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Variability within the common bean *phaseolus vulgaris* germplasm

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Abstract

Genetic variability is the most important aspect in any crop breeding. Bean production in Uganda is characterized by much variation in environmental conditions, cropping systems, preferences and constraints. The breeding programme aims at improving national bean production through provision of superior varieties released periodically and also conserve genetic variability ex-situ. The modern agricultural tendency of exclusive use of widely adapted and widely diffused varieties enhances local adaptation and performance at the expense of genetic variability. Farmers' varietal selection criteria were found to be variable and partially responsible for genetic variability on-farm. However, with introduced improved cultivars narrowing of genetic variability on-farm may compromise production stability for farmers. The germplasm collected over the past years represent the variation in morphological as well as agronomic traits within the varieties grown in various districts of the country. The implications of the above factors and the characterization of the available germplasm form the discussion basis of this paper.

Keywords: Genetic variability; *Phaseolus vulgaris* germplasm

Introduction

Beans are believed to have been introduced in East Africa by the Spanish and Portuguese in the 16th century (Greenway, 1945). In Uganda it is estimated that beans got there in the 18th century. Throughout the years diverse germplasm of this crop has been introduced. Beans play an important nutritional role as a source of protein for low income groups and institutions. Availability of dried bean seed throughout the year contributes to food security. Among the grain legumes grown in Uganda, the common bean (*Phaseolus vulgaris* L.) has the highest annual acreage and production. Though beans have recently acquired the status of an export crop, most farmers are growing it at subsistence level rather than commercially. The production constraints for bean production include diseases, pests, low soil fertility, low yield potential, susceptibility of genotypes to moisture levels i.e rainfall or drought, etc.

Farmers have always evaluated their newly acquired germplasm in the field under prevalent natural conditions and made their selections according to their set criteria. Farmers continuous demand for new genotypes is indicative of their recognition of the genetic potential of this crop yet to be tapped. When new bean varieties are introduced they must perform in farme's production environments better than currently sown cultivars within the input levels affordable by the farmers and the new varieties should also be acceptable by the consumers.

The longevity of specified seed stocks at farm level is partly dependent on food availability, fanner's appreciation of the new génetic stock, abiotic and biotic stresses prevalent within the seasons.

Beans are grown as a monocrop as well as being intercropped with various crops e.g bananas, cassava, sweet potatoes, maize, etc. In the course of variety selection suitability to the farming system as well as culinary and economic characteristics are taken into account resulting in a diversity among the landraces and cultivars grown. In most cases the farmers and consumers tend to stick to the local varieties (landraces), especially if improved varieties are inferior in taste and other colinary characteristics. The Uganda National Bean Programme has a large bean germplasm collection representing the various types that have been introduced in the country over the years. For their effective utilisation to enhance bean production, comprehensive characterisation is essential. This paper highlights the status of the Uganda bean germplasm collection, its conservation and utilisation in the crop improvement programme.

Germplasm collection

Prior to the setting up of the bean breeding programme in 1960, collection of landraces took place, mainly for agronomic evaluation alongside a few introduced varieties (Leakey, 1994) and varieties like Mutiike 4, Banja 2, Canadian Wonder, etc were recommended though few subsistence farmers made use of research recommendations. Vigorous collection was resumed by the breeder in 1960 collecting from individual farmers, open markets and shops throughout the country. The only passport data recorded was geographical origin, local variety name, seed colour and size. By 1984 a total of 204 landraces were collected, mainly of *Phaseolus vulgaris* but also with a few samples of *P.lunatus*, *P.acutifolius* and *Vigna mungo*. As the hybridisation programme progressed, 130 breeding lines (K- series) and 445 introductions were added to the collection. Unfortunately most of this material was lost in the 1982-85 period of civil strife (Male-Kayiwa et al, 1992)

However more germplasm got introduced in the country unofficially and farmers continued to nurture the diversity thus obtained, while at the same time natural selection favoured some genotypes over others.Collection was resumed in 1986 covering most districts in the country , with samples obtained from individual farmers, markets, shops and from agricultural extension staff. In addition numerous breeding lines of different nurseries were obtained from CIAT and other collaborators on bean research especially within East, Central and Southern Africa region. However, not all acquired breeding lines are retained in the collection. Presently (1998) over 600 accessions are in the collection. The collection carried out in the period 1986-1997 represent a wide range of seed types, some of which were collected as mixtures while most were obtained as pure lines. Nearly all districts of the country have representative samples though some districts have more entries than others, depending on the accessibility as well as the importance of the bean crop in the area. Collection focuses on varieties grown by the farmers, which usually constitute a rich source of adaptation to local conditions.

Germplasm diversity

High yielding improved varieties increase average grain yield per hactare as well as the national production. However, with introduction of improved cultivars generally the genetic diversity gets eroded. A survey of 29 districts in Uganda revealed that 135 distinct landraces and cultivars were in use (Grisley and Sengooba, 1993), dominated by Calima seed types, large kidneys and sugar type Kanyebwa. The diversity is further exemplified by the numerous names of the different bean landraces/ varieties though in some cases the same variety would have several names while in other cases different varieties could mistakenly be referred to by the same name. The variation represents both the Andean and Mesoamerican gene pools.Diversity on farm was most prevalent in South-western Uganda where varietal mixtures are more common than in other parts of the country. Another formal survey (Mugisa-Mutetika et al,1995) conducted in districts of Kampala, Mpigi, Iganga and Kabale revealed that domestic food requirements, bean diseases and poor yield were the major factors that led to loss of local germplasm. Farmers tend to resort to local markets for bean seed, whereby some of the varieties purchased are new ones commercially introduced from neighbouring countries e.g Tanzania, Rwanda, etc. Researchers' on-farm variety trials have also introduced diversity on farmers fields and some of the introduced varieties have been recovered in collections. Retention of introduced varieties and their spread is governed by the fact that farmers produce and exchange seed.

Patterns of genetic variation are known to arise from climatic, edaphic, biotic and/or human factors. Therefore the diversity noted within the present bean collection is a reflection of these factors. For example early maturity is highly desirable in areas where rainfall is unreliable and unevenly distributed, while the late maturity is mainly associated with intercrops and long growth cycles. Seed size is another highly variable character with regional preferences reflected. However, inspite of the expressed preferences e.g large seed in most areas apart from the northern region, the seed sizes are found within mixtures grown countrywide. The same applies to seed colours, though reds are most preferred countrywide while blacks predominate in northern Uganda and large white are preferred in Arua region areas bordering Congo. If seed colour and seed size are considered together, the composition of varietal mixtures is in the range of 4 - 24 individual components. Farmers selection criteria include characteristics such as yield, taste, disease resistance, cooking time, maturity period, seed colour and size, growth habit, marketability, etc (Ugen and Wortmann, 1994). Though a number of farmers in different districts grow the lima bean (*Phaseolus lunatus* L.), germplasm of this crop is not assembled since it is ranked low in importance as a crop countrywide.

Characterisation based on agromorphological characters e.g growth habit, flowering dates, pigmentation, seed and pod characteristics, reaction to diseases and pests, tolerance to edaphic factors, etc has revealed a lot of variation. A large array of seed colour and seed size are evident, while the highest percentage of accessions are of bush growth habit Type I or II. The climbing beans are commonly from south-west Uganda and a few introduced lines from Rwanda and CIAT. As a general rule the climbers in south-west Uganda are mostly grown as mixtures.

Germplasm conservation

Simple low-cost technology based on seed drying with silica gel to low moisture which was developed for medium term storage of bean germplasm is utilised in bean germplasm conservation(Fischler, 1993). Development of this technology was necessitated due to power failures and equipment breakdown associated with low temperature storage normally utilised in genebanks. Two bottled bean seed samples per accession are stored at room temperature at Kawanda Agricultural Research Institute in collaboration with CIAT. Regeneration, as is the case for medium term storage, is undertaken after five years in storage. The trials carried out in 1993 and 1995 showed that 85% seed viability was achieved with this method.

Germplasm utilisation

The overall reason for establishing and maintaining a germplasm collection is its potential use in breeding. Bean germplasm is evaluated for adaptation, yield and reaction to stress i.e diseases, pests, and nutrient stress. Selected landraces or breeding lines are used as parents in the hybridisation programme depending on the required character combinations. For example variety K20 had landrace Banja 2 and introduction Dicol Nima within its pedigree as a resistance source for anthracnose disease. This variety K 20 has spread in many East and Central African countries where it has shown high yield and wide adaptation.

Presently a breeding programme to incorporate resistance to bean common mosaic virus, common bacterial blight and angular leafspot into popular landraces Kahura and Kanyebwa and also improvement on multiple resistance of released varieties is under way. Some crosses utilising some introduced CIAT breeding lines and the above mentioned landraces were also made targeting improved nitrogen fixation. The effort to improve on yield per unit area is continuous and parents to be complemented are selected from within the germplasm.

Introduced germplasm has been screened for superior well adapted genotype to release and as a result varieties K 131 (MCM 5001), K 132 (CAL 96), MCM 2001, MCM 1015, OBA 1 have been released while DRK 57, SUG 73 and POA 2 are scheduled for release. All these came in from CIAT. The selection is based mainly on early maturity, acceptable seed size and colour and resistance to most prevalent bean diseases. Climbing bean breeding lines introduced from Rwanda between 1988 - 92 have been evaluated and some lines e.g Vunukingi, Ngwinorare, Gisenyi and Umubano (G 2333) are due for formal release. Evaluation of germplasm is undertaken from time to time as new production constraints (e.g root rots in Kisoro district) are identified and parents are identified within the germplasm. Evaluation of climbing bean genotypes most suited to the lowland areas is being undertaken in Mpigi and Kampala districts. So far an introduction from Rwanda proved high yielding in both highland and lowland areas and is also scheduled for release.

Concluding remarks

Though a lot of germplasm has been assembled its characterisation has been limited as more emphasis in the breeding programme has been on elite lines evaluation for faster releases. The characterisation based on agromorphological data cannot be satisfactorily used to sort out duplicates within the collection. More detailed seed protein or isozyme analysis is essential to sort out similar materials and thus reduce the collection to manageable levels within the resources available. The usefulness of germplasm in bean breeding cannot be underrated especially taking into account the continuous demand for an improved version of the most popular tasty landraces Kanyebwa and Kahura. With continuous introduction of breeding lines for inclusion in the hybridisation programme, there is hope that the desired genotypes will be attained both for the local market and export.

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