, while only the color yellow was significant for dry beans. In general, these results imply that consumers do not place strong preferences on grain color. Notably, beans red or reddish in color were not commanding a premium price. The general result is that consumers probably place greater preference on taste and that grain size and color are not good proxies for taste.

Bean Seed

The bean seed issue in Uganda can be separated into that of seed for currently produced cultivars and landraces and newly released cultivars (Grisley, 1990b). Farmers access to seed of acceptable quality for cultivars and landraces currently in use is not believed to be a problem because supplies are retained from season to season, or if lost through extraordinary circumstances, purchased on local markets. However, for newly released cultivars there is no institutional mechanism to get the seed into the production system.

Under present circumstances, neither the Uganda Seed Unit nor the German sponsored grain legume seed project are producing bean seed and have no plans for large scale seed production in the near future. In addition, there are no private sector firms that produce seed commercially. There are thus no organizations in a position to produce and distribute seed of newly released bean cultivars.

If the seed of newly released cultivars is to be produced and distributed, the bean research program may have to take a leading role. However, involvement of the bean research program in the production and distribution of even small quantities of seed will require additional funding.

Additional Research in Socio-Economics

Additional research in socio-economics that will be of use by the bean program in the research planning process are in the areas of yield loss due to diseases and pests and technology adoption and diffusion. Most bean cultivars are suspectable to a variety of diseases and insect pests. Many researchers believe that some of these diseases and insects cause economic losses to farmers. In addition, the insect bruchids is believed to be responsible for significant losses while beans are in storage. While casual observation tends to support these views for selected diseases and pests, few studies have been undertake that have used reliable research methodologies on a large scale. Additional work needs to be done in this area so that research priorities can be set.

More research information is needed in the area of technology adoption and diffusion. While technology is being developed, farmer assessment of the technology is needed. The testing of technology by farmers is essential and after release monitoring of adoption and diffusion will be necessary. Information gleamed from farmers both before and after technology is released is important in the dynamics of a research program.

References

Grisley, B. (1989). The Geographical and Competitive Position of Beans in SADCC and Eastern Africa. Paper presented at First SADCC Regional Bean Research Workshop, Mbabane, Swaziland.

Grisley, B. (1990a). Overview of Bean Production in Sub-Saharan Africa. Unpublished paper, Kawanda Research Station, Uganda.

Grisley, B. (1990b). Seed for Bean Production in Sub-Saharan Africa: issues, Problems, and Possible Solutions. Paper presented at East Africa Workshop on Beans, Nairobi, Kenya.

Grisley, B., and D. Mwesigwa (1990), The Retail Market for Fresh and Dry Beans in Uganda: An Investigation of Cultivars and Prices and Implications for Breeders. Unpublished manuscript, Kawanda Research Station, Uganda.

Grisley, B., and T. Sengooba (1991). Common Bean Cultivars Sown by Farmers in Uganda; A Survey of District Agricultural Officers. Unpublished manuscript, Kawanda Research Station, Uganda.

Kisakye, J. (1990). Follow-up survey of farmers participating in OFR bean variety trials. Unanalyzed survey data, Kawanda Research Station, Uganda.

Ministry of Agriculture. Selected tables from unidentified manuscript. Planning Division, Entebbe, Uganda

SESSION III. Bean Production Problems, Their Causes and Importance by Agro-Ecological Zone

The purpose of this session is to identify significant problems in bean production by agro-ecological zone. The agro-ecological zones identified are the short grassland, tall grassland, and highland zones. Workshop participants were divided into three working groups to discuss bean production by zone.

Both biotic and abiotic problems were considered in each agro-ecological zone. For each problem identified, the source of the available evidence and any additional evidence needed to further clarify the problem were identified.

The findings are reported in Tables 1, 2, and 3 for the short grassland, tall grassland, and highland zones, respectively.

The bean production problems identified were ranked by order of importance with regard to their severity in reducing bean production. The variables considered by agro-ecological zone were:

1. The percent of fields affected.

2. The percent of seasons in which the problem occurs.

3. The estimated damage level.

Information on these variables are shown in Tables 4, 5, and 6 for the short grassland, tall grassland, and highland zones, respectively.

Table 1. Bean Production Problems and Evidence of the Problems in the Short Grassland Zone

Problem	Evidence available	Additional evidence needed
Cultivar:		
Low yield potential	OFR[b]	adequate
Diseases:[a]		
CBB	survey data	adequate
Rust	survey data	adequate
ALS	survey data	adequate
BCMV	survey data	adequate
Anthracnose	survey data	adequate
FLS	observations	surveys
Insects and pests:		
Aphids	observations	surveys
Beanfly	observations	surveys
Thrips	observations	surveys
Flower beetle	observations	surveys
Bruchids	survey data	adequate
Nematodes	hints	surveys
Weeds:		
Digitaria	observations	surveys
Cyperus	observations	surveys
Soil nutrition problems:		
Low nitrogen	OFR and OSR[b]	adequate
Low phosphate	OFR and OSR	adequate
Low potash	OFR and OSR	adequate
Low bases	-	-
High aluminum	-	experiments
Other:		
Water stress	observations	-
Land short	observations	surveys
Low prices	secondary data	adequate
Labor short	farmer observation	surveys
Shading	observations	experiments

[a] Abbreviations are used for common bean diseases.
[b] OFR and OSR are on-farm and on-station research, respectively.

Table 2. Bean Production Problems and the Evidence of the Problems of the Tall Grassland Zone[a]

Problem	Evidence available	Additional evidence needed
Cultivar:		
Low yield potential	farmers' obs. and OFR	adequate
Insects and pests:		
Aphids	farmers' obs. and OFR	yield loss assessment
Beanfly	field obs. and OFR	adequate
Bruchids	farmers' obs. and OFR	adequate
Leaf beetle	field observation	adequate
Thrips	farmer and field obs.	yield loss assessment
Helioths	field observation	adequate
Pod bores	field observation	yield loss assessment
Nematodes	field observation	yield loss assessment
Weeds:		
Digitaria	field obs. and OFR	econ. loss assessment
Oxalis	field obs. and OFR	econ. loss assessment
Cyperus	field obs. and OFR	econ. loss assessment
Soil nutrition problems:		
Low P	obs. surveys, OFR	more detailed surveys
Low K	obs. surveys, OFR	more detailed surveys
Low N	obs. surveys, OFR	more detailed surveys
Mn toxicity	obs. and surveys	extent of distribution
Al toxicity	field observation	loss & distribution
Diseases:		
Anthracnose	field observation	yield loss and extent of dist. and freq.
CBB	field obs. and OFR	yield loss and survival in soil
BCMV	field obs. and OFR	yield loss, host range, & strain.
ALS	farmers' obs. and OFR	yield loss assessment
Rust	farmers' obs. and OFR	loss & distribution
FLS	observations	yield loss assessment
Other:		
Water stress	field observation	analyses rainfall data
Shading	field obs. & exper.	extent of distribution

[a] See footnote a in Table 1.
[b] OFR is on-farm research.

Table 3. Bean Production Problems and Evidence of the Problems in the Highland Zone[a]

Problem	Evidence available	Additional evidence needed
Cultivar:		
Low yield potential	observations and OFR	adequate
Diseases:		
Halo blight	observation & surveys	yield loss estimate
Ascochyta	observation & surveys	yield loss estimate
Anthracnose	observation & surveys	yield loss estimate
BCMV	observation & surveys	yield loss estimate
FLS	observations	yield loss estimate
ALS	observation & surveys	yield loss estimate
CBB	observation & surveys	yield loss estimate
Insects and pests:		
Aphids	observation & surveys	yield loss estimate
Beanfly	observation & surveys	yield loss estimate
Beetles	observation & surveys	yield loss estimate
Bruchids	observation & surveys	yield loss estimate
Thrips	observation & surveys	yield loss estimate
Moles	observations	field surveys
Rats	observations	yield loss estimate
Weeds:		
Digitaria	observations	yield loss estimate
Oxalis	observations	yield loss estimate
Soil nutrition problems:		
Low N	obs., analyses, OFR	-
Low P	obs., analyses, OFR	-
Low K/Ca	obs., analyses, OFR	-
Al toxicity	obs., analyses, OFR	-
Mn toxicity	obs., analyses, OFR	-

[a] See footnote a in Table 1.

Table 4. Bean Production Problems in the Short Grasslands: Their Importance and Rank

Problem	% fields[a]	% seasons[b]	Damage[c] level	Importance[d]	Rank
Cultivar:					
Low yield potential	100	100	8	0.8	1
Disease:[e]					
CBB	80	100	7	0.56	2
Rust	50	30	2	0.03	18
ALS	80	100	3	0.24	7
BCMV	60	50	6	0.18	9
FLS	40	60	1	0.024	19
Insects and pests:					
Aphids	60	50	5	0.15	12
Beanfly	70	50	5	0.18	9
Thrips	40	60	2	0.05	17
Bruchids	80	100	2	0.12	3
Flower beetle	60	100	2	0.12	16
Weeds:					
Digitaria	60	100	4	0.24	7
Cyperus	70	100	2	0.14	14
Soil nutrition problems:					
Low nitrogen	60	100	8	0.48	3
Low phosphate	70	100	6	0.42	5
Low potash	70	100	4	0.28	6
High aluminum	40	100	2	0.14	14
Low bases	70	100	3	0.12	16
Other:					
Water stress	50	50	3	0.17	11
Shading	50	100	3	0.15	12

[a] Estimated percent of fields in the country that has the problem.
[b] Estimated percent of seasons in which the problem occurs.
[c] Scale of 1 to 9 with 9 the highest damage level. For the low yield problem the damage level is the estimated due to the lack of higher yielding varieties and not to the actual presence of a problem.
[d] Estimated importance of the problem calculated from the first three columns.
[e] Abbreviations are used for common bean diseases.

Table 5. Bean Production Problems in the Tall Grassland: Their Importance and Rank[a]

Problem	% fields	% seasons	Damage level	Importance	Rank
Cultivar:					
Low yield potential	100	-	6	6	1
Diseases:					
CBB	60	-	3	1.8	4
ALS	70	-	2	1.4	6
BCMV	20	-	2	0.4	11
Rust	70	-	1	0.7	9
FLS	50	-	1	0.5	11
Anthracnose	10	-	1	0.1	15
Insect and pests:					
Aphids	20	-	1	0.2	16
Beanfly	?	-	1	1.0	8
Bruchids	100	-	1	0.3	15
Leaf beetles	5	-	1	0.05	16
Thrips	60	-	2	1.2	7
Pod bores	60	-	1	0.6	10
Nematodes	40	-	1	0.04	17
Weeds:					
Digitaria	80	-	2	1.6	5
Oxalis	40	-	1	0.4	12
Cyperus	30	-	1	0.04	17
Soil nutrition problems:					
Low nitrogen	50	-	5	2.5	2
Low phosphate	50	-	5	2.5	2
Low potash	15	-	1	0.15	17
High aluminum	5	-	3	0.15	17
High magnesium	20	-	5	1.0	7
Low bases	20	-	2	0.4	12
Other:					
Water stress	20	-	2	0.4	12
Shading	5	-	2	0.4	19

[a] See footnotes in Table 4.

Table 6. Bean Production Problems of the Highlands: Their Importance and Rank[a]

Problem	% fields	% seasons	Damage level	Importance	Rank
Cultivar:					
Low yield potential	90	100	5	4.56	1
Diseases:					
Halo blight	80	50	5	2.00	5
Ascochyta	60	70	4	1.68	6
Anthracnose	100	100	3	3.00	2
FLS	50	30	2	1.20	11
BCMV	30	100	4	2.70	8
ALS	90	100	3	0.20	3
CBB	20	50	2	2.70	12
Insects and pests:					
Aphids	90	60	5	0.80	3
Beanfly	80	50	2	0.07	10
Beetles	5	30	0.5	0.38	18
Bruchids	75	30	2	1.5	7
Thrips	80	60	0.5	0.05	16
Moles	10	50	0.1	.003	14
Rats	10	30	0.1	0.1	17
Weeds:					
Digitaria	50	100	0.2	0.1	13
Oxalis	60	70	0.5	0.2	12
Other:					
Soil fertility	80	100	3	2.4	4
Water logging	10	30	1	0.03	15
Hail damage	1	5	0.01	.0006	19
Water stress	40	60	4	0.96	9

[a] See footnotes in Table 4.

SESSION IV. Identification of the Casues of Bean Production Problems

The purpose of Session IV is to identify the causes of bean production problems and analyze for interrelationships between problems and causes.

Participants broke into two working groups that considered separate categories of biotic production problems, while a third working group considered abiotic production problems. For each problem considered, the primary, secondary, and related causes are identified.

The summary results of the three working groups' findings are reported in Table 7.

Table 7. Bean Production Problems, and Their Causes

Problems Primary cause	Secondary cause	Related causes
Low soil phosphate:[a]		
No inorganic fert.	none available	-
Fixed with Al	weathering and low ph	-
Soil erosion	no soil conservation	small farm size
Nutrient export	continuous cropping	land shortage
Fixed with Fe	-	-
Crop competition	small farm size	-
High Mn	-	-
Low soil org. matter	burning of residues	farmers unaware
Low yield potential:		
Cultivars	poor adaptation to environment	
Breeding research	no input during 1976-85 period	
Genetic variation	little for abiotic and biotic problems	
Screening	no system to identify heavy yield lines	
Low water availability:		
Late planting	-	-
Poor rainfall distr.	deforestation	shortage of land
Intercropping	-	-
Soil erosion	no vegetative cover	labor shortage
Water holding cap.	low organic matter	crop residue removal
Potash deficiency:		
No K fert.	none available	-
Nutrient export	no mulching	-
K, Ca+Mg imbalance	-	-
Inherent low K	parent materials	-
No use inorg. fert.	high labor require	-
Soil erosion	steep slopes	no erosion barriers
little soil cover	poor management	-
Low availability of nitrogen:		
No use of N fert.	none available	-
Nutrient export	continuous cropping	shortage of land
Low B.N.F.	ineffective rhizobium	-
Volatilization	water logging	-
Soil erosion	low organic matter	removal crop residue
Leaching	late planting	-
Intercropping	-	-
Little use of inorganic manures	poor distribution	-

Table 7 continued

Primary cause	Secondary cause	Related cause
Manganese toxicity:		
Prolonged dry season	-	-
Reducing conditions for Mn^{+4} to Mn^{+2}	-	-
Root exudates by assoc. crops (banana/bean)		-
Susceptible cultivars	-	-
Volcanic and low ph	-	-
Mn from crush breccia	-	lateritic limestone
Anthracnose:		
Infected seed	farmers' seed	no certified seed
Susceptible cultivar	no resistance evaluation	
Chemical control	uneconomical	-
Cultural methods	limited land and labor	-
Angular leaf spot:		
Cultivars	no resistant lines	screening/breeding
Seed	farmers' seed	no certified seed
Chemical control	uneconomical	-
Cultural control	cultural methods limited	
Bean common mosaic virus:		
Cultivars	very suspectable	little research
Seed	Farmers' seed	no certified seed
Aphids	no effective control	little research
Cultural methods	poor farmer knowledge	little research
Ascochyta:		
Susceptible cultivars		
Seed	farmers' seed	no certified seed
chemical control	uneconomical	lack of chemicals
cultural methods	poor farmer knowledge	little research
Common bacterial blight:		
Cultivars	very suspectable	little research
Chemical control	expensive chemicals	little research
Infected seed	poor farmer knowledge	no certified seed
Infected soil/debris	poor farmer knowledge	little research

Table 7 continued

Primary cause	Secondary cause	Related cause
Halo blight:		
Cultivars	very suspectable	little research
Infected seed	farmers' seed	no certified seed
Cultural control	limited effectiveness	-
Chemical control	uneconomical	-
Root rots:		
Chemicals	uneconomical	no research
Cultivars	lack of resistance	little research
Cultural control	poor farmer knowledge	little research
Bruchids:		
Cultivars	susceptible	little research
Storage	poor hygiene	no chemicals
	no cultural control	little research
Infested seeds	poor farmer knowledge	little research
Beanfly:		
ChemicaL	uneconomical	lack of chemicals
Cultivars	lack of resistance	little research
Cultural methods	poor farmer knowledge	little research
Digitaria:		
Cultural control	mono/intercropping	shortage of land
No herbicide use	uneconomical	no research

[a] Abbreviations are used for chemical elements.

SESSION V. Identification and Evaluation of Possible Solutions to Bean Production Problems

The purpose of this Session is to identify and evaluate possible solutions to the bean production problems identified in Session IV.

Again, three working groups, two biotic and one abiotic, were organized to consider solutions. The criteria used in the evaluation of solutions were:

1. Estimated probability that the technology will function.

2. Estimated profitability of the technology if adopted by farmers.

3. Estimated compatibility of the technology with farmers' currently used methods of production.

4. Estimation of the technology's contribution to reducing farmers' risks in production.

5. Estimated need for institutional support from extension and the agricultural input supply sector.

6. Estimated ease in testing of the technology by both farmers and researchers.

These criteria were used in the determination of what further research action should be taken on each of the identified solutions.

The results of this Session are reported in Table 8.

able 8. Possible Solutions to Bean Production Problems: Performance Expectations

ossible olution	Tech. func.[a]	Level profit[b]	Compta- bility[c]	Risk[d]	Support[e] Ext.	input	Test ease[f] farm	res.	Final decision
ultivars:									
ow yield potential	l[g]	h[g]	h[g]	-[h]	y[i]	-[i]	l[g]	h[g]	breeding
itrogen deficiency:									
ariety	m	m	h	h	y	y	m	m	research
hizobia strain	m	m	l	h	y	y	l	m	research
limbing bean	h	-	m	m	y	y	h	h	research
aize/bean	h	-	m	m	y	y	m	m	verify
anana/bean	l	-	m	m	y	y	m	m	verify
omposting	m	m	h	h	y	-	m	h	OFT/econ.
reen manure	h	m	l	m	y	y	l	m	research
oil conserva.	m	l	h	m	y	-	l	m	OFT/econ.
gro-forest	h	m	m	m	y	-	l	l	OFT/OSR
utrient syn.	m	m	m	m	y	-	l	m	research
losses	m	m	m	m	y	-	-	l	research
hosphate deficiency:[j]									
norg. fert.	h	-	m	m	y	y	h	h	OFT/econ.
rg. fert.	m	m	m	m	y	-	m	h	OFT/econ.
ock P	-	-	m	-	y	y	m	h	research
ime	m	l	l	m	y	y	m	h	OFT/econ.
ow P tolerance	m	h	h	h	y	y	h	l	screening
anganese toxicity:[j]									
olerance	m	h	h	m	y	y	h	m	breeding
ime	m	l	l	m	y	y	m	h	OFT/econ.
a/P fert.	l	-	m	m	y	y	m	m	research
unyu soil	-	-	-	-	-	-	-	m	research
otash deficiency:[j]									
norg. fert.	h	m	m	m	y	y	m	h	OFT/econ.
rganic matter	m	l	m	m	y	-	m	m	OFT/econ.
shes	h	m	h	m	y	-	h	h	OFT/econ.
rban waste	m	m	m	m	y	-	h	h	research
arieties	m	m	h	m	y	y	h	h	breeding
oot rots:									
ultivars	h	m	h	h	y	-	h	m	research
oil fertility	m	l	h	m	y	y	m	h	research
ult. control	m	l	h	m	y	y	m	h	explore
hem. control	h	l	m	h	y	Y	l	h	no res.

Table 8 continued

Possible Solution	Tech. func.	Level profit	Compatibility	risk	Support ext.	Support input	Test ease farm	Test ease res.	Final decision
Halo blight:									
Cultivars	h	h	h	h	y	-	h	m	research
Clean seed	h	h	h	m	y	y	h	m	inst prob
Crop rotate	m	m	l	m	y	-	l	l	research
Debris control	m	m	m	m	y	-	m	h	explore
Weed control	m	m	h	m	y	-	m	h	research
Chem. control	l	l	l	l	y	-	l	m	no res.
Common bacterial blight:									
Cultivars	h	h	h	h	y	y	h	m	research
Clean seed	h	h	h	h	y	y	l	l	seed unit
Crop rotation	h	m	m	m	y	y	l	m	research
Remove debris	m	m	h	m	y	-	h	h	research
Host weeds	m	m	h	m	y	-	h	h	explore
Planting date	l	h	m	m	y	-	m	h	no res.
Bruchids Zabrotes:									
Resistance	m	h	h	-	y	-	h	l	breeding
Cultural	l	m	m	-	y	-	h	l	explore
chemical	m	m	l	-	n	-	m	m	identify
Biological	l	m	m	-	n	-	l	l	no res.
Bruchids Acanthoscelides:									
Resistance	l	h	h	-	y	-	h	l	breeding
Cultural	l	m	h	-	y	-	l	h	explore
Chemical	m	l	l	-	y	-	m	h	no res.
Ascochyta:									
Resistance	l	h	h	-	y	-	l	h	breeding
Clean seed	m	l	h	-	n	-	m	m	no res.
Cultural	m	l	h	-	n	-	l	l	research
Anthracnose:									
Resistance	h	h	h	-	y	-	h	l	breeding
Clean seed	l	l	h	-	y	-	m	m	no res.
Cultural	l	m	h	-	n	-	l	l	research
Seed dressing	l	l	m	-	n	-	m	m	extension
Angular leaf spot:									
Resistance	h	h	h	-	y	-	l	h	breeding
Chemical	m	l	l	-	n	-	l	l	no res.
Cultural	m	m	m	-	n	-	m	m	research
Bean common mosaic virus:									
Resistance	h	h	h	-	y	-	l	m	breeding
Cultural	l	l	m	-	n	-	m	m	research
Vector control	l	l	l	-	n	-	l	m	explore

Table 8 continued

Possible Solution	Tech. func.	Level profit	Compta-bility	risk	Support ext.	Support input	Test ease farm	Test ease res.	Final decision
Low water availability:									
Drought toler.	l	m	h	h	y	y	m	l	screening
Mulching	l	l	l	m	y	-	l	h	-
Intercropping	m	m	m	m	y	-	l	m	-
Organic matter	m	l	m	m	y	-	l	m	-
Water loss	-	-	-	-	-	-	-	-	Modelling
Digitaria:									
Crop rotation	m	h	m	m	y	-	m	h	explore
Seeding rate	l	m	m	l	y	y	m	l	no res.
Herbicides	h	l	h	h	y	y	l	h	explore
Intercrop	m	h	m	h	-	-	h	h	explore
IPM[k]	h	m	m	m	y	y	l	h	explore

Estimated probability that the technology will function.
Estimated profitability of the technology if adopted.
Estimated compatibility of the technology with the present production system.
Estimation of the technology's contribution to reducing risk in production.
Estimated institutional support needed from extension (Ext.) and the input sector (input).
Estimated testing ease of the technology on-farm and on the research station.
The letters l, m, and h indicate low, medium, and high, respectively.
A dash indicates that either no decision could be reached or there was no information available.
The letters y and n indicate yes and no.
Abbreviations are used for chemical elements.
Integrated pest management.

SESSION VI. Setting Research Priorities to Solve Bean Production Problems

The purpose of this Session is to rank the solutions to bean production problems that were identified in Session V.

Three working groups were used in this Session. The criteria considered in the determination of the rankings were:

1. The type of research output.

2. Its overall estimated impact on the bean production sector.

3. The estimated level of research funds required to attain the solution.

4. The estimated period of time needed to attain the solution.

5. Priority rank.

The results of this Session are reported in Table 9 for abiotic problems and Table 10 for biotic problems.

Other information summarized in this Session.

1. The top ten problems ranked by priority in Tables 9 and 10 are identified by the three agro-ecological zones in Table 11.

2. Participants estimates of the amount of funds and period of time required to attain all solutions that were priority ranked 1, 2, and 3 were considered separately. Participants estimates for each solution by rank and on average are shown in Table 12.

3. Estimated staffing requirements to solve each of the identified abiotic and biotic problems are shown in Tables 13 and 14.

4. The estimated researcher requirements for the top three priority ranked problems are shown in Table 15.

Table 9. Summary of Information Used in Prioritizing Solutions for Solving Abiotic Problems in Bean Production

Problem Solution	Research output	Research impact	Level funds	Time period	Priority rank
Nitrogen problems:					
Fert. maize/bean	level app.	2[a]	med	med	1[b]
Compost	technology	2	low	short	1
Soil conservation	technology	-	-	-	1
Nitrogen fixing	cultivar	1	low	long	2
Fert. climb bean	level app.	4	low	short	2
Fert. banana/bean	level app.	3	med	med	2
Nitrogen fixing	strain	4	low	med	3
Green manure	technology	3	low	short	3
High Manganese:					
Tolerance	cultivar	3	low	med	2
Res. excessive Mn	information	4	med	med	3
Liming	level app.	4	low	short	4
Calcium	level app.	4	low	med	4
Low potash:					
K flux banana/bean	information	4	med	short	4
Urban waste	technology	5	low	short	5
Tolerance	cultivar	4	low	long	5
Low phosphate:					
Rock phosphate	level app.	4	low	short	2
Research on P	information	4	low	short	3
Tolerance	cultivar	2	low	long	3
Liming	level app.	4	low	short	4
Drought:					
Tolerance	cultivar	4	med	long	5
Water loss	information	5	low	short	5
Other solutions:					
Agro-forestry	technology	3	med	long	2
Nutrient synchno.	technology	4	med	short	3
Use of models	information	4	med	short	3

[a] 1 implies highest impact.
[b] 1 = so vital, easy and potentially useful that it must be implemented, 2 = implement at current level of support, 3 = postpone until increased financial support, 4 = needs to be done, but not by the bean program, 5 = too ambitious for bean program. When fertilizer was indicated to be a possible solution, it was assumed that its price per kg was less than the price of one kg of dry beans.

Table 10. Summary Information Used in Prioritizing Solutions for Solving Biotic Problems in Bean Research[a]

Problem Solutions[b]	Research output[c]	Research impact	Level funds	Time period	Priority rank
Germ plasma eval.	cultivars	2	high	long	1
BCMV breeding	cultivar	2	med	med	1
Bruchid zabrotes	resistance	1	med	med	1
CBB breeding	cultivar	1	med	long	1
CBB cultural control	package	3	low	med	1
Halo blight resist.	cultivar	2	med	long	1.5
Chemical beanfly	recommend	2	med	short	2
ALS cultural	package	3	med	med	2
ALS breeding	cultivar	3	med	long	2
Cultural digitaria	package	3	low	med	2.5
ALS chemical	recommend	3	med	short	3
Anth. breeding	cultivar	4	med	med	3
Anth. cultural	package	4	med	med	3
Anth. clean seed	recommend	4	med	short	3
Halo blight cultural	package	3	med	med	3
ASCO breeding	cultivar	4	med	long	3
IPM for digitaria	package	3	med	long	3
Herb. for digitaria	weed killer	3	high	med	3.5
ASCO clean seed	recommend	4	med	med	4
Bruchid acantho.	cultivar	1	high	long	4
Beanfly breeding	cultivar	2	med	long	4
Root rot resistance	cultivar	-	high	long	4
Root rot cultural	package	-	med	med	4

[a] See footnotes in Table 9.
[b] Abbreviations are used for common bean diseases.
[c] Cultivar means breeding new cultivars, resistance means putting resistant material into currently used cultivars, package means the development of a cultural package, and recommend means that a recommendation is already available.

Table 11. Summary of the Top-Ten Bean Production Problems in the Short Grass, Tall Grass, and Highland Agro-Ecological Zones

Problem	Agro-ecological zone short grass	tall grass	high land	Average
Low yield potential	1[a]	1	1	1
Angular leaf spot	3	6	7	2
Low nitrogen	-[b]	2	3	2
Common bacterial blight	-	4	2	4
Low phosphate	-	2	5	5
Bruchids	7	-	3	6
Anthracnose	2	-	-	7
Digitaria	-	5	7	7
Low potash	-	-	6	9
Water stress	9	8	-	9
Bean common mosaic virus	8	-	9	9
Ascochyta	6	-	-	9

[a] The most important production problem is identified as 1.
[b] A dash indicates that the problem was not ranked in the top ten in the respective ecological zone.

Table 12. Summary of Estimated Financial Resources and Time Necessary to Undertake Solutions to Problems in the Top-Three Priority Ranks

Estimation level	Priority rank 1	2	3	Total
Funding				
Low	2[a]	5	4	11
Medium	5	5	10	20
High	1	0	1	2
Time period				
Short	1[b]	3	6	10
Medium	4	4	5	14
Long	3	3	3	9

[a] Number of solutions with priority rank 1 that had an estimated low funding requirement for implementation.
[b] number of solutions with priority rank 1 that had an estimated short time period to complete the research to determine the solution.

Table 13. Estimated Staff Requirements for Solving Abiotic Problems in Bean Production

Solution[a]	Workshop participants estimates Research area and % of researcher's time
Nitrogen problems:	
Fert. maize/beans	agron. or soil sci. (50%), plus extension
composting	agronomist (10%), plus extensionists
soil conservation	-
N fixing cultivar	breeder (10%), micro-biologist (20%)
Fert. climb beans	agron. or soil sci. (30%), plus extension
Fert. banana/bean	agron. or soil sci. (50%), plus extension
N fixing strain	micro-biologist (10%)
Green manure	agronomist (10%), plus extensionists
High magnesium:	
Tolerance	agron. or soil sci. (10%)
Research exc. Mn	soil scientists (10%)
Liming	agron. or soil sci. (20%), plus extension
Calcium	soil scientist (20%)
Drought:	
Tolerance	breeder (10%)
Water loss	agronomist (25%)
Low potash:	
K flux banana/bean	agronomist or oil scientist (10%)
Urban waste	extensionists
Tolerance	breeder (10%)
Low phosphate:	
Rock phosphate	agronomist or soil scientist (20%)
Research on P	soil scientist (50%)
Tolerance	breeder (10%) and agronomist (10%)
Liming	agronomist or soil scientist (20%)
Other solutions:	
Agro-forestry	agronomist (10%) and socio-economist (10%)
nutrient synchno.	agronomist or soil scientist (50%)
Use of modelling	agronomist or soil scientist (50%)

[a] Abbreviations are used for common diseases of bean and for chemical elements.

Table 14. Estimated Staff Requirements for Solving Biotic Problems in Bean Production[a]

Solution	Workshop participants estimates Research area and % of researcher's time
Germ plasma eval.	breeder (50%)
BCMV breeding	breeder(50%) and pathologist (50%)
Bruchid (zab)	breeder (30%) and entomologist (20%)
CBB breeding	breeder (50%) and pathologist (50%)
CBB cul. control	path. (30%), Agron. (15%), economist (10%)
Halo blight resist.	breeder (25%) and pathologist (15%)
Chemical bean fly	entomologist (20%)
ALS cultural	agronomist (10%) and pathologist (10%)
ALS breeding	breeder (33%) and pathologist (40%)
ALS chemical	pathologist (10%)
Anth. breeding	breeder (25%) and pathologist (25%)
Anth. cultural	agronomist (10%) and pathologist (10%)
Anth. clean seed	pathologist (10%) and agronomist (5%)
Halo bl't cultural	breeder (25%) and pathologist (15%)
ASCO breeding	breeder (50%) and pathologist (50%)
IPM for digitaria	agron., econ., & weed scientist (each 30%)
Herb. for digitaria	agron., econ., & weed scientist (each 10%)
Cultural digitaria	agron., econ., & weed scientist (each 30%)
ASCO clean seed	pathologist (10%) and agronomist (5%)
Bruchid acantho.	no estimate
Bean fly breeding	no estimate
Root rot resistance	breeder (40%) and pathologist (40%)
Root rot cultural	path. (45%), agron. (15%), and econ. (10%)

[a] See footnote in Table 13.

Table 15. Summary of Estimated Researcher Requirements for Problem Areas Receiving a Top Three Priority Rank

Research area	Priority rank[a] 1	2	3	Totals
Breeder	2.05[b]	0.43	1.10	3.58
Pathologist	1.45	0.50	0.55	2.50
Agronomist[c]	0.75	1.60	1.65	4.00
Economist	0.10	0.40	0.80	1.30
Weed scientist	0.00	0.30	0.30	0.60
Soil scientist	0.00	0.00	0.60	0.60
Entomologist	0.20	0.20	0.00	0.40
Micro-biologist	0.00	0.20	0.10	0.30
Total	4.55	3.63	5.1	13.28
Percent of total	34	27	38	100

[a] See column 5 in Tables 9 and 10.
[b] Total number of researchers required by research area and bean production problem priority rank.
[c] In research related to soils the agronomist can be replaced by a soil scientist.

SESSION VII. Other Issues and Topics on Bean Production

I. Yield Loss Due to Biotic and Abiotic Problems.

There was a general consensus by conference participants that additional work was needed in yield loss assessment. (See, also, the additional evidence needed column in Tables 2 and 3.) More evidence of yield loss due to diseases was needed at the farm level in order to prioritize research. It was agreed that the importance of bruchids and beanfly at the farm level has been established. Yield loss assessment was assigned a priority ranking of 1.5 (see footnote b, Table 9).

II. On-Farm Research, Socio-Economics, and Diagnostic Surveys.

It was agreed that the on-farm research involvement be maintained at current levels. However, there was a need to improve current methods, as well as develop additional methods. This was particularly emphasized in the case of breeders involvement with on-farm variety trials. Additional work needs to be done in the area of methods development in farmer participatory research and quantification and reporting of subjective data taken from farmers.

It was suggested that more collaboration between researchers at Makerere University and Kawanda research Station was necessary to standardize on-farm research priorities and research methods.

The number and content of diagnostic surveys undertaken was appropriate for continued bean research.

Participants assigned a priority ranking of 2 to on-farm research and diagnostic survey work (see footnote b, Table 9).

III. Partitioning of the Country by Ecological Zone for Research Purposes.

At the beginning of the Workshop, problems in bean production were identified by the three ecological zones short grassland, tall grassland, and highland. These zones were dropped in the remainder of the workshop to consider bean production problems and potential solutions for the country at large.

However, it was noted that bean research in the past has emphasized an ecological zone approach and that future research would continue in the same manner. The three ecological zones are currently being served by the Serere Research Station in the short grassland zone, Kawanda Research Station in the tall grassland zone, and Kachwekano Research

Station in the highland zone. While there is sufficient research station capacity in each zone, there is some deficiency in the distribution of research sub-stations, or variety trial centers (VTC). Breeders need to conduct additional research to determine if the distribution of the VTCs adequately cover all ecological zones.

The workshop participants assigned a priority ranking of 1-2 to the issue of ecological zone based bean research (see footnote b, Table 9).

VI. The Research and Extension Linkage.

The was a general consensus that the researcher/extension linkage in the bean program was weak and that technology being generated was not reaching farmers. To rectify this situation, the following suggestions were forthcoming:

1. Farm demonstrations, open days, and workshops.

2. More on-farm research.

3. Documentation of information through the development and distribution of extension pamphlets.

4. Dissemination of seed to farmers for newly released cultivars. The Uganda Seed Unit is not currently producing bean seed. More research should be undertaken in the area of seed production and dissemination for newly released cultivars.

5. The organization of forums where researchers, extension people, and farmers could regularly meet and evaluate research progress.

6. Annual reports and pamphlets published should be made available to the extension staff.

CLOSING REMARKS: NATIONAL RESEARCH PLANNING WORKSHOP ON BEANS

by
Professor Joseph Mukiibi

Secretary for Research, Ministry of Agriculture, Uganda

Participants of the workshop, invited guests, ladies and gentleman:

It gives me great pleasure to be with you this afternoon, even if for only a short period of time. I would have wished to be with you throughout this planning workshop, but was unable to do so because of other scheduled activities. I look forward to seeing the published proceedings.

It is most encouraging to see that you have given due attention to the planning of the activities of the bean programme, because this is absolutely essential for an organized approach in the tackling of researchable problems and for the efficient use of scarce resources. Proper planning in the past has helped the bean programme to continuously and steadily focus on the objectives of increasing bean productivity and overall production.

The composition of the workshop participants is a reflection of the wealth of knowledge on the bean crop and the diversity of experience in research planning available in this country. The information you have generated will be valuable and could act as a model in the research planning process for many of our other commodity research programmes.

Research on beans has been going on for the last 30 years in this country. A major breakthrough was made in 1968 when the cultivar K 20 was released. However, the continuous civil unrest during the decade of 1970s and the early 1980s and the scarcity of research resources have hindered progress in agricultural research in general and bean research in particular for nearly two decades.

With CIAT's assistance, the bean programme has been making steady progress. I am pleased and encouraged to learn that new technologies for increasing bean productivity are in the research pipeline and that they are being refined for release to farmers.

As agriculture researchers, we are all under continuous pressure to increase agricultural production. Beans are one of the major crops in which we have focused particular attention. There is, indeed, a great need to increase bean production. Household food demands are increasing daily with the rapid increase in population. In addition, farmers need to increase bean production for generating cash income and the country as a whole needs more bean production for generating exports.

Improved technologies for increasing bean production are required. These technologies must contribute to increased productivity and be cost effective.

While the importance and demand for beans in Uganda is growing, major problems persist in production. Our national average yield is around 740 kilograms per hectare and we know that potential yield is about three times this level.

There is an urgent need to realize this potential while at the same time sustaining the wealth of our natural environment. I am pleased to learn that you have considered research on technologies that will not only lead to higher productivity, but also on the sustainability of the productivity gains.

Within the Ministry of Agriculture we are most concerned with both national and household food security needs. Beans are an important food crop in achieving food security. I am pleased that this issue has also been addressed in this workshop.

The agricultural sector of this country is set for an agricultural revolution and the bean programme has organized itself to get the ball rolling to increase bean production. The collaborative effort between Uganda and CIAT, designed to increase bean productivity, is in the right place at the right time. We encourage CIAT to participate in our agricultural revolution and, in particular, to assistance us in achieving our goal of increasing bean productivity.

Your meeting has touched upon the important issue of technology transfer. I am pleased that steps will be taken to insure that the technologies your programme develops will be made available to farmers. The Ministry of Agriculture has a mechanism in place to assist in the transfer of technology. Use this mechanism to insure that the developed technology is both quickly and widely distributed to farmers across the country.

I believe this workshop to be most useful. We all look forward to the results, not only in terms of published proceedings, but also over the longer run in terms of new technology developments and increased bean productivity.

let us hope that you have both enjoyed and learned from this planning experience. For those who came from outside Uganda, we hope that you have had a pleasant stay. You are always welcome.

I now declare this workshop on "National Research Planning for Bean Production in Uganda" closed.

Workshop Participants

National Bean Programme: Kawanda Research Station, P.O. Box 7065, Kampala, Uganda

Eldad E. Karamura (entomology)
Edmund Kikoba (agronomy/weeds)
Jane Kisakye (agronomy)
Beatrice Male-Kayiwa (breeding)
Sophy Musaana (breeding)
Z. Muyaka (extension)
Silim Nandy (entomology)
Charles S. Niringiye (agronomy)
Fina A. Opio (pathology)
Therasa Sengooba (pathology)

Makerere University: Faculty of Agriculture, P.O. Box 7062, Kampala, Uganda

Larry Adupa (biometrics)
Charles C. Kitaale (economics)
Edward N. B. Nsubuga (economics)
Victor A. Ochwoh (soils)
Joe Ssenteza (economics)
Bernad Tayebwa (economics)
Godfrey P. Turicho-Habwe (economics)
Manuel Vanegas (economics)
Peter Ngategize (economics)

Ministry of Agriculture:

Adriel M. Kabaara (coffee farming systems)
James B. Komayombi (extension)
Joseph Othieno (extension)
Jane Rose Tumusiime (economics)
Josephine Zizinga (extension)
B. Bashaasha (economics)

CIAT: P.O. Box 6247, Kampala, Uganda

Bill Grisley (economics)
Charles S. Wortmann (agronomy)
Howard Gridley (breeding)
Jeff Mutimba (training)
Kwasi Ampofo (entomology)
David M. Mwesigwa (economics)
Robin Buruchara (pathology)
Roger Kirkby (agronomy)

Other Institutions

Ramesh Thakare (farming systems)
IFAD/World Bank Project
SWRARP, P.O. Box 1395
Mbarara, Uganda