AFRICAN BEAN PRODUCTION ENVIRONMENTS: THEIR DEFINITION, CHARACTERISTICS AND CONSTRAINTS

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PREFACE

This publication is a working document on bean production in Africa. It classifies 70 major bean production areas according to environmental criteria and provides information for each bean production area on physical and socio-economic characteristics, cropping systems, producer and consumer preferences, and on the major biotic and abiotic constraints. The data were gleaned from many sources including the observations made over the last ten years by CIAT and national program bean researchers. Inaccuracies are likely to be found, and useres are requested to report to the authors inaccuracies which they identify. It is expected the document will need to be revised after one or two years to reflect this feedback from users.

This volume is the eleventh in a series or working documents that serves research on beans (*Phaseolus vulgaris*) in Africa. Working documents will include bibliographies, research reports and bean network discussion papers. These publications are intended to complement an associated series of Workshop Proceedings.

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Further information on regional research activities on bean in Africa that are part of these projects is available from:

Pan-Africa Coordinator, CIAT, P.O. Box 23294, Dar es Salaam, Tanzania.

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

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PUBLICATIONS OF THE NETWORK ON BEAN RESEARCH IN AFRICA

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

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No. 4. Bean Varietal Improvement in Africa, Maseru, Lesotho, 30 January - 2 February, 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, 4-7 October, 1989.

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

No. 8. Atelier sur la Fixation Biologique d'Azote du Haricot en Afrique, Rubona, Rwanda, 27-29 Octobre, 1988.

No. 9. Quatrieme Seminaire Regional sur l'Amelioration du Haricot dans la Region des Grands Lacs, Bukavu, Zaire, 21-25 Novembre, 1988.

No. 10. National Research Planning for Bean Production in Uganda, Makerere University, Kampala, Uganda, 28 January - 1 February, 1991.

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No. 12. Ninth SUA/CRSP Bean Research Workshop and Second SADCC/CIAT Regional Bean Research Workshop. Progress in Improvement of Common Beans in Eastern and Southern Africa, Sokoine University of Agriculture, Morogoro, Tanzania, 17-22 September, 1990.

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No. 15. First Pan-Africa Working Group Meeting on Anthracnose of Beans, Ambo, Ethiopia, 17-23 February, 1991.

No. 16. Cinquieme Seminaire Regional sur l'Amelioration du Haricot dans la Region des Grands Lacs, Bujumbura, Burundi, 13-17 Novembre, 1989.

No. 17. Sixieme Seminaire Regional sur l'Amelioration du Haricot dans la Region des Grands Lacs, Kigali, Rwanda, 21-25 Janvier, 1991.

No. 18. Conference sur Lancement des Varietes, la Production et la Distribution de Semaines de Haricot dans la Region des Grands Lacs, Goma, Zaire, 2-4 Novembre, 1989.

No. 19. Recommendations of Working Groups on Cropping Systems and Soil Fertility Research for Bean Production Systems, Nairobi, Kenya, 12-14 February, 1990.

No. 20. Proceedings of the First African Bean Pathology Workshop, Kigali, Rwanda, 14-16 November, 1987.

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The Banana-bean Intercropping System - Bean Genotype x Cropping System Interactions. 1993. C.S. Wortmann and T. Sengooba. Field Crops Research, Vol. 31 pp. 19-25.

No. 5. Contribution of Bean Morphological Characteristics to Weed Suppression. C.S. Wortmann. Agronomy Journal 85(4):840-843.

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AFRICAN BEAN PRODUCTION ENVIRONMENTS: THEIR CHARACTERISTICS AND CONSTRAINTS

Abstract

Bean production in Africa is very heterogeneous with much variation in environmental conditions, cropping systems, preferences and constraints. This working document contains information on the many bean producing areas in Africa. The data were gleaned from numerous sources but a major part of these are from the observations of CIAT and national bean program researchers over the last ten years. Thirteen bean producing environments are defined from consideration of altitude, latitude, soil pH and seasonal rainfall. Seventy bean producing areas, having estimated annual bean production of between 2,000 and 220,000 hectares, are described on the bases of environmental and socio-economic characteristics, cropping systems, farmer and consumer preferences, and biotic and abiotic constraints. The importance of the constraints was evaluated both on a pan-African and a regional basis. Angular leaf spot, anthracnose, bean stem maggot, bruchids, low soil nitrogen and low soil phosphorus were determined to be the most important constraints to greater productivity on a pan-African basis.

Introduction

Beans (*Phaseolus vulgaris* L.) are an important food crop in eastern and southern Africa. Beans were probably introduced to the eastern Africa coast by Portuguese traders in the sixteenth century (Greenway, 1945). These traders called at Sofala (Mozambique), Zanzibar and Mombasa and their goods, including various new food plants, were carried to the interior by Arab slave traders and by Swahili merchants (Binns, 1976; Merril, 1954; Oliver & Mathew, 1963). Beans became established as a food crop in Africa before the colonial era, but there is little clear indication of the status the crop attained. The wealth of local names given to distinctive cultivars, and the genetic variation, are together

evidence of the long establishment of beans as a crop. Beans are now recognized as the second most important source of human dietary protein and the third most important source of calories of all agricultural commodities produced in eastern and southern Africa (Pachico, 1993).

The bean-growing ecosystems of Africa are numerous and highly diverse (Allen & Edje, 1990). Their potential for production and their management requirements are determined by the interplay of many factors, including climate, soil type and a range of socio-economic and biological factors. Research is concerned with adapting germplasm (Smithson, 1989) and means of production more precisely to specific environments. Development of appropriate technologies requires a good understanding of constraints and opportunities of the bean growing ecosystems. Such understanding is needed for:

the identification of problems and the setting of research priorities undertaken by national institutions and regional research networks;

establishing collaborative research efforts;

identification of suitable locations for research;

targeting technology that is agroecosystem-specific; and

the interpretation of results of regional and pan-African trials.

This document provides a review of the distribution of bean production in Africa and gives information on the important bean producing areas. The review is often limited by the paucity and poor quality of available information wich comes from a variety of sources; much is derived from observations of bean researchers made over the last ten years, including results from at least 20 diagnostic surveys, numerous on-farm trials, an African network of more than 150 researchers at over 40 experiment stations in 18 countries, and a series of national and regional planning workshops for bean research. Also, conditions and constraints are not static but subject to perpetual change. Therefore, this document should be considered as a first attempt to present information on African

bean production areas. We encourage researchers to add to this information base and to suggest necessary revisions in order that a more accurate revision can be made.

The document begins with the distribution of bean production in Africa, with a second approximation of a bean map included in the Appendix. The major African bean environments (AFBE) are characterized and the area of beans sown are presented with physical information for each of the major bean producing areas (MBPAs). Characteristics of the bean cropping systems, of socio-economic factors and of producer and consumer preferences are presented in sequence for each MBPA. Sections follow on the distribution and importance of agronomic constraints, including diseases, insect pests and edaphic constraints, the overall importance of which is addressed.

Distribution of bean production in Africa

A map showing an approximation of bean production in Africa is presented in the Appendix. This is a revision of a map prepared by the CIAT Agroecological Unit (Gray, 1990). Information from several sources was used to estimate the distribution of bean production. National data were used when available. In some cases, FAO data were used. The information for Ethiopia is largely from farming systems' surveys. Reliable statistics on bean production are generally lacking for Zaire and the estimates given are a consensus of data from researchers familiar with bean production in Zaire.

The distribution of beans in Africa is obviously irregular but there are some notable concentrations:

1. The Great Lakes area consisting of Burundi, Rwanda, southwestern Uganda and extreme eastern Zaire;
2. The slopes of Mt. Elgon in Uganda and Kenya, and western Kenya;
3. The slopes of Mt. Kenya and of the Aberdares in central Kenya;
4. Central Malawi and the Tete Highlands of Mozambique; and

5. The Hararghe Highlands of Ethiopia.

Other notable concentrations include the Tall Grass Zone of Uganda, the Northern and the Southern Highlands of Tanzania, and Kagera Region of Tanzania. In this document, 70 bean growing areas have been characterized, with areas of annual bean production ranging from 2000 to 220,000 hectares.

Classification of environments and bean production areas

The criteria on which we have based the AFBEs herein defined are altitude, amount of rainfall per bean growing season, mode of rainfall and soil pH. While the levels of these criteria are arbitrary, the cut-off points are of biological significance to the bean crop.

Altitude affects temperature and therefore affects times to maturity, incidence and severity of both disease and insect pests, and rates of evapotranspiration. Three levels were used in classifying the AFBE: >1500, 1000-1500 and <1000 meters above sea level (masl).

Amount and mode of rainfall determine the probability of soil moisture deficits and the number of important bean producing seasons per year. Environments were classified as having more or less than a mean of 400 mm of precipitation available to the bean crop. Rainfall in the low latitude zone between approximately 7°S to 7°N is effectively bimodal as a consequence of the movements of the Inter-continental Convergence Zone. The unimodal rainfall pattern of the higher latitudes is associated with significant photoperiod effects.

Soil pH relates to the soil's capacity to supply nutrients as well as to aluminium and manganese toxicity problems. Environments were classed as having a mean soil pH of above or below 5.5.

Thirteen important AFBEs resulted from this classification (Table 1). The MBPAs are listed for each AFBE with its area of bean production, latitude range and major soil types according to the FAO legend (FAO, 1977). These AFBEs account for an annual total of 3,830,000 hectares of bean crop.

Two AFBEs account for 50% of the hectares of beans. The sub-humid, low latitude highlands of high potential in eastern Africa account for 1,012,000 hectares and the sub-humid, low latitude, mid-altitude high potential areas account for 885,000 hectares.

An alternative classification of bean growing areas defined primarily by geographic location with consideration to altitude differences might be more useful for regional planning. Five regional areas are: a) the highlands of eastern Africa and b) the mid-altitude areas of East Africa within the range of 6°S to 13°N latitude and east of 27°E longitude; c) southern Africa, south of 6°S latitude; d) western Africa including areas west of 15°E longitude; and e) the lowland areas which are below 1000 masl and scattered throughout Africa.

Bean cropping systems

Beans are compatible with numerous other crops in mixed cropping seasons. Beans are primarily a crop of small-scale producers and generally few inputs are used. The result is a wide range of bean production systems. The major cropping systems include beans intercropped with maize, sorghum, tuber and root crops, or bananas, or beans grown in sole crop (Table 2). Generally, two crops per year are harvested in the low latitude areas where the main sowing times are March or April and September or October. In the northern mid-latitude areas, the main sowing time is June to July. In the southern mid-latitudes, the main sowing time is in November and December. Relay intercropping is often practiced in the mid-latitude areas if rainfall is sufficient.

Producer and consumer preferences

Producers are concerned about risk avoidance and yield of good quality beans (Allen et al., 1989). They recognize the importance of good adaptation of cultivars and resistance or tolerance to the major constraints. They are also concerned about culinary quality and taste, and some qualitative traits such as seed size and color

major constraints. They are also concerned about culinary quality and taste, and some qualitative traits such as seed size and color and plant growth habit. Generally a wide range of seed colors and sizes is acceptable (Grisley and Munene, 1992, Grisley and Mwesigwa, 1991, Voysest and Dessert, 1991). Preferences exist but are often associated with preference for known cultivars and are not strongly exclusive. With the exception of blacks, which are accepted locally in northern Uganda and southern Ethiopia, all seed colors are acceptable in most MBPAs (Table 3). Large and medium-sized seeds are preferred, but smaller seeds are acceptable to certain limits, especially by poorer consumers and producers who rely on low-priced food and seed. Grain types are commonly marketed separately in all countries except, Burundi, Rwanda and Zaire. Bush type growth habits, whether determinant or indeterminant, are most commonly preferred by farmers. Climbing beans have higher yield potential and are important in the densely populated areas of Rwanda, Burundi, eastern Zaire, southern and northern Malawi and south-western Uganda (Graf et al., 1991).

Socio-economic characteristics

Human population density is a major determinant of intensity of bean production. Population tends to be most concentrated in highland areas (Table 4). In most MBPAs, women are primarily responsible for bean production. Most beans are produced for home consumption by small-scale farmers (Woolley et al., 1991). However, considerable amounts are marketed for local consumption and for export to neighboring countries (Grisley, 1990). Production of dry beans for specialized markets is rare, but include the production of white-seeded Navy beans in Ethiopia and Zimbabwe, high quality bean seed in northern Tanzania for export to Europe, and yellow grain types in N.E. Zaire for the Kinshasa domestic market. Beans are generally allowed to mature and dry in the field before harvest. In some MBPAs, the consumption of "fresh beans" (i.e. beans not yet physiologically mature) is common and may account for as much as 40% of the beans consumed and a larger

proportion of the marketed crop value (Grisley and Mwesigwa, 1991). Use of bean leaves is less common, but locally and seasonally important.

Bean diseases

Ratings of the importance of various bean diseases are presented in Tables 5-6 and summarized in Tables 11-15. Incidence and severity of diseases generally vary considerably from season to season. Some diseases that are generally seen to be of little economic importance can at times be devastating. Nevertheless, diseases like angular leaf spot (*Phaeoisariopsis griseola*), anthracnose (*Colletotrichum lindemuthianum*), rust (*Uromyces appendiculatus*), common bacterial blight (*Xanthomonas campestris* pv. *phaseoli*) and bean common mosaic are widespread and can decrease yield considerably. Other diseases, including halo blight (*Pseudomonas syringae* pv. *phaseolicola* and pv. *syringae*) and ascochyta blight (*Phoma exigua* var. *diversispora* and/or *Ascochyta phaseolorum*), can also cause significant crop loss, but they tend to be confined to specific environments. Another group of bean diseases, although widespread, tends not to cause large losses. All the rest of the many diseases recorded on beans in Africa are either sporadic or local (Allen, Buruchara and Smithson, in press; Beebe and Pastor-Corrales, 1991). The ratings given are based on observations made by researchers in recent years. In very few cases are there yield loss data to support these ratings (Wortmann, 1992). An exception is common bacterial blight for which Opio (1993) estimated yield losses in Uganda ranging from 26.6 to 61.7%, and 6.2 to 7.8%, for a susceptible and a tolerant cultivar, respectively.

Solving the many disease-related problems is further complicated by the occurrence of pathogenic variation. The geographic distribution of races of halo blight and of the pathogenicity groups of bean common mosaic virus are shown in Tables 7 & 8.

The ratings of importance are related to estimated mean reduction in yield potential as follows: high importance indicates a reduction in sole crop yield potential of more than 300 kg ha^{-1}; moderate importance is equivalent to 100 - 300 kg ha^{-1} reduction; and low importance is equivalent to less than 100 kg ha^{-1}.

Insect pests

Ratings of importance are given for several insect pests, including aphids (chiefly, *Aphis fabae*), pod borers (*Heliothis* spp. and *Maruca testulalis*), bean stem maggot (*Ophiomyia* spp.), foliage beetles (*Ootheca* spp.), bruchids including *Zabrotes subfasciatus* (Boheman) and *Acanthoscelides obtectus* (Say), and thrips (*Megalurothrips sjostedti*). Pod bugs, mostly of *Clavigralla* spp., are common pests in humid, warm environments. Bean stem maggot is the insect pest of greatest concern (Tables 7 & 11). The importance of aphids may at times be underestimated due to inadequate consideration of their role in transmission of bean common mosaic virus. The importance of thrips may also be underestimated as these small insects often go undetected. Some pests are of localized importance, including: whitefly (*Bemisia tabaci*) in northern Sudan; *Apoderus humeralis* ("Le cigarier", a bean leafroller) and *Pyrameis cardui* in Madagascar (Rabary, 1993); and Meloids (pollen and blister beetles, often referred to as 'CMR beetles') in Lesotho, Swaziland and South Africa.

Edaphic constraints

The importance of edaphic stresses was determined primarily through interpretation of information provided in the FAO soil map of the world (FAO, 1977). More precise information was used for Kenya (Jaetzold and Schmidt, 1982; FURP, 1987). In interpreting ratings of importance of edaphic constraints, it must be appreciated that the ratings were confined to the major soil types of the area. Therefore, in some cases, the ratings may overemphasize the importance of the problems, as farmers avoid sowing of beans on soils where little production can be achieved.

Especially where the intensity of crop production is not high, most of the bean production may be concentrated on the moderate to good soils. In such cases, the ratings may be more relevant to the future, as increasing pressure on the land causes more intensive use of marginal lands.

Soil organic carbon levels for representative soil profiles and researcher observations were considered for the ratings of the importance of low soil N, P and K supply. Also, available P and exchangeable K were considered, as well as soil pH, in estimating the importance of these deficiencies. The importance of low availability of exchangeable bases and toxicities of aluminum and manganese were determined from representative profile descriptions of major soil types using criteria of the Fertility Capability Classification System (Buol and Couto, 1980). The importance of P fixation by iron oxides (FeP) was determined from results of chemical analyses or from soil color of representative soils. FeP fixation was considered to be important when the free Fe_2O_3 / clay ratio was more than 0.15, or when the soil color was redder than 7.5 YR according to the Munsell Soil Color Charts. Ratings of these edaphic constraints are presented in Table 10.

Importance of bean production constraints

The importance of bean production constraints in Africa is shown in Table 11 for Africa as a whole, and in Tables 12-15 for four bean production regions. Data on constraints in western Africa, wherein beans are of generally little importance, were too scarce for most MBPAs to attempt to evaluate the importance of the biotic constraints for the region. The importance of the constraints is indicated in the tables as area in hectares, and as percent of bean production area, where the constraint is of high or moderate importance. As there were insufficient data on certain constraints for some MBPAs to hazard an estimate, total land area considered differs for constraints but the estimates of percentage area affected is determined from the area which received a score for the constraint in Tables 5, 6, 9 & 10. Values of importance

were calculated as the sum of the products of the percentages of area affected multiplied by assumed mean seed yield losses of 0.4 and 0.2 Mt ha^{-1} for high and moderate importance, respectively. For example, the score for the importance of angular leaf spot (Table 11) was determined as: (67 * 0.4) + (25 * 0.2) = 31.8

Angular leaf spot was found to be the most important constraint to bean production overall in Africa (Table 11). This is followed in importance by low soil nitrogen availability and bean stem maggot. Other problems of major overall importance in Africa, in order of descending importance, are low available phosphorus, anthracnose, bruchids, common bacterial blight, aphids, bean common mosaic and aluminum and manganese toxicities. Phosphorus fixation by iron oxides appears to be a major problem as it is a cause of low supply of phosphorus to the bean crop, but also complicates the use of phosphate fertilizers.

In the highlands of eastern Africa (Table 12), bean production is found to be most constrained by anthracnose and angular leaf spot. Low soil nitrogen and phosphorus follow. Other major constraints in these highlands, in order of descending importance, are bean stem maggot, aphids, halo blight and bruchids.

Angular leaf spot and common bacterial blight were determined to be the major constraints in the mid-altitude zone of eastern Africa (Table 13). Other important constraints are low soil N, mid-season drought, bean stem maggot, bruchids, bean common mosaic and rust.

Bean production appears to be most affected by low soil P in southern Africa, followed by low soil N and bean stem maggot, angular leaf spot, bruchids, anthracnose, rust and Al and Mn toxicities (Table 14). Lowland bean production is dispersed throughout southern and northern Africa and appears to be most affected by low soil nitrogen, mid-season soil moisture deficits, aphids, bruchids, low soil phosphorus, late season drought, rust and bean stem maggot (Table 15). Bean production data from western Africa are insufficient to evaluate the importance of constraints in those MBPAs.

The information presented in Tables 11 to 15 is potentially useful in planning research and development efforts at a regional or pan-African level. However, many constraints are very important locally while of lesser importance regionally and may deserve the attention of regional collaborative research efforts as well as of the national research institutes.

Conclusion

An annual area of 3,830,000 hectares of bean production have been accounted for in 13 AFBEs. Two of these AFBEs account for 50% of the production while four have less than 100,000 hectares of annual production.

The three main AFBEs are favorable environments for crop production, with moderate to very high rural population densities. Major biotic constraints in these AFBEs in order of descending importance, are angular leaf spot, anthracnose, common bacterial blight and bean stem maggot. Generally, soil moisture is adequate to produce good bean crops. Low soil N and P availability are major constraints, but they are potentially manageable with organic and inorganic fertilizer use, accompanied by cultivars efficient in the use of nutrients and resistant or tolerant to the major biotic stresses. Bean production is primarily on a small-scale with little input use. As demand for beans increases and varieties with resistance or tolerance to the major biotic stresses become increasingly available, input use is likely to increase so leading to substantial increases in productivity.

Increases in production will be more difficult to achieve in those AFBEs where constraints associated with low soil pH and inadequate soil moisture are of major importance. In addition to improved varietal resistance or tolerance to the biotic stresses, tolerance will be needed to toxicity problems associated with low soil pH as well as to the low nutrient supply (or to the occasional soil moisture deficits). Only then will there be much response to input use or to the adoption of high yielding varieties. While the returns to research may not be as great in these AFBEs as in the

higher potential areas, their problems need to be addressed as dependence on these AFBEs is likely to increase as bean crops are further extended to more marginal soils in response to growing land pressure.

As the picture of current and projected future role of the bean crop becomes clearer, the direction of research and the orientation of policy will be determined with greater confidence. Data bases such as this one need constant revision, with input from the many users of this document, to remove inaccuracies and to allow better analyses of factors affecting bean production intensity, yields and trends.

References

Allen, D.J., M. Dessert, P. Trutman and J. Voss. 1989. Common beans in Africa and their constraints. In: H.F. Schwartz and M.A. Pastor-Corrales (eds.) Bean Production Problems in the Tropics, 2nd ed.. CIAT, Cali, Colombia. p. 9-13.

Allen, D.J. and O.T. Edje. 1990. Common bean in African farming systems. In: Smithson, J.B. (ed.) Progress in Improvement of Common Bean in Eastern and Southern Africa. Bean Research 5, CIAT Africa Workshop Series, No. 12. p. 20-31.

Beebe, S. and M.A. Pastor-Corrales. 1991. Breeding for disease resistance. In: A. Van Schoonhoven and O. Voysest (eds.) Common Bean Research for Crop Improvement. CIAT, Cali/CABI, Farnham Royal p. 561-617.

Binns, B.L. 1976. Ethnobotany of plant names in Malawi: their origins and meanings. Society of Malawi Journal 29:46-55.

Buol, S.W. and W. Couto. 1980. Soil fertility capability assessment for use in the humid tropics. In: D.J. Greenland (ed.) Characterization of Soils in Relation to their Classification and Management for Crop Production: Examples from Some Areas of the Humid Tropics. Oxford University Press.

Buruchara, R.A. 1993. Summary of working group sessions. In: R.A. Buruchara and U.C. Scheidegger (eds.) Proceedings of the Pan-Africa Bean Pathology Working Group Meeting. Thika, Kenya, 26-30 May, 1992. CIAT Africa Workshop Series No. 23.

Carter, S.E., L.O. Fresco, P.G. Jones and J.N. Fairbairn. 1992. An atlas of cassava in Africa: historical, agroecological and demographic aspects of crop distribution. CIAT Publication No. 206, CIAT, Cali, Colombia.

Edington, B.R. and V.H. Whitlock. 1988. Identification of an isolate of bean common mosaic virus from the Transvaal and Natal. Annals of Applied Biology 113:645-648.

FAO. 1977. Soil map of the world 1:5,000,000. Volume IV, Africa. UNESCO, Paris. 299p.

FURP. 1987. Description of the First Priority Sites in the Various Districts. Fertilizer Use Research Project (Phase I), Final Report, Annex III. Ministry of Agriculture, Kenya, in cooperation with the German Agency for Technical Cooperation.

Graf, W., J. Voss and P. Nyabenda. 1990. Climbing bean introduction in southern Rwanda. In: R. Tripp (ed.) Planned Change in Farming Systems: Progress in On-farm Research. John Wiley & Sons Ltd., Chichester. p. 39-62.

Gray, J. 1990. Bean (*P. vulgaris*) distribution in Africa -- first approximation. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Greenway, P. 1945. The origin of some East African food plants. III. East African Agricultural Journal 10:177-180.

Grisley, W. 1990. An overview of bean production in sub-Saharan Africa. In: Janssen, W. (ed.) Trends in CIAT Commodities, 1990. CIAT, Cali, Colombia. p. 61-88.

Grisley, W. and D. Mwesigwa. 1991. Consumer preferences for fresh and dry beans in Uganda: implications for bean breeders. Manuscript.

Grisley, W. and D. Mwesigwa. 1991. A report on the socio-economics of bean production and marketing in Uganda: information for research planning. In: W. Grisley (ed.) Proceedings of a Workshop on National Research Planning for Bean Production in Uganda. Kampala, Uganda, January, 1991. CIAT African Workshop Series No. 9. p 75-81.

Grisley, W. and S. Munene. 1992. Dry beans sold at retail markets in Kenya: cultivars, grain types, prices, and sources. Manuscript.

Jaetzold, R. and H. Schmidt. 1983. Farm Management Handbook of Kenya, Vol. II: Natural Conditions and Farm Management Information. Ministry of Agriculture, Kenya, in cooperation with the German Agency for Technical Cooperation (GTZ).

Merril, E.D. 1954. The botany of Cook's voyages and its unexpected significance in relation to anthropology, biogeography and history. Chronica Botanica, Waltham.

Mukoko, O.Z. 1992. Breeding beans (*Phaseolus vulgaris* L.) for resistance to bean common mosaic virus in Zimbabwe. Ph. D. Dissertation, Univ. Cambridge, 117 pp.

Oliver, R. and G. Mathew. 1963. History of East Africa. Clarendon Press, Oxford.

Opio, A.F. 1993. Pathogenic variation, seed transmission and survival of *Xanthomonas campestris* pv. *phaseoli* in *Phaseolus* beans. Ph.D. Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania. 257 pp.

Pachico, D. 1993. The demand for bean technology. In: G. Henry (ed.) Trends in CIAT Commodities 1993. CIAT. p. 60-73.

Rabary, B. 1993. Management of acid soils: a diagnostic survey in Ambohibary and Antanifotsy. Presented at the 3rd Multi-disciplinary Workshop of the Eastern Africa Bean Research Network, Thika, Kenya, April, 1993.

Smithson, J.B. 1989. Utilization of existing variability. In: J.B. Smithson. CIAT Africa Workshop Series, No. 4. p. 68-85.

Spence, N.J. 1992. The identification, distribution and ecology of bean common mosaic virus occurring in different regions of Africa. Ph.D. Thesis. Univ. Birmingham, 242 pp.

Spence, N.J. and D.G.A. Walkey. 1991. Identification of strains of bean common mosaic virus occurring in different regions of Africa. Annual Report of the Bean Improvement Cooperative 34:5-6.

Teverson, D.M. 1991. Genetics of pathogenicity and resistance in the halo blight disease of beans in Africa. Ph.D. Dissertation, Univ. Birmingham, 205 pp.

Voysest, O. and M. Dessert. 1991. Bean cultivars: classes and commercial seed types. In: A. Van Schoonhoven and O. Voysest (eds.) Common Bean Research for Crop Improvement. CIAT, Cali/CABI, Farnham Royal. p. 119-162.

Wooley, J., R.L. Ildefonso, T.A.P. Castro and J. Voss. 1991. Bean cropping systems in the tropics and subtropics and their determinants. In: A. Van Schoonhoven and O. Voysest (eds.) Common Bean Research for Crop Improvement. CIAT, Cali/CABI, Farnham Royal. p. 119-162.

Wortmann, C.S. 1992. Assessment of yield loss caused by biotic stress on beans in Africa. Occasional Publication Series, No. 4. CIAT, Colombia.

Table 1. Environmental characteristics and hectares of the main bean production areas of Africa.

Major bean producing area		Area ('000 ha)	Latitude range	Major soil types (FAO)[1]
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude >1500 masl[2]; >400 mm available moisture; soil pH >5.5; bimodal/PPN[2]				
Burundi:	Central plateau	250	2.5S - 4.0S	Nh
Ethiopia:	Awassa/N. Sindamo	35	6.0N - 8.0N	Ne, Xh
Kenya:	Central Highlands	165	1.0S - 1.5S	Nh, Tm, Ne
	Western Highlands	182	1.0S - 1.5S	Nh, Fo
Rwanda:	Central plateau	150	2.0S - 3.0S	Nh
	Northwest	70	1.5S - 2.0S	Tm
Tanzania:	Northern Highlands	80	3.0S - 3.5S	Nh
Uganda:	Southwest Highlands	35	1.0S - 1.5S	Nh, Tm
	Mt. Elgon	45	0.7N - 1.4N	Nh, Tm
AFBE 2: Sub-humid highlands on acid soils at low latitudes >1500 masl; >400 mm available moisture; soil pH <5.5; bimodal/PPN				
Burundi:	Zaire-Nile Crest	40	2.5S - 3.5S	Fh
Kenya:	Tea zone	10	1.0S - 0.0S	Th
Rwanda:	Zaire-Nile Crest	40	1.5S - 2.5S	Fh
Tanzania:	Usambara & Luguru	50	4.5S - 6.0S	Ne
Zaire:	South Kivu	130	2.0S - 5.0S	Nd
AFBE 3: Sub-humid highlands at mid-latitudes >1500 masl; >400 mm available moisture; soil pH >5.5; unimodal/PP+				
Ethiopia:	Hararghe Highlands	95	8.0N - 9.0N	Be, Bd
	Western	25	8.6N - 10.0N	Ne
Malawi:	Misuku Hills, South	70	9.0S - 16.5S	Fo, Ne
Mozambique:	Lichinga (North)	75	11.5S - 14.5S	Fo, Lf, Fr
	Tete	15	16.5S - 18.0S	Bc
	Western Highlands	25	14.0S - 15.5S	Fo, Lf
Tanzania:	S. Highlands	110	6.5S - 10.0S	Be, Nd
Zimbabwe:	Highveld	15	17.0S - 18.0S	Lf
Cameroon:	Western	75	5.0N - 6.0N	Ne, Nd
Guinea:	Guinea	30	10.0N - 12.0N	Bf
Nigeria:	Kano	5	11.5N - 12.5N	Lf
	Jos Plateau	5	9.5N - 10.0N	Lf
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes >1500 masl; >400 mm available moisture; soil pH <5.5; unimodal/PP+				
Angola:	Central Highlands	80	11.5S - 14.5S	Fo, Qf
Madagascar:	Antsirabe	13	19.5S - 20.5S	Be, Bf, Fr
Malawi:	Northern (Rumphi)	20	10.5S - 11.0S	Fo, Bc
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes >1500 masl; <400 mm available moisture; soil pH <5.5; unimodal/PP+				
Lesotho:	Lowlands/foothills	7	29.0S - 30.0S	We, I-Bc-L

Table 1 continued.

Major bean producing area		Area ('000 ha)	Latitude range	Major soil types (FAO)[1]
AFBE 6: Sub-humid areas at mid-altitude and low latitude 1000-1500 masl; >400 mm available moisture; soil pH >5.5; bimodal/PPN				
Burundi:	Moso-Bugesera	90	2.0S - 4.5S	Nd, Nh
Kenya:	Nyanza	80	1.5S - 1.0N	Fr, Fo
Tanzania:	Kagera	90	1.0S - 3.5S	Lf, Fo
	Northern mid-alt.	40	1.0S - 3.0S	Ne, Nd, To
	West (Kigoma)	45	3.5S - 9.0S	Bc, Ne
Uganda:	Short grass zone	120	1.5N - 3.0N	Fo
	Tall grass zone	200	1.0S - 3.5N	Af, Fo, Ne
Zaire:	N.E.	220	3.0N - 2.5S	Fo, Ne
AFBE 7: Sub-humid areas at mid-altitude and mid-latitude 1000-1500 masl; >400 mm available moisture; soil pH >5.5; unimodal/PP+				
Malawi:	Central Plateau	35	13.0S - 14.5S	Lf
Sudan:	South	50	4.0N - 5.0N	Ne, Lf
Zaire:	Shaba Region	70	5.0S - 13.0S	Fr
Zambia:	East	5	10.0S - 14.5S	Fo, Lc
Zimbabwe:	Mid-veld	6	16.5S - 20.0S	Lf
Togo:	Atakpame	5[3]	7.0N - 8.0N	Lf
AFBE 8: Semi-arid areas at mid-altitude and low latitude 1000-1500 masl; <400 mm available moisture; soil pH >5.5; bimodal/PPN				
Kenya:	Eastern	170	0.0 - 2.5N	Lf, Bc
	Other semi-arid	80	3.0S - 0.5N	Lf, Vp, Bk
Rwanda:	Eastern	60	2.0S - 2.5S	Fo
Tanzania:	N. fringe areas	30	1.0S - 5.0S	Nd, To
AFBE 9: Semi-arid areas at mid-altitude and mid-latitude 1000-1500 masl; <400 mm available moisture; soil pH >5.5; unimodal/PP+				
Angola:	Fringes	30	7.0S - 16.0S	Lf,Fo
Cape Verde:		15	14.5N - 17.5N	To
Ethiopia:	Rift Valley	64	6.5N - 8.5N	Xh
Ethiopia:	Mid. Alt. Hararghe	20	8.0N - 9.0N	Bd, Be
S. Africa:	Transkei	70	25.0S - 27.0S	Lc, Vc
	Natel	17	30.0S - 33.0S	Lc
Zimbabwe:	Mid-veld fringes	3	16.5S - 20.0S	Lf
AFBE 10: Sub-humid areas at mid-altitude on acid soils at mid-latitudes 1000-1500 masl; >400 mm available moisture; soil pH <5.5; unimodal/PP+				
Zambia:	Northeast	11	8.5S - 10.5S	Fo
Zaire:	Kasai	70	6.0S - 11.0S	Fx, Fo
AFBE 11: Semi-arid areas at mid-altitudes on acid soils at mid-latitudes 1000-1500 masl; <400 mm available moisture; soil pH <5.5; unimodal/PP+				
Madagascar:	following rice	10	17.5S - 21.0S	Je
Zambia:	N.C. and N.W.	8	12.0S - 15.0S	Fr
Swaziland:	High and mid veld	2	26.0S - 27.0S	Ne, Lc, Fr

Table 1, continued.

Major bean producing area		Area ('000 ha)	Latitude range	Major soil types (FAO)[1]
AFBE 12: Lowlands at mid-latitudes <1000 masl; unimodal/PP+				
Eygpt:	Nile Delta	20	30.0N - 32.0N	Jc
Madagascar:	Toliary	8	20.0S - 25.5S	Bk, Qc
	Mahajanga	5	15.5S - 16.5S	Qc, Bk
Malawi:	C. (r. m.[4])	10	13.0S - 14.5S	Nd, Bc
Mauritius:	(irrigated)	20	20.0S - 20.5S	Ne
Morocco:	North	7	34.0N - 36.0N	Lc
Mozambique:	S. (r. m.)	20	25.0S - 26.5S	Bc
Sudan:	N. (irrigated)	20	16.7N - 18.0N	Jc
Tunisia:	North	3	36.0N - 37.0N	Bk
AFBE 13: Lowlands at low latitudes <1000 masl; bimodal/PPN)				
Burundi:	Imbo Plain	20	2.5S - 4.5S	Vp
Tanzania:	Morogoro	20	6.5S - 7.5S	Bh, Bc
Zaire:	Kinshasa (r.m.)	20	4.0S - 6.0S	Fo, Qf

[1] Codes for the major soil types are: Bc, Chromic Cambisol; Bd Dystric Camisol; Be Eutric Cambisol; Bh Humic Cambisol; Fh Humic Ferralsol; Fo Orthic Ferralsol; Fr Rhodic Ferralsol; Jc Calcaric Fluvisol; Je Eutric Fluvisol; Lc Chromic Luvisol; Lf Ferric Luvisol; Nd Dystric Nitosol; Ne Eutric Nitosol; Nh Humic Nitosol; Tm Mollic Andosol; Qc = Cambic Arenosl; Th Humic Andosol; To Ochric Andosol; Vp Pellic Vertisol; We Eutric Planosol. Source: FAO, 1973.

[2] masl indicates meters above sea level. PPN and PP+ indicate probable importance of photoperiod sensitivity in the AFBE with PPN indicating neutral conditions and PP+ indicating probable photoperiod effects.

[3] According to Enquetes et Statistiques Agricoles, Togo (1984), Togo may have a much larger area of bean production than indicated here.

[4] r.m. indicates production dependent on use of residual moisture.

Table 2. Characteristics of bean cropping systems in the major bean producing areas in Africa.

Major bean production areas		Major bean cropping systems[1]	Sowing times	Crops/ year	Intensity of bean production[2]	Input use level[2]
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude						
Burundi:	Central plateau	BAN, TUB, SC	Mar, Oct	2	VH	M
Ethiopia:	Awassa/N. Sindamo	MZ, SC, MZr	Feb, Jul	2	M	M
Kenya:	Central Highlands	MZ	Mar, Sep	2	H	M
	Western Highlands	MZ	Mar, Sep	2	H	M
Rwanda:	Central plateau	BAN, TUB, SC	Mar, Sep	2	VH	L
	Northwest	BAN, TUB, SC	Apr, Oct	2	VH	L
Tanzania:	Northern Highlands	MZ, BAN	Mar, Oct	2	H	M
Uganda:	Southwest Highlands	SOR, SC, SP	Apr, Oct	2	H	L
	Mt. Elgon	MZ, SC, BAN	Mar, Aug	2	VH	L
AFBE 2: Sub-humid highlands on acid soils at low latitudes						
Burundi:	Zaire-Nile Crest	BAN, SC	Mar, Oct	2	H	M
Kenya:	Tea zone	MZ	Mar, Sep	2	M	M
Rwanda:	Zaire-Nile Crest	BAN, SC	Mar, Sep	2	H	L
Tanzania:	Usambara & Uluguru	MZ, BAN, SC	Mar, Oct	2	M	M
Zaire:	South Kivu	BAN, SC	Mar, Oct	2	H	L
AFBE 3: Sub-humid highlands at mid-latitudes						
Ethiopia:	Hararghe Highlands	SOR, MZ, SC	Mar, Jun	2	H	L
	Western	MZ, SC	Mar, Jul	2	L	L
Malawi:	Misuku Hills, South	MZ, SC, COF	Dec	1	H	L
Mozambique:	Lichinga (North)	MZ, MZr	Dec	1	M	L
	Tete	MZ	Dec	1	M	L
	Western highlands	MZ	Dec	1	M	L
Tanzania:	S. Highlands	MZ, SC, TUB	Dec, Apr	2	M	L
Zimbabwe:	Highveld	SC	Jan	1	L	M
Cameroon:	Western	MZ, SC	Mar, Jul	2	M	M
Guinea:	Guinea	MZ, SC	Apr	1		
Nigeria:	Kano	SC				
	Jos Plateau	SC				
AFBE 4: Sub-humid highlands on acid soils at higher latitudes						
Angola:	Central Highlands	MZ, SC	Nov	1	M	L
Madagascar:	Antsirabe	MZ, MzR	Oct, Feb	2	L	
Malawi:	North (Rumphi)	MZ, SC	Dec	1	M	L
AFBE 5: Semi-arid highlands on acid soils at higher latitudes						
Lesotho:	Lowlands/foothills	SC	Oct	1	L	M
AFBE 6: Sub-humid areas at mid-altitude and low latitude						
Burundi:	Messo-Bugesera	TUB, MZ, BAN	Mar, Sep	2	H	M
Kenya:	Nyanza	MZ	Mar, Sep	2	H	M
Tanzania:	Kagera	BAN, MZ	Mar, Sep	2	H	L
	Northern highlands	MZ, BAN, SC	Mar, Sep	2	M	M
	West (Kigoma)	MZ	Mar, Oct	2	M	L
Uganda:	Short grass zone	SC, MZ, TUB	Mar, Aug	2	L	L
	Tall grass zone	MZ, SC, TUB	Mar, Sep	2	M	L
Zaire:	N.E.	TUB, MZ, BAN	Mar, Sep	2	H	L

Table 2 continued.

Major bean producing area		Major cropping systems	Sowing times	Crops/ year	Intensity of bean production	Input use level
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes						
Malawi:	Central Plateau	MZ	Dec	1	M	M
Sudan:	South	SOR, MIL	Mar, Aug	2	M	L
Zaire:	Shaba Region	MZ, SC	Nov	1	M	L
Zambia:	East	MZ	Jan	1	L	M
Zimbabwe:	Mid-veld	MZ, SC	Dec	1	L	M
Togo:	Atakpame					
AFBE 8: Semi-arid areas at mid-altitude and low latitude						
Kenya:	Eastern	MZ	Oct, Mar	2	M	L
	Other semi-arid	MZ, SC	Oct, Mar	2	L	L
Rwanda:	Eastern	BAN, TUB, SC	Mar, Sep	2	H	L
Tanzania:	N. fringe areas	MZ, SC	Oct, Apr	2	L	L
AFBE 9: Semi-arid areas at mid-altitude and mid-latitudes						
Angola:	Fringes	SC	Dec	1	L	L
Cape Verde:		MZ	Aug	1	M	L
Ethiopia:	Rift Valley	SC, MZ	Jun	1	L	M
Ethiopia:	Mid. Alt. Hararghe	SOR, MZ	Jul, Dec	2	H	L
S. Africa:	Transkei	SC	Dec	1	M	H
	Natal	SC	Dec	1	M	H
Zimbabwe:	Mid-veld fringes	SC	Nov	1	L	M
AFBE 10: Sub-humid areas at mid-altitude on acid soils at mid-latitudes						
Madagascar:	Central	MZ, SC, TUB	Nov, Feb	2	L	L
Zambia:	Northeast	TUB, MIL, MZ	Dec, Mar	2	L	M
Zaire:	Kasai	SC, TUB, MZ	Mar, Oct	2	M	L
AFBE 11. Semi-arid areas at mid-altitude on acid soils at mid-latitudes						
Madagascar:	following rice	SC	Jun	1	L	M
Zambia:	N.C. and N.W.	SC, MZ	Dec	1	L	L
Swaziland:	High and mid veld	SC, MZ	Jan	1	L	M
AFBE 12: Lowlands at mid-latitudes						
Eygpt:	Nile delta	SC	Mar, Oct	2	L	H
Madagascar:	Toliary	SC	Apr	1	L	L
	Mahajanga	SC	May, Nov	2	L	L
Malawi:	C. (r. m.)	SC	Jun	1	L	M
Mauritius:	(irrigated)	SC	Jun	1	L	H
Morocco:	North	SC	Mar, Oct	2	L	M
Mozambique:	S. (r. m.)	SC	Jun	1	L	L
Sudan:	N. (irrigated)	SC	Sep	1	H	H
Tunisia:	North	SC	Mar	1	L	M

Table 2, continued.

Major bean producing area		Major cropping systems	Sowing times	Crops/ year	Intensity of bean production	Input use level
AFBE 13: Lowlands at low latitudes						
Burundi:	Imbo Plain	SC, BAN, TUB	Mar, Oct	2	M	M
Tanzania:	Morogoro	MZ, SC	Mar, Oct	2	L	M
Zaire:	Kinshasa (r.m.)	SC	May	1	M	M

[1] BAN, MZ, MIL, SOR, SP and TUB indicate intercropping with banana, maize, millet, sorghum, sweet potato and tuber crops, respectively. MZr indicates relay intercropping with maize. SC indicates sole crop bean production.

[2] Intensity of bean production and level of input use are qualitatively rated as very high (VH), high (H), moderate (M) and low (L). Intensity of production refers to the economic importance of beans in the systems. Input use intensity refers to the amount of purchased inputs used.

Table 3. Producer/consumer preferences in the major bean growing areas of Africa.

Major bean production areas		Seed color[1]	Seed size[2]	Growth habit[3, 4] I	II	IIIa	IIIb	IV
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude								
Burundi:	Central plateau	Y	>25	H	H	L	L	M
Ethiopia:	Awassa/N. Sindamo	Y	>25	H	H	M	L	L
Kenya:	Central Highlands	Z	>25	H	H	L	L	L
	Western Highlands	Z	>25	H	H	L	L	L
Rwanda:	Central plateau	X	>25	M	M	L	M	M
	Northwest	Y	>25	M	M	L	M	H
Tanzania:	Northern Highlands	R,C,P	>30	H	H	M	L	L
Uganda:	Southwest Highlands	Y	>35	M	M	M	L	M
	Mt. Elgon	Y	>35	M	M	L	L	L
AFBE 2: Sub-humid highlands on acid soils at low latitude								
Burundi:	Zaire-Nile Crest	X	>20	M	M	L	L	L
Kenya:	Tea zone	Z	>30	H	M	L	L	L
Rwanda:	Zaire-Nile Crest	X	>20	M	M	M	M	M
Tanzania:	Usambara & Uluguru	Z	>30	H	H	L	L	L
Zaire:	South Kivu	Y	>25	M	M	L	H	M
AFBE 3: Sub-humid highlands at mid-latitudes								
Ethiopia:	Hararghe Highlands	X	>20	H	H	M	L	L
	Western	Y	>25	H	H	M	L	M
Malawi:	Misuku Hills, South	Y	>20	M	M	M	M	L
Mozambique:	Lichinga (North)	Y	>25	H	H	M	L	L
	Tete	Y	>25	H	H	M	L	L
	Western Highlands	Y	>25	H	H	M	L	L
Tanzania:	Southern Highlands	Y	>20	H	H	M	L	L
Zimbabwe:	Highveld	R,C,W	>30	H	H	L	L	L
Cameroon:	Western	X	>25	M	M	M	L	L
Guinea:	Guinea							
Nigeria:	Kano							
	Jos Plateau							
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes								
Angola:	Central Highlands	Y	>20	H	H	M	L	L
Madagascar:	Antsirabe	Y	>35	M	M	M	M	L
Malawi:	North (Rumphi)	Y	>20	M	M	M	L	L
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes								
Lesotho:	Lowlands/foothills	R,W,Pi	>25	H	H	M	L	L
AFBE 6: Sub-humid areas at mid-altitude and low latitude								
Burundi:	Moso-Bugesera	Y	>25	H	H	M	L	L
Kenya:	Nyanza	Z	>30	H	H	M	L	L
Tanzania:	Kagera	Y	>20	H	H	L	L	L
	Northern mid-alt.	R,C	>30	H	H	L	L	L
	West (Kigoma)	W,Yel	>20	M	M	M	L	L
Uganda:	Short grass zone	Z	>20	M	M	M	L	L
	Tall grass zone	Y	>30	H	H	M	L	L
Zaire:	N.E.	Y	>25	M	M	M	L	L

Table 3, continued.

Major bean production areas		Seed color[1]	Seed size[2]	Growth habit[3, 4] I	II	IIIa	IIIb	IV
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes								
Malawi:	Central Plateau	Y	>30	H	H	L	L	L
Sudan:	South	Z	>20	H	H	H	L	L
Zaire:	Shaba Region	Y	>25	H	H	M	L	L
Zambia:	East	Y	>25	H	H	M	L	L
Zimbabwe:	Mid-veld	R,C,W	>30	H	H	M	L	L
Togo:	Atakpame							
AFBE 8: Semi-arid areas at mid-altitude and low latitude								
Kenya:	Eastern	Z	>25	H	M	L	L	L
	Other semi-arid	Z	>25	H	M	L	L	L
Rwanda:	Eastern	Y	>25	M	M	M	M	M
Tanzania:	N. fringe areas	Y	>25	H	M	L	L	L
AFBE 9: Semi-arid areas at mid-altitude and mid-latitudes								
Angola:	Fringes	Y	>20	M	M	M	L	L
Cape Verde:		R, Yel						
Ethiopia:	Rift Valley	W	>20	H	H	M	L	L
Ethiopia:	Mid. Alt. Hararghe	X	>25	M	M	M	L	L
S. Africa:	Transkei	W,Pi	>25	H	H	M	L	L
	Natal	W,Pi	>25	H	H	M	L	L
Zimbabwe:	Mid-veld fringes	R,C,W	>30	H	H	M	L	L
AFBE 10: Sub-humid areas at mid-altitude on acid soils at mid-latitudes								
Madagascar:	Central	Y	>30	M	M	M	L	L
Zambia:	Northeast	Y	>25	H	H	M	L	L
Zaire:	Kasai	Y	>25	H	H	M	L	L
AFBE 11: Semi-arid areas at mid-altitudes on acid soils at mid-latitudes								
Madagascar:	following rice	Z	>30	H	H	L	L	L
Zambia:	N.C. and N.W.	Y	>25	H	H	M	L	L
Swaziland:	High and mid veld	Y	>30	H	H	M	L	L
AFBE 12: Lowlands at mid-latitudes								
Eygpt:	Nile Delta	W	>30	H	H	L	L	L
Madagascar:	Toliary	C	>35	M	M	M	L	L
	Mahajanga	C	>35	M	M	M	L	L
Malawi:	C. (r. m.)	R	>30	H	H	L	L	L
Mauritius:	(irrigated)		>30	H	H	L	L	L
Morocco:	North	W,R	>30	H	H	L	L	L
Mozambique:	S. (r. m.)	Y	>25	H	M	M	L	L
Sudan:	N. (irrigated)	W,R	>30	H	H	L	L	L
Tunisia:	North	W,R	>30	H	H	L	L	L

Table 3, continued.

Major bean production areas		Seed color[1]	Seed size[2]	Growth habit[3, 4] I	II	IIIa	IIIb	IV
AFBE 13: Lowlands at low latitude								
Burundi:	Imbo Plain	Y	>25	H	H	M	L	L
Tanzania:	Morogoro	Y	>25	H	H	L	L	L
Zaire:	Kinshasa (r.m.)	Y	>25	H	H	M	L	L

[1] Key to seed colors: R = red, C = Calima (Rosecoco), P = purple, W = white, B = brown, Pi = Pinto, Yel = yellow, X = a non-exclusive range of colors, Y = a range of colors except black, Z = a range of colors except black and white.

[2] Seed size in grams per 100 seeds.

[3] Code to growth habits: I = determinate, bush; II = indeterminate, bush; IIIa = indeterminate trailing; IIIb = semi-climbing; IV = climbing.

[4] Levels of preference are high (H), moderate (M) and low (L).

Table 4. Socio-economic characteristics of the main bean production areas of Africa.

Major bean producing area		Population[1,2] density	Woman's responsibility for bean crop (%)	Consumption importance: Fresh bean seed	Consumption importance: Bean leaves
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude					
Burundi:	Central Plateau	7/8	90	H	H
Ethiopia:	Awassa/N. Sindamo	5	50	L	L
Kenya:	Central Highlands	7/8	80	M	L
	Western Highlands	7/8	80	M	L
Rwanda:	Central plateau	8	90	H	H
	Northwest	8	90	H	H
Tanzania:	Northern Highlands	7	80	M	L
Uganda:	Southwest Highlands	7	95	H	M
	Mt. Elgon	7	90	H	L
AFBE 2: Sub-humid highlands on acid soils at low latitudes					
Burundi:	Zaire-Nile Crest	6	90	H	H
Kenya:	Tea zone	6	80	L	L
Rwanda:	Zaire-Nile Crest	7	90	H	H
Tanzania:	Usambara & Uluguru	6/7	80	M	L
Zaire:	South Kivu	5	85	H	H
AFBE 3: Sub-humid highlands at mid-latitudes					
Ethiopia:	Hararghe highlands	4	30	L	L
	Western	4	30	L	L
Malawi:	Misuku Hills, South	6	80	M	H
Mozambique:	Lichinga (North)	3	80	M	L
	Tete	4	80	M	L
	Western highlands	3	80	M	L
Tanzania:	Southern Highlands	5	80	L	L
Zimbabwe:	Highveld	4	40	L	L
Cameroon:	Western	7			
Guinea:	Guinea	5			
Nigeria:	Kano	7			
	Jos Plateau				
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes					
Angola:	Central Highlands	4/5	80	M	L
Madagascar:	Antsirabe	6	80	M	L
Malawi:	North (Rumphi)	5	80	M	L
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes					
Lesotho:	Lowlands/foothills	5	70	L	L
AFBE 6: Sub-humid areas at mid-altitude and low latitude					
Burundi:	Moso-Bugesera	8	90	H	H
Kenya:	Nyanza	5	80	M	L
Tanzania:	Kagera	4/6	85	M	L
	Northern mid-alt.	3/4	60	L	L
	West (Kigoma)	4/5	85	M	L

Table 4, continued.

Major bean producing area		Population density	Woman's responsibility for bean crop (%)	Consumption importance: Fresh bean seed	Consumption importance: Bean leaves
Uganda:	Short grass zone	5	80	H	L
	Tall grass zone	6	80	H	L
Zaire:	N.E.	4	80	H	L
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes					
Malawi:	Central Plateau	6	90	H	H
Sudan:	South	2/4	80	M	L
Zaire:	Shaba Region	3	90	M	L
Zambia:	East	3	80	L	L
Zimbabwe:	Mid-veld	4	60	L	L
Togo:	Atakpame	4			
AFBE 8: Semi-arid areas at mid-altitude and low latitude					
Kenya:	Eastern	4	80	M	L
	Other semi-arid	3	80	M	L
Rwanda:	Eastern	7	85	H	H
Tanzania:	N. fringe areas	3	80	M	L
Other fringe areas of AFBE 6		3	80	M	L
AFBE 9: Semi-arid areas at mid-altitude and mid-latitude					
Angola:	Fringes	4	80	L	L
Cape Verde:					
Ethiopia:	Rift Valley	5	30	L	L
Ethiopia:	Mid. Alt. Hararghe	3	30	L	L
S. Africa:	Transkei	4	30	L	L
	Natal	4	30	L	L
Zimbabwe:	Mid-veld fringes	4	50	L	L
AFBE 10: Sub-humid areas at mid-altitude on acid soils at mid-latitude					
Madagascar:	Central	5	80	M	L
Zambia:	Northeast	2	80	L	L
Zaire:	Kasai	3	85	L	L
AFBE 11: Semi-arid areas at mid-altitude on acid soils at mid-latitudes					
Madagascar:	following rice	5	80	L	L
Zambia:	N.C. and N.W.	2/4	85	M	L
Swaziland:	High and mid veld	5	80	L	L
AFBE 12: Lowlands at mid-latitudes					
Eygpt:	Nile Delta	5	30	L	L
Madagascar:	Toliary	4	80	L	L
	Mahajanga	4	80	L	L
Malawi:	C. (r. m.)	6	80	L	L
Mauritius:	(irrigated)	6	50	L	L
Morocco:	North	4	30	L	L
Mozambique:	S. (r. m.)	4	80	L	L
Sudan:	N. (irrigated)	4	50	L	L
Tunisia:	North	4	30	L	L

Table 4, continued.

Major bean producing area		Population density	Woman's responsibility for bean crop (%)	Consumption importance: Fresh bean seed	Consumption importance: Bean leaves
AFBE 13: Lowlands at low latitude					
Burundi:	Imbo Plain	6	90	H	H
Tanzania:	Morogoro	4	60	M	L
Zaire:	Kinshasa (r.m.)	5/7	70	L	L

[1] Key to estimated population densities in persons Km^2: 1 = <1; 2 = 1 - <5; 3 = 5 - <10; 4 = 10 - <25; 5 = 25 - <50; 6 = 50 - <100; 7 = 100 - < 250; 8 = 250 - <500.

[2] Source: Carter et al., 1992.

Table 5. Relative importance[1] of bean fungal diseases of foliage and pods in the main bean production areas of Africa.

Major bean producing area		ALS[2]	Rust	ANT	ASC	WB	FLS	WM	Scab
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude									
Burundi:	Central plateau	H	L	H	M	L	L	L	A
Ethiopia:	Awassa/N. Sindamo	M	H	H	L	L	M	L	A
Kenya:	Central Highlands	H	M	H	L	A	L	L	L
	Western Highlands	H	M	H	L	A	L	L	L
Rwanda:	Central plateau	H	L	H	H	A	L	L	A
	Northwest	H	L	H	M	L	L	L	L
Tanzania:	Northern Highlands	H	M	H	H	L	M	H	L
Uganda:	Southwest Highlands	H	M	H	H	L	M	A	L
	Mt. Elgon	H	L	H	M	L	L	A	L
AFBE 2: Sub-humid highlands on acid soils at low latitude									
Burundi:	Zaire-Nile Crest	H	L	H	L	L	L	L	A
Kenya:	Tea zone	M	L	H	M	A	L	L	L
Rwanda:	Zaire-Nile Crest	H	L	H	M	A	L	L	A
Tanzania:	Usambara & Uluguru	H	M	H	M	L	L	L	L
Zaire:	South Kivu	H	L	H	L	L	L	A	A
AFBE 3: Sub-humid highlands at mid-latitudes									
Ethiopia:	Hararghe highlands	M	H	M	M	L	L	L	A
	Western	M	M	M	M	M	L	L	A
Malawi:	Misuku Hills, South	H	M	M	M	M	L	A	L
Mozambique:	Lichinga (North)	H	H	M	L	L	L	A	L
	Tete	H	H	M	L	L	L	A	L
	Western highlands	H	H	M	L	L	L	A	L
Tanzania:	S. Highlands	M	L	M	M	L	L	L	L
Zimbabwe:	Highveld	H	H	H	A	A	A	L	L
Cameroon:	Western	H	H	M	L		M		
Guinea:	Guinea								
Nigeria:	Kano								
	Jos Plateau								
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes									
Angola:	Central Highlands	M	L	H	L	A	A	A	A
Madagascar:	Antsirabe	M	M	M	M	L	L	A	A
Malawi:	North (Rumphi)	H	H	H	M	L	L	A	L
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes									
Lesotho	Lowland/foothills	A	M	A	A	A	A	A	A
AFBE 6: Sub-humid areas at mid-altitude and low latitude									
Burundi:	Moso-Bugesera	H	L	M	M	L	M	L	A
Kenya:	Nyanza	H	M	H	L	A	M	M	L
Tanzania:	Kagera	H	M	M	L	L	M	L	L
	Northern mid-alt.	H	H	M	L	L	M	M	L
	West (Kigoma)	H	M	M	L	L	M	L	L
Uganda:	Short grass zone	H	L	L	L	L	L	A	L
	Tall grass zone	H	M	L	L	L	L	A	L
Zaire:	N.E.	H	M	H	L	L	M	A	A

Table 5, continued.

Major bean producing area		ALS[2]	Rust	ANT	ASC	WB	FLS	WM	Scab
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes									
Malawi:	Central Plateau	H	H	M	L	M	M	A	L
Sudan:	South	H	M	A	L	A	A	A	A
Zaire:	Shaba Region	L	L	L	L	L	L	A	A
Zambia:	East	H	M	L	L	L	L	A	L
Zimbabwe:	Mid-veld	M	L	L	A	A	A	L	L
Togo:	Atakpame	M	M	L	A	H	A	A	A
AFBE 8: Semi-arid areas at mid-altitude and low latitude									
Kenya:	Eastern	M	M	M	L	A	L	L	L
	Other semi-arid	M	M	M	L	A	L	L	L
Rwanda:	Eastern	H	M	H	L	A	M	M	A
Tanzania:	N. fringe areas	H	M	M	L	L	L	L	L
AFBE 9: Semi-arid areas at mid-altitude and mid-latitudes									
Angola:	Fringes	M	L	H	L	A	A	A	A
Cape Verde:									
Ethiopia:	Rift Valley	M	H	M	L	L	L	L	A
Ethiopia:	Mid. Alt. Hararghe	M	H	M	L	L	M	L	A
S. Africa:	Transkei	L	M	L	L	A	A	L	L
	Natal	M	M	L	M	A	A	L	M
Zimbabwe:	Mid-veld fringes	L	L	L	A	A	A	L	L
AFBE 10: Sub-humid areas at mid-altitude on acid soils at mid-latitudes									
Madagascar:	Central	H	H	M	L	L	A	A	A
Zambia:	Northeast	M	M	M	H	L	L	A	H
Zaire:	Kasai	L	L	L	L	L	L	A	A
AFBE 11: Semi-arid areas at mid-altitudes on acid soils at mid-latitudes									
Madagascar:	following rice	M	M	M	L	L	A	A	A
Zambia:	N.C. and N.W.	M	M	L	L	L	L	A	L
Swaziland:	High and mid-veld	L	M	A	A	A	A	A	A
AFBE 12: Lowlands at mid-latitudes									
Eygpt:	Nile Delta	?	L	?	?	?	?	?	?
Madagascar:	Toliary	L	M	L	A	A	A	A	A
	Mahajanga	L	M	L	A	A	A	A	A
Malawi:	C. (r. m.)	L	L	L	L	L	L	A	L
Mauritius:	(irrigated)	L	H	L	A	A	A	L	A
Morocco:	North	?	L	?	?	?	?	?	?
Mozambique:	S. (r. m.)	L	L	L	L	L	L	L	L
Sudan:	N. (irrigated)	L	L	A	L	A	A	A	A
Tunisia:	North	L	M	L	?	?	?	?	?

Table 5, continued.

Major bean producing area		ALS[2]	Rust	ANT	ASC	WB	FLS	WM	Scab
AFBE 13: Lowlands at low latitudes									
Burundi:	Imbo Plain	H	M	L	L	M	L	L	A
Tanzania:	Morogoro	M	M	L	L	L	L	L	L
Zaire:	Kinshasa (r.m.)	L	L	L	L	L	L	L	L

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss. A = absent or not reported.

[2] ALS = angular leaf spot caused by *Phaeoisariopsis griseola*; ANT = anthracnose caused by *Colletotrichum lindemuthianum*; rust is caused by *Uromyces appendiculatus*; ASCO = ascochyta blight caused by *Phoma exigua* var. *diversispora* and/or *Ascochyta phaseolorum*; WB = web blight caused by *Thanatephorus cucumeris* or in the imperfect state by *Rhizoctonia solani*; FLS = floury leaf spot caused by *Mycovellosiella phaseoli*; WM = white mold caused by *Sclerotinia sclerotiorum*; and scab is caused by *Sphaceloma* state of *Elsinoe phaseoli*.

[3] Sources: Buruchara, 1993; Allen (in prep.).

Table 6. Relative importance[1] of various bean fungal, bacteria and viral diseases in the main bean production areas of Africa.

Major bean producing area		Charcoal[2] rot	Root rots	Fusarium wilt	CBB	Halo blight	BCMV
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude							
Burundi:	Central Plateau	L	H	L	L	M	M
Ethiopia:	Awassa/N. Sindamo	A	L	A	H	L	L
Kenya:	Central Highlands	L	M	A	L	H	H
	Western Highlands	L	M	A	L	H	H
Rwanda:	Central plateau	L	H	H	L	M	M
	Northwest	L	L	L	L	M	L
Tanzania:	Northern Highlands	L	L	A	L	H	M
Uganda:	Southwest Highlands	L	L	A	L	M	M
	Mt. Elgon	L	L	A	L	M	M
AFBE 2: Sub-humid highlands on acid soils at low latitude							
Burundi:	Zaire-Nile Crest	L	H	L	L	L	L
Kenya:	Tea zone	L	L	A	L	H	H
Rwanda:	Zaire-Nile Crest	M	H	H	L	L	L
Tanzania:	Usambara & Uluguru	L	L	A	M	L	M
Zaire:	South Kivu	A	L	A	M	M	L
AFBE 3: Sub-humid highlands at higher latitudes							
Ethiopia:	Hararghe Highlands	A	L	A	M	L	L
	Western	A	L	A	M	L	L
Malawi:	Misuku Hills, South	A	L	A	M	H	L
Mozambique:	Lichinga (North)	A	L	A	M	M	L
	Tete	A	L	A	M	M	L
	Western highlands	A	L	A	L	M	L
Tanzania:	Southern Highlands	L	L	A	L	H	L
Zimbabwe:	High-veld	L	L	?	L	M	L
Cameroon:	Western						
Guinea:	Guinea						
Nigeria:	Kano						
	Jos Plateau						
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes							
Angola:	Central Highlands	A	L	A	L	L	L
Madagascar:	Antsirabe	A	L	L	L	L	L
Malawi:	North	A	M	A	M	M	M
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes							
Lesotho:	Lowlands/foothills	L	L	L	H	H	L
AFBE 6: Sub-humid areas at mid-altitude and low latitude							
Burundi:	Messo-Bugesera	L	M	L	H	L	H
Kenya:	Nyanza	M	M	A	H	L	H
Tanzania:	Kagera	L	L	?	M	L	M
	Northern highlands	L	L	?	M	L	M
	West	L	L	?	M	L	M
Uganda:	Short grass zone	L	L	A	H	L	M
	Tall grass zone	L	L	A	H	L	M
Zaire:	Northeast	A	L	A	H	L	L

Table 6, continued.

Major bean producing area		Charcoal[2] rot	Root rots	Fusarium wilt	CBB	Halo blight	BCMV
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes							
Malawi:	Central plateau	A	L	A	H	L	M
Sudan:	South	L	A	?	H	L	L
Togo:	Atakpame	L	A	A	A	A	H
Zaire:	Shaba Region	L	M	A	?	L	?
Zambia:	East	L	L	A	H	L	M
Zimbabwe:	Mid-veld	L	L	?	H		
AFBE 8: Semi-arid areas at mid-altitude and low latitude							
Kenya:	Eastern	H	L	A	M	L	H
	Other semi-arid	H	L	A	M	L	H
Rwanda:	Eastern	L	M	M	H	L	L
Tanzania:	N. fringe areas	L	L	?	H	L	M
Other fringe areas of AFRB 6		L	L	?			
AFBE 9: Semi-arid areas at mid-altitude and mid-latitudes							
Angola:	Fringes	A	L	A			
Cape Verde:							
Ethiopia:	Rift Valley	A	L	A	H	L	L
	Mid. Alt. Hararghe	A	L	A	H	L	L
S. Africa:	Transkei	A	L	L			
	Natal	A	L	L			
Zimbabwe:	Mid-veld fringes	L	L	L			
AFBE 10. Sub-humid areas at mid-altitude on acid soils at mid-latitudes							
Madagascar:	Central	A	M	L	M	L	L
Zambia:	Northeast	L	L	A	M	L	L
Zaire:	Kasai	A	L	A		L	
AFBE 11: Semi-arid areas at mid-altitudes on acid soils at mid-latitudes							
Madagascar:	following rice	A	M	L	L	L	L
Zambia:	N.C. and N.W.	L	L	A	M	L	L
Swaziland:	High and mid-veld	L	A	A			
AFBE 12: Lowlands at mid-latitudes							
Eygpt:	Nile Delta	M	L	?	L	?	M
Madagascar:	Toliary	A	A	A	L	A	A
	Mahajanga	A	A	A	L	A	A
Malawi:	C. (r. m.)	A	L	A	L	L	L
Mauritius:	(irrigated)	L	L	A	L	L	L
Morocco:	North	?	?	?	?	?	M
Mozambique:	S. (r. m.)	L	L	A	L	L	L
Sudan:	N. (irrigated)	M	L	A	L	L	L
Tunisia:	North	?	?	?	?	?	M

Table 6, continued.

Major bean producing area		Charcoal[2] rot	Root rots	Fusarium wilt	CBB	Halo blight	BCMV
AFBE 13: Lowlands at low latitudes							
Burundi:	Imbo Plain	M	L	L	M	L	L
Tanzania:	Morogoro	L	L	?	L	L	L
Zaire:	Kinshasa (r.m.)	A	L	A	L	L	L

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg h loss. A = absent or not reported.

[2] Charcoal rot is caused by *Macrophomina phaseolina*; the root rots refer to a compl of root and stem rots consisting primarily of those caused by *Phythium* spp., *Rhizocton solani*, and *Fusarium solani*; Fusarium wilt or vascular wilt is caused by *Fusari oxysporum*; CBB = common bacterial blight caused by *Xanthomonas campestris* pv. *phaseol* halo blight is caused by *Pseudomonas syringae* pv. *phaseolicola* and pv. *syringae*; a BCMV = bean common mosaic virus.

[3] Sources: Buruchara, 1993; Allen (in prep.).

Table 7. The geographic distribution[1] of races of *Pseudomonas syringae* pv. *phaseolicola* in Africa.

Country	Races on *Phaseolus vulgaris*									Additional races on other hosts			
Burundi			3	4									
Ethiopia				4		6				2		7	
Kenya				4		6	7						
Lesotho	1	2				6		8					
Madagascar										1			
Malawi		2			5				9				
Mauritius		2											
Rwanda	1	2		4									
Swaziland						6							
Tanzania		2	3	4	5	6						7	8
Uganda			3	4									
Zaire						6							
Zambia		2	3	4									
Zimbabwe		2				6						7	

[1] Only includes countries where halo blight races have been positively identified.

[2] Source: Teverson, 1991.

Table 8. The geographic distribution[1] of the pathogenicity groups[2] comprising bean common mosaic virus in Africa[3].

Country	Pathogenicity groups				
Burundi	1	3	4b	5a	6a
Ethiopia	1		4b		
Kenya				5a	6a
Lesotho					6a
Malawi			4b		6a
Rwanda		3	4b		6a
South Africa				5	
Tanzania	1	3	4b		6a
Uganda	1		4b		6a
Zaire		3			6a
Zambia			4b		6a
Zimbabwe	1		4a 4b		6a

[1] Only includes countries from where BCMV strains have been positively identified.

[2] Strains representative of pathogenicity groups: NL1 1; NL7 2; NL8 3; Florida 4a; NL6 4b; NY15 5a; NL2 5b; NL3 6a; NL5 6b; and NL4 7. Serotype A consists of temperature independent necrosis inducing strains belonging to pathogenicity groups 3, 6a and 6b. B serotypes belong to pathogenicity groups 1, 2, 4a, 5a and 7 which do not induce necrosis, and groups 4b and 5b which may induce necrosis at high temperatures.

[3] Sources: Edington and Whitlock, 1988; Mukoko, 1992; Spence and Walkey, 1991; Spence, 1992.

Table 9. Relative importance[1] of insect pests of beans in the major bean producing areas of Africa.

Major bean producing area		Aphids[2]	BSM	Thrip	Heli.	Maruca	Ooth.	Bru.	Cla.
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude									
Burundi:	Central Plateau	M	H	L	L	M	M	M	L
Ethiopia:	Awassa/N. Sindamo	L	M	M	L	L	L	M	L
Kenya:	Central Highlands	H	H	L	M	L	L	M	M
	Western Highlands	H	H	L	M	L	L	M	M
Rwanda:	Central Plateau	M	M	L	M	L	L	M	L
	Northwest	M	M	L	M	L	L	M	L
Tanzania:	Northern Highlands	M	H	L	M	M	H	M	L
Uganda:	Southwest Highlands	H	M	L	L	L	L	M	L
	Mt. Elgon	H	M	L	L	L	L	M	L
AFBE 2: Sub-humid highlands on acid soils at low latitude									
Burundi:	Zaire-Nile Crest	M	H	L	L	M	M	M	L
Kenya:	Tea zone	L	H	L	M	L	L	M	L
Rwanda:	Zaire-Nile Crest	M	H	L	L	L	L	M	L
Tanzania:	Usambara & Uluguru	M	L	L	M	M	H	M	L
Zaire:	South Kivu	M	M	L	L	L	L	M	L
AFBE 3: Sub-humid highlands at mid-latitudes									
Ethiopia:	Hararghe Highlands	L	H	L	L	L	L	M	L
	Western	L	M	L	L	L	L	M	L
Malawi:	Misuku Hills, South	M	M	L	L	M	M	M	M
Mozambique:	Lichinga (North)	L	H	L	M	L	L	M	L
	Tete	L	H	L	M	L	L	M	L
	Western highlands	L	H	L	M	L	L	M	L
Tanzania:	Southern Highlands	L	H	M	M	M	M	M	M
Zimbabwe:	High-veld	L	M	M	M	L	L	M	L
Cameroon:	Western	L	M	M			M	M	
Guinea:	Guinea								
Nigeria:	Kano								
	Jos Plateau								
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes									
Angola:	Central Highlands	L	M	L	L	L	L	M	L
Madagascar:	Antsirabe	M	L	L	H	L	L	M	L
Malawi:	North (Rumphi)	L	M	L	M	M	M	M	M
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes									
Lesotho	Lowlands/foothills	L	M	L	L	L	L	M	M
AFBE 6: Sub-humid areas at mid-altitude and low latitude									
Burundi:	Moso-Bugesera	M	H	L	L	M	M	H	M
Kenya:	Nyanza	M	H	M	M	L	L	M	M
Tanzania:	Kagera	M	M	L	L	L	L	M	L
	Northern mid-alt.	M	M	L	M	M	H	M	M
	West (Kigoma)	M	M	L	L	L	L	M	L
Uganda:	Short grass zone	L	M	L	L	L	L	M	L
	Tall grass zone	L	M	M	M	M	L	M	M
Zaire:	Northeast	L	M	L	L	L	L	M	L

Table 9, continued.

Major bean producing area		Aphid[2]	BSM	Thrip	Heli.	Maruca	Ooth.	Bru.	Cla.
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes									
Malawi:	Central Plateau	M	M	M	M	L	M	M	M
Sudan:	South	L	M	L	L	L	L	M	M
Zaire:	Shaba Region								
Zambia:	East	M	M	L	L	M	M	M	M
Zimbabwe:	Mid-veld	M	M	M	M	M	M	M	L
Togo:	Atakpame	M	M	M	M	M	M	M	M
AFBE 8: Semi-arid areas at mid-altitude and low latitude									
Kenya:	Eastern	H	H	L	L	L	L	M	L
	Other semi-arid	H	H	L	L	L	L	M	L
Rwanda:	Eastern	M	H	L	L	M	L	M	L
Tanzania:	N. fringe areas	M	M	L	M	L	H	M	M
AFBE 9: Semi-arid areas at mid-altitude and mid-latitudes									
Angola:	Fringes								
Cape Verde:									
Ethiopia:	Rift Valley	L	M	L	L	L	L	H	L
Ethiopia:	Mid-alt. Hararghe	L	H	L	L	L	L	H	L
S. Africa:	Transkei								
	Natal								
Zimbabwe:	Mid-veld fringes	M	M	L	M	L	L	M	L
AFBE 10 Sub-humid areas at mid-altitude on acid soils at mid-latitudes									
Madagascar:	Central	M	M	L	H	L	L	M	M
Zambia:	N. E.	H	H	L	L	L	L	M	M
Zaire:	Kasai	M	M	L	L	L	L	M	L
AFBE 11: Semi-arid areas at mid-altitudes on acid soils at mid-latitudes									
Madagascar:	following rice								
Zambia:	N.C. and N.W.	H	H	L	L	L	L	M	M
Swaziland:	High and mid-veld		M		M	L	L	M	L
AFBE 12: Lowlands at mid-latitudes									
Eygpt:	Nile Delta	M							
Madagascar:	Toliary	M							
	Mahajanga	L							
Malawi:	C. (r. m.)	M	M	L	L	M	M	M	M
Mauritius:	(irrigated)	M	L	H	L	L	L	M	L
Morocco:	North								
Mozambique:	S. (r. m.)	M	L	M	M	L	L	M	L
Sudan:	N. (irrigated)								
Tunisia:	North	M							

Table 9, continued.

Major bean producing area		Aphid[2]	BSM	Thrip	Heli.	Maruca	Ooth.	Bru.	Cla.
AFBE 13: Lowlands at low latitudes									
Burundi:	Imbo Plain	M	M	L	L	M	M	M	M
Tanzania:	Morogoro	M	M	L	M	M	H	M	M
Zaire:	Kinshasa (r.m.)								

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

[2] Aphid (*Aphis fabae*); BSM = bean stem maggot (*Ophiomyia* spp.); thrip = *Megalurothrips sjostedti*; Heli. = *Heliothis* complex; Maruca = *Maruca testulalis*; Ooth. = *Ootheca* spp.; Bru = bruchids including *Zabrotes subfasciatus* and *Acanthoscelides objectus*; and Cla. = *Clavigralla* spp. of pod bugs.

Table 10. Relative importance of edaphic stresses in the main bean production areas of Africa.

Major bean producing area		Low soil N	Low soil P	Low soil K	Low ex. bases	Al/Mn toxic.	FeP fix.	Water deficits E	M	L
AFBE 1: Sub-humid eastern Africa highlands of high potential at low latitude										
Burundi:	Central Plateau	H	H	L	L	M	M	L	L	L
Ethiopia:	Awassa/N. Sindamo	M	M	L	L	L	M	L	L	M
Kenya:	Central Highlands	H	H	L	M	L	M	L	M	M
	Western Highlands	H	H	L	M	L	M	L	L	L
Rwanda:	Central Plateau	H	H	L	L	M	M	L	L	L
	Northwest	M	M	L	M	M	H	L	L	L
Tanzania:	Northern Highlands	M	M	L	L	L	M	L	L	L
Uganda:	Southwest Highlands	M	M	L	L	L	M	L	L	L
	Mt. Elgon	M	M	L	L	L	M	L	L	L
AFBE 2: Sub-humid highlands on acid soils at low latitude										
Burundi:	Zaire-Nile Crest	H	H	M	M	H	H	L	L	L
Kenya:	Tea zone	M	H	M	H	H	H	L	L	L
Rwanda:	Zaire-Nile Crest	H	H	M	M	H	H	L	L	L
Tanzania:	Usambara & Uluguru	M	M	H	M	M	M	L	L	L
Zaire:	South Kivu	H	H	M	H	H	M	L	L	L
AFBE 3: Sub-humid highlands at mid-latitudes										
Ethiopia:	Hararghe Highlands	M	M	L	L	L	M	L	M	M
	Western	M	M	L	L	L	M	L	L	L
Malawi:	Misuku Hills, South	M	M	L/M	L	L	M	L	L	L
Mozambique:	Lichinga (North)	H	H	M	M	M	M	L	L	L
	Tete	M	M	L	L	L	L	L	L	M
	Western Highlands	H	H	M	M	M	M	L	L	M
Tanzania:	Southern Highlands	M	M	L	L	L	M	L	L	M
Zimbabwe:	High-veld	M	M	L	L	L	L	L	L	L
Cameroon:	Western	M	M	L	L	L	M	L	L	L
Guinea:	Guinea	M	M	L	L	L	L	L	L	L
Nigeria:	Kano (irrigated)	M	L	L	L	L	L	L	L	L
	Jos Plateau	M	M	L	L	L	L	L	L	L
AFBE 4: Sub-humid highlands on acid soils at mid-latitudes										
Angola:	Central Highlands	M	H	M	H	M	M	L	L	L
Madagascar:	Antsirabe	M	H	L	M	M	L	L	L	L
Malawi:	North (Rumphi)	H	H	M	M	M	M	L	L	M
AFBE 5: Semi-arid highlands on acid soils at mid-latitudes										
Lesotho:	Lowlands/foothills	H	M	M	M	M	L	M V	H ER	H T
AFBE 6: Sub-humid areas at mid-altitude and low latitude										
Burundi:	Moso-Bugesera	H	H	M	L	L	M	L	M	L
Kenya:	Nyanza	H	H	M	M	M	H	L	M	M
Tanzania:	Kagera	H	L	L	M	M	L	L	L	L
	Northern highlands	H	M	L	M	M	M	L	M	L
	West (Kigoma)	H	M	L	L	L	L	L	M	L

Table 10, continued.

Major bean producing area		Low soil N	Low soil P	Low soil K	Low ex. bases	Al/Mn toxic.	FeP fix.	Water deficits E	M	L
Uganda:	Short grass zone	M	M	M	M	M	M	M	H	M
	Tall grass zone	M	M	M	M	M	M	L	M	L
Zaire:	Northeast	M	M	M	M	M	M	L	M	L
AFBE 7: Sub-humid areas at mid-altitude and mid-latitudes										
Malawi:	Central Plateau	H	H	L	M	M	M	L	M	L
Sudan:	South	M	H	L	L	L	M	M	M	L
Zaire:	Shaba Region	M	H	M	M	M	H	L	L	L
Zambia:	East	H	H	L	L	L	M	L	L	L
Zimbabwe:	Mid-veld	M	M	L	L	L	L	L	H	M
Togo:	Atakpame	M	M	L	L	L	L	L	L	L
AFBE 8: Semi-arid areas at mid-altitude and low latitude										
Kenya:	Eastern	H	M	L	L	L	L	M	H	H
	Other semi-arid	M	M	L	L	L	L	M	H	H
Rwanda:	Eastern	H	M	M	L	M	M	M	H	H
Tanzania:	N. fringe areas	M	L	L	L	L	M	M	H	M
AFBE 9: Semi-arid areas at mid-altitude and mid-latitudes										
Angola:	Fringes	H	H	M	M	M	M	L	M	M
Cape Verde:										
Ethiopia:	Rift Valley	H	L	L	L	L	L	L	M	H
	Mid. Alt. Hararghe	M	M	L	L	L	L	L	M	M
S. Africa:	Transkei	H	H	L	L	L	L	L	M	L
	Natal	H	H	L	L	L	L	L	L	L
Zimbabwe:	Mid-veld fringes	H	H	L	L	L	M	L	H	H
AFBE 10: Sub-humid areas at mid-altitude on acid soils at mid-latitudes										
Madagascar:	Central	H	H	H	H	H	H	L	M	L
Zambia:	Northeast	H	H	M	H	H	M	L	L	L
Zaire:	Kasai	H	H	M	M	M	M	L	L	L
AFBE 11: Semi-arid areas at mid-altitudes on acid soils at mid-latitudes										
Madagascar:	following rice	M	M	L	L	H	M	L	M	H
Zambia:	N.C. and N.W.	M	M	M	M	M	H	L	M	H
Swaziland:	High and mid-veld	M	M	L	L	L	L	L	M	H
AFBE 12: Lowlands at mid-latitudes										
Egypt:	Nile delta	M	L	L	L	L	L	L	L	L
Madagascar:	Toliary	M	L	L	L	L	L	L	L	L
	Mahajanga	M	L	L	L	L	L	L	L	L
Malawi:	C. (r. m.)	H	M	L	L	L	M	L	M	H
Mauritius:	(irrigated)	H	M	L	L	M	L	L	L	L
Morocco:	North	M	L	L	L	L	L	L	M	M
Mozambique:	S. (r. m.)	M	L	L	L	L	L	L	M	H
Sudan:	N. (irrigated)	M	L	L	L	L	L	L	L	L
Tunisia:	North	M	L	L	L	L	L	L	M	M

Table 10, continued.

Major bean producing area	Low soil N	Low soil P	Low soil K	Low ex. bases	Al/Mn toxic.	FeP fix.	Water deficit E	M	L
AFBE 13: Lowlands at low latitudes									
Burundi: Imbo Plain	M	M	L	L	L	L	M	H	H
Tanzania: Morogoro	H	M	L	M	M	L	M	H	H
Zaire: Kinshasa (r.m.)	H	M	L	L	L	L	L	M	H

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

[2] FeP fix. refers to fixation of phosphates by iron oxides.

[3] Water deficits refer to soil moisture deficits during the vegetative (E), early reproductive or R5 & R6 (M), late (L) stages of growth.

Table 11. Importance of various bean production constraints in Africa as indicated by number of hectares ('000), and percent of area, having a constraint of high or moderate importance [1, 2].

Constraint	High importance Hectares	(% area)	Moderate importance Hectares	(% area)
Angular leaf spot	2567	(67)	939	(25)
Rust	619	(17)	1635	(44)
Anthracnose	1782	(47)	1113	(30)
Ascochyta blight	286	(8)	865	(26)
Web blight	0	(0)	172	(5)
Floury leaf spot	0	(0)	825	(24)
White mold	0	(0)	100	(4)
Scab	0	(0)	75	(2)
Charcoal rot	260	(7)	50	(1)
Root and stem rots	490	(13)	597	(16)
Fusarium wilt	190	(7)	60	(2)
Common bacterial blight	1015	(29)	1014	(29)
Halo blight	607	(18)	840	(26)
Bean common mosaic virus	772	(22)	1279	(37)
Aphids	613	(18)	1552	(46)
Bean stem maggot	1581	(46)	1765	(51)
Thrips	20	(6)	421	(12)
Heliothis	0	(0)	1080	(35)
Maruca	0	(0)	1071	(31)
Ootheca	200	(6)	656	(19)
Bruchids	174	(5)	3317	(95)
Clavigralla	0	(0)	1092	(33)
Low soil N	2015	(53)	1753	(46)
Low soil P	1667	(44)	1773	(47)
Low soil K	110	(3)	1424	(37)
Low exchangeable bases	296	(8)	1550	(41)
Al/Mn toxicity	306	(8)	1683	(44)
FeP fixation	257	(6)	2636	(69)
Soil moisture deficits				
early season	75	(2)	500	(13)
mid season	594	(15)	1274	(34)
late season	452	(12)	951	(25)

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

[2] Estimates of importance of diseases and insect pests generally exclude the bean production of West Africa (approximately 100,000 ha), and occasionally other areas where information is lacking.

Table 12. Importance of various bean production constraints in the Eastern Africa Highlands as indicated by number of hectares ('000), and percent of area, having a constraint of high or moderate importance [1].

Constraint	High importance Hectares	(% area)	Moderate importance Hectares	(% area)
Angular leaf spot	1327	(89)	155	(10)
Rust	175	(13)	492	(36)
Anthracnose	1272	(92)	120	(8)
Ascochyta blight	265	(19)	575	(42)
Web blight	0	(0)	25	(2)
Floury leaf spot	0	(0)	150	(11)
White mold	0	(0)	0	(0)
Scab	0	(0)	0	(0)
Charcoal rot	0	(0)	0	(0)
Root and stem rots	480	(35)	347	(25)
Fusarium wilt	190	(14)	0	(0)
Common bacterial blight	35	(3)	300	(22)
Halo blight	427	(31)	690	(51)
Bean common mosaic virus	347	(25)	610	(45)
Aphids	382	(28)	820	(61)
Bean stem maggot	852	(62)	500	(37)
Thrips	0	(0)	35	(3)
Heliothis	0	(0)	680	(50)
Maruca	0	(0)	420	(31)
Ootheca	130	(10)	290	(22)
Bruchids	0	(0)	1392	(100)
Clavigralla	0	(0)	347	(29)
Low soil N	957	(70)	435	(32)
Low soil P	957	(70)	435	(32)
Low soil K	50	(4)	210	(16)
Low exchangeable bases	130	(10)	547	(40)
Al/Mn toxicity	210	(16)	530	(39)
FeP fixation	150	(11)	1252	(92)
Soil moisture deficits				
early season	0	(0)	0	(0)
mid season	0	(0)	255	(19)
late season	0	(0)	150	(11)

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

Table 13. Importance of various bean production constraints in the eastern Africa mid-altitude zone as indicated by number of hectares ('000), and percent of area, having a constraint of high or moderate importance [1].

Constraint	High importance Hectares	(% area)	Moderate importance Hectares	(% area)
Angular leaf spot	960	(70)	419	(31)
Rust	219	(16)	955	(69)
Anthracnose	280	(21)	639	(47)
Ascochyta blight	0	(0)	90	(7)
Web blight	0	(0)	0	(0)
Floury leaf spot	0	(0)	640	(47)
White mold	0	(0)	100	(7)
Scab	0	(0)	75	(5)
Charcoal rot	260	(19)	0	(4)
Root and stem rots	0	(0)	150	(11)
Fusarium wilt	0	(0)	60	(4)
Common bacterial blight	929	(68)	435	(32)
Halo blight	0	(0)	0	(0)
Bean common mosaic virus	430	(32)	525	(38)
Aphids	160	(12)	430	(32)
Bean stem maggot	415	(30)	949	(70)
Thrips	0	(0)	200	(15)
Heliothis	0	(0)	345	(25)
Maruca	0	(0)	390	(29)
Ootheca	70	(5)	90	(7)
Bruchids	174	(13)	1190	(87)
Clavigralla	0	(0)	410	(30)
Low soil N	559	(40)	825	(60)
Low soil P	140	(10)	965	(70)
Low soil K	0	(0)	690	(50)
Low exchangeable bases	0	(0)	670	(48)
Al/Mn toxicity	0	(0)	730	(53)
FeP fixation	0	(0)	810	(59)
Soil moisture deficits				
early season	75	(5)	502	(36)
mid season	545	(39)	739	(53)
late season	359	(26)	170	(12)

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

Table 14. Importance of various bean production constraints in southern Africa as indicated by number of hectares ('000), and percent of area, having a constraint of high or moderate importance [1].

Constraint	High importance Hectares	(% area)	Moderate importance Hectares	(% area)
Angular leaf spot	260	(42)	340	(42)
Rust	250	(31)	123	(15)
Anthracnose	230	(28)	351	(43)
Ascochyta blight	21	(3)	200	(25)
Web blight	0	(0)	105	(13)
Floury leaf spot	0	(0)	35	(4)
White mold	0	(0)	0	(0)
Scab	0	(0)	0	(0)
Charcoal rot	0	(0)	0	(0)
Root and stem rots	10	(1)	100	(12)
Fusarium wilt	0	(0)	0	(0)
Common bacterial blight	106	(16)	199	(34)
Halo blight	180	(22)	150	(18)
Bean common mosaic virus	0	(0)	121	(21)
Aphids	19	(3)	189	(30)
Bean stem maggot	314	(49)	321	(51)
Thrips	0	(0)	166	(27)
Heliothis	0	(0)	0	(0)
Maruca	0	(0)	211	(33)
Ootheca	0	(0)	246	(38)
Bruchids	0	(0)	635	(100)
Clavigralla	0	(0)	335	(53)
Low soil N	419	(51)	386	(47)
Low soil P	570	(70)	235	(29)
Low soil K	60	(7)	404	(50)
Low exchangeable bases	166	(20)	333	(41)
Al/Mn toxicity	96	(12)	413	(51)
FeP fixation	138	(17)	569	(70)
Soil moisture deficits				
early season	0	(0)	0	(0)
mid season	9	(1)	230	(28)
late season	43	(5)	321	(39)

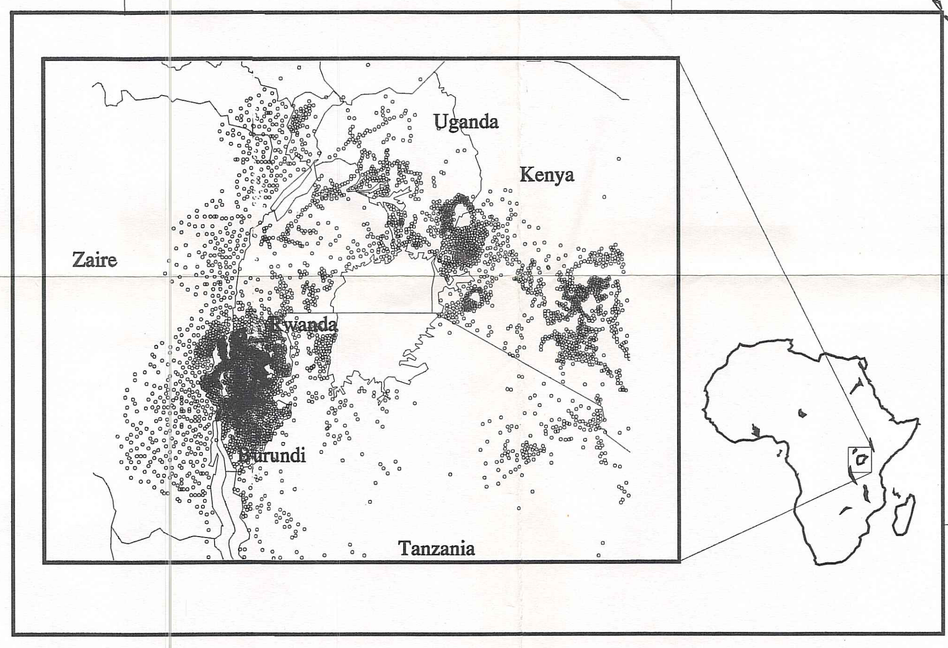
[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

Table 15. Importance of various bean production constraints in the lowlands of Africa as indicated by number of hectares ('000), and percent of area, having a constraint of high or moderate importance [1].

Constraint	High importance Hectares	(% area)	Moderate importance Hectares	(% area)
Angular leaf spot	20	(15)	20	(15)
Rust	20	(15)	70	(44)
Charcoal rot	0	(0)	10	(6)
Common bacterial blight	0	(0)	20	(12)
Bean common mosaic virus	0	(0)	23	(14)
Aphids	7	(6)	113	(94)
Bean stem maggot	0	(0)	50	(56)
Thrips	20	(22)	20	(22)
Heliothis	0	(0)	40	(50)
Maruca	0	(0)	50	(56)
Ootheca	0	(0)	30	(43)
Bruchids	0	(0)	90	(100)
Low soil N	70	(44)	67	(42)
Low soil P	0	(0)	113	(100)
Low soil K				
Low exchangeable bases				
Al/Mn toxicity	0	(0)	10	(8)
FeP fixation	0	(0)	10	(8)
Soil moisture deficits				
early season	0	(0)	40	(33)
mid season	40	(33)	60	(50)
late season	50	(42)	10	(8)

[1] The relative importance of the stresses is indicated H = high or >300 kg ha^{-1} loss in mean yield potential, M = moderate or 100 - 300 kg ha^{-1} loss, and L = low or < 100 kg ha^{-1} loss.

40 W
20 W
20 E
40 E
60 E
20 N
0
20 S
Tunisia
Morocco
Algeria
Libya
Egypt
Western Sahara
Mauritania
Mali Rep.
Niger
Chad
Sudan
Senegal
The Gambia
Guinea Bissau
Guinea
Sierra Leone
Liberia
Ivory Coast
Upper Volta
Ghana
Togo
Benin
Nigeria
Cameroon
Cen.African R.
Eq. Guinea
Gabon
Congo
Zaire
Uganda
Kenya
Ethiopia
Djibouti
Somali Rep.
Tanzania
Rwanda
Burundi
Mozambique
Malawi
Zambia
Angola
Zimbabwe
Namibia
Botswana
Swaziland
Lesotho
South Africa
Malagasy Rep.



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