BEAN PRODUCTION SYSTEMS IN MBALE DISTRICT, UGANDA WITH EMPHASIS ON VARIETAL DIVERSITY AND THE ADOPTION OF NEW CLIMBING VARIETIES

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PREFACE

This volume, the twentieth in a working document series that serves research on common bean (*Phaseolus vulgaris*) in Africa, reports results from a study of bean production in an area of eastern Uganda where this crop is becoming increasingly commercialized. The objectives of this study were to characterize the systems under which farmers produce beans, including indigenous climbing types, and to assess the adoption of newly introduced climbing cultivars with the intention of drawing lessons about technology dissemination. The study was carried out by the Centro Internacional de Agricultura Tropical (CIAT) in collaboration with Wageningen Agricultural University (WAU) and the Mount Elgon Conservation and Development Project (MECDP).

The Network on Bean Research in Africa serves to stimulate, focus and coordinate research efforts on common bean. The network is organized by CIAT in collaboration with two interdependent sub-regional networks of national programs: the Eastern and Central Africa Bean Research Network (ECABREN) and the SADC Bean Research Network (SABRN) for southern Africa.

Financial support for regional bean projects comes from the Canadian International Development Agency (CIDA), the Swiss Agency for Development and Cooperation (SDC) and the United States Agency for International Development (USAID).

Working documents will include bibliographies, research reports and bean network discussion papers. These publications are intended to complement two associated series of Workshop Proceedings and Reprints.

Further information on bean research in Africa is available from:

Pan-Africa Coordinator, CIAT, P.O.Box 6247, Kampala, Uganda.

Regional Coordinator, Eastern and Central Africa Bean Research Network, P.O. Box 2704, Arusha, Tanzania.

Regional Coordinator, SADC Bean Network, P.O.Box 2704, Arusha, Tanzania.

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BEAN PRODUCTION SYSTEMS IN MBALE DISTRICT, UGANDA WITH EMPHASIS ON VARIETAL DIVERSITY AND THE ADOPTION OF NEW CLIMBING VARIETIES

Soniia David and Michiel Hoogendijk[1]

ABSTRACT

This study investigates bean production systems, varietal diversity and adoption in Mbale District of Uganda, one of the few areas of the country where climbing beans are traditionally grown. Despite considerable genetic resources in beans in the study sites, individual farm households sow relatively few varieties as a result of biotic stresses and a narrow profile of marketed seed types. Rwandan climbing bean varieties introduced in the early 1990s were adopted by a modest number of surveyed farmers and have been successfully incorporated into the existing production system. The paper draws lessons about technology dissemination from collaboration between bean researchers and a non-governmental organization.

INTRODUCTION

Small-scale farmers throughout Eastern and Southern Africa grow common bean (*Phaseolus vulgaris* L.) primarily for food but most producers sell some proportion of their harvests in response to local, regional and international demand. Indeed, beans are fast becoming an important low-value cash crop in the Region. Mbale District in Eastern Uganda is an ideal location for the commercialization of beans for several reasons. The District borders onto Kenya, a net importer of beans, has relatively fertile soils and is one of the few locations in Uganda and Eastern Africa where high yielding climbing beans are grown traditionally[2].

Since the early 1990s, various efforts to test and promote climbing bean production in Mbale District of Uganda were initiated by the Uganda National Bean Program (UNBP), CIAT and the Mount Elgon Conservation and Development Project (MECDP), an international NGO based in Mbale[3]. Three climbing bean varieties released in Rwanda were introduced to Mbale

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[1] The authors are, respectively, Rural Sociologist, Pan-African Bean Research Alliance, International Center for Tropical Agriculture (CIAT), based at Kawanda Agricultural Research Institute, Kampala, Uganda; and former M.Sc. candidate in the Department of Plant Breeding, Wageningen University of Agriculture, The Netherlands.

[2] Climbing bean systems are also indigenous to the following areas: Kisoro and Kabarole Districts in southwestern and western Uganda; northwestern Rwanda; central and southern Malawi; southern highlands of Tanzania; and north Kivu, Zaire (Ferguson et al., 1992; Grisley et al., 1993; Sperling et al., 1994; Wortmann and Allen, 1994). Factors accounting for location specificity of climbing bean systems are unclear.

[3] The Mount Elgon Conservation and Development Project, a project of the World Conservation Union (IUCN), seeks to conserve the biodiversity of Mount Elgon National Park and alleviate pressure on park resources.

farmers through on-farm varietal trials and direct distribution. Climbing beans have several advantages over bush beans, including higher yields per unit area, better resistance to diseases and easier drying during heavy rainfall due to staggered harvesting. Some disadvantages mentioned by farmers include the need for staking, demand for highly fertile soils and a longer maturity period (Graf et al., 1991; Voss and Graf, 1991; Sperling et al., 1994).

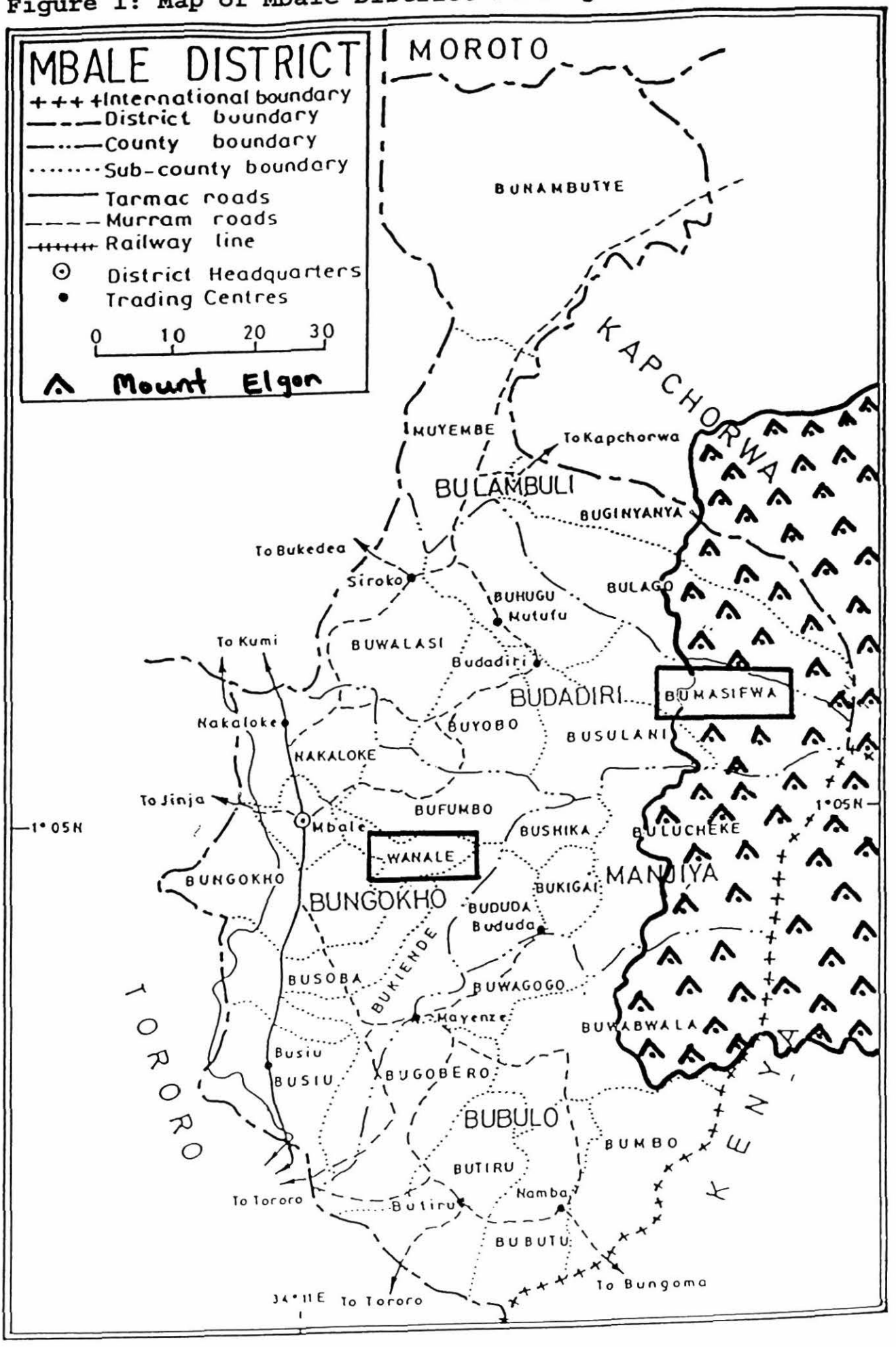
This paper reports on a study undertaken to document bean production systems in the highlands of Mbale District. Its main objectives are to characterize the systems under which farmers produce bush and climbing beans, with greater emphasis on the latter, investigate bean varietal diversity and assess the adoption of newly introduced climbing cultivars with the intention of drawing lessons about technology dissemination. Bean seed sources and marketing are also described to the extent that these issues affect production. The rationale for focussing on climbing beans was to diagnose the strengths and weaknesses of the production system and assess the prospects for its improvement through the introduction of improved genetic materials. A thorough understanding of the existing system was expected also to provide useful lessons for the expansion of this technology to areas of Mbale District where climbing bean is not traditionally grown. The focus on varietal diversity contributes to the discussion of factors affecting varietal variation and the dynamism and resilience of local seed systems.

THE SETTING

Uganda is a land-locked country of 236,000 square kilometers located in Eastern Africa surrounded by Kenya, Tanzania, Sudan, Zaire and Rwanda. Common bean is the most widely grown and consumed grain legume and is produced in all areas of the country. Mbale District, located in the east of the country, shares similar characteristics with other climbing bean environments (Table 1): high population density, high rainfall and small, fragmented landholdings. The topography of the District is dominated by Mount Elgon which straddles the border with Kenya (Figure 1). In 1990-91, bean production in the District was estimated at 5,118 tons grown on 3,656 hectares (Republic of Uganda, 1992). The area planted to climbing beans is unknown, but is estimated to be small and restricted to the central and northern regions of the District. Following the decline of coffee production in the early 1980s, bean production became more commercialized in many parts of Mbale in response to favorable market opportunities across the border in Kenya.

The present study focuses on two parishes where seed of three new climbing bean cultivars was introduced in the early 1990s: Bugitimwa and Bubentsye. Bugitimwa Parish, located in Bumasifwa Sub-county in the north of the District, has a population of approximately 3,837 people living in 14 villages. High altitude (>1800 masl) areas of this parish are inaccessible by road and are connected by footpaths to Gombe trading center. Gombe is approximately 40 km from Mbale Town, the District capital, on a road not plied by public transport and which is frequently impassable during the rainy season.

Figure 1: Map of Mbale District showing study parishes



Bubentsye Parish, located in Wanale Sub-county in central Mbale, has a population of 9,080 people living in 11 villages. It is approximately 10 km from Mbale Town and is served once a day by public transport[4].

Table 1: Selected characteristics of Mbale district

Annual rainfall (mm)	1311-1993
Altitude of study parishes	1800+
Dominant soil type	Humic nitisols
Slopes	10%+
Major ethnic group	Bagisu
Average household size	5.2
Average farm size	< 1 ha; considerable land fragmentation
Population density (km^2)	494
Labour availability	High

Source: Kayiso, 1993

MATERIALS AND METHODS

Trials and Seed Dissemination

The present survey monitored the adoption of three climbing bean varieties (type 4a) released in the mid-1980s by the national bean program of Rwanda: Umubano (G2333), Gisenyi and Urunyumba[5]. Some characteristics of the three varieties, which are adapted to medium altitudes, are listed in Table 2. Between 1991 and 1992, the UNBP, in following a strategy of increasing bean productivity through the release of high yielding, stress-resistant cultivars, initiated on-farm varietal trials (OFVTs) in Bubentsye Parish with Umubano, Gisenyi and Urunyumba[6]. Thus, at the time of the present survey, the new varieties had been in circulation in Bubentsye Parish for 4 years (8 seasons).

[4] By public transport and foot the trip from Mbale Town to Gombe takes approximately 4 hours under dry conditions. The trip from Mbale Town to Bubentsye by public means takes approximately one and a half hours.

[5] In Rwanda the varieties were released under the following names: Umubano, Gisenyi 2 bis and Urunuymba 3. At the time of writing, none of these varieties were released in Uganda.

[6] On-farm trials with these varieties were also conducted in Kabale, south-western Uganda, an area where climbing beans are not traditionally grown (Grisley et al., 1993).

Table 2: Characteristics of climbing bean cultivars introduced to Mbale District from Rwanda

	UMUBANO	GISENYI	URUNYUMBA
Seed color	Dark red	Striped cream and black	Mottled yellow and red
Seed size	Small	Large	Medium
Origin	Mexico via CIAT	Landrace from Rwanda	Landrace from Rwanda
Days to maturity (at 1650 m)	90	88	85
Yield (t/ha)	4-4.5	2-3	2-3
Disease susceptibility	Fusarium wilt	Anthracnose	Bean common mosaic virus, angular leaf spot
Disease resistance/ tolerance	Anthracnose, ascochyta	Ascochyta	Anthracnose, ascochyta

Source: Nyabyenda, 1991

Between 1992 and 1993, CIAT and the UNBP collaborated with the MECDP to conduct OFVTs with the same three varieties in Buginyanaya Sub-county and Bumasifwa sub-county. In Bugitimwa Parish (Bumasifwa), a total of 11 farmers, located at different altitudes, hosted researcher-designed, farmer-managed trials with the three varieties and a local check. Larger, wealthier farmers, regarded as more cooperative than other farmers, were deliberately selected to host trials. Direct seed distribution, through the extension system, started in the first season of 1994, when approximately 25 kg of the three varieties packaged in small quantities (250 grams and less), was distributed free of charge to individual farmers and groups in two Project parishes: Bugitimwa and Ulukusi. Although the exact amount distributed of each variety is unknown, the amount of Umubano seed given out surpassed that of the other varieties. At the time of the survey, the Rwandan varieties had been in circulation in Bugitimwa and Ulukusi for 3 years (6 seasons). The present study focusses only on those farmers in Bugitimwa and Bubentsye who received seed between 1992 and 1994 as farmers involved in earlier trials could not be located.

Data Collection Methods

Between October 1995 and January 1996, multiple methods were used to collect information on the farming system, the climbing bean production system, the seed dissemination strategy used by the MECDP and adoption of the new varieties. As outlined in appendix A, these included: interviews with staff of MECDP and extension agents, semi-structured interviews with trial farmers, key informant interviews, participatory rural appraisal (PRA) exercises with individual farmers and groups and a formal survey of bean farmers.

Two groups of farmers in Bugitimwa and Bubentsye Parishes were interviewed during the

formal survey: 1. farmers who were known to have received seed of the new varieties from extension agents or from trial farmers (n=44), and 2. bean farmers drawn from the wider population using a non-random systematic sampling procedure (n=43). Thus, the total sample size was 87. In presenting results we refer to three categories of farmers: 1. "direct seed recipients"- farmers who were given seed of the new climbing bean varieties for trials or through direct distribution by extension; 2. "indirect seed recipients"- farmers who were known to have been given seed of the new varieties by direct seed recipients; and 3. "other farmers" -the sample of systematically selected bean farmers. "Seed recipients" refers to the first two categories of farmers.

The samples of direct and indirect seed recipients were systematically selected from lists provided by the extension agent who distributed seed and by direct seed recipients who had passed on seed of the new varieties. The same interview schedule was used for both samples of seed recipients, while a similar schedule was used for the sample of "other farmers". Topics covered include: bean varieties grown, seed sources, varietal loss, staking materials, climbing bean production estimates[7], marketing of climbing beans, and adoption and evaluation of the new bean varieties. Samples of landraces grown by surveyed households were collected but no attempt was made to perform isozyme analysis to acertain varietal diversity. Thus, varietal diversity was assessed visually.

Farmer Characteristics

Survey data confirm that extension agents deliberately selected better-off households for trials and seed distribution, as shown in Table 3. Although not randomly selected, farmers in the "other" category are more likely to be representative of the wider population of bean farmers in the two parishes, judging by their socio-demographic characteristics. The majority of the 87 respondents were men (53%) above 30 years of age (67%). Male headed households with one wife were predominant (58%), but about a third (32%) of men in the sample were involved in polygynous marriages. All trial farmers received seed of the three new varieties; 63% of the remaining direct seed recipients received seed of only one variety.

BEAN PRODUCTION SYSTEMS IN THE MOUNTAINS OF MBALE

The principal food crops grown in Bugitimwa and Bubentsye are matoke (cooking bananas), maize, beans, cassava, cocoyam and Irish potatoes. Coffee, the most important cash crop, was grown by 70% of households surveyed in Bugitimwa and 30% of Bubentsye households. Other crops commonly grown for the market include: passion fruit (37% of farmers in Butitimwa and 59% of farmers in Bubentsye), onions (72% in Bugitimwa and 18% in Bubentsye) and various vegetables (42% in Bugitimwa and 98% in Bubentsye). Farmers in Bubentsye appear to specialize in more exotic, perishable fruits and vegetables (e.g. passion fruit, cabbage, carrots and field peas) due to their proximity to Mbale Town, and hence to the Kampala market; onions, tomatoes and other traditional horticultural produce are more

[7] Production estimates were elicited for both seasons of 1995, although the survey was conducted before the end of the 1995b season. The study areas experienced drought in 1995a but amounts sown in 1995a were probably "normal" as no serious agroenvironmental adversities were experienced in the previous season.

Table 3: Summary of survey sample characteristics (percent)

	Seed recipients		Other farmers	
	Bugitimwa (n=20)	**Bubentsye (n=24)**	**Bugitimwa (n=23)**	**Bubentsye (n=20)**
Household type				
Male-headed	95	92	100	95
Female-headed	5	8	0	5
Land size				
≤ 1 acre	10	29	26	25
1-3 acres	50	38	39	60
4+ acres	40	33	35	15
Number of cattle owned				
None	5	21	43	30
1-2	55	38	30	60
3+	40	42	26	10
Household wealth status				
Rich	42	54	22	15
Average	42	8	22	40
Poor	16	38	57	45

important in Bugitimwa, a more, remote, frequently inaccessible, area. The mean number of cash crops grown by farmers surveyed in Bubentsye was significantly higher than that grown by Bugitimwa farmers (6.3 compared with 5.3; $p \leq .01$).

Bush beans are commonly intercropped with matoke bananas, coffee, Irish potatoes, maize and cassava. Although no measurements were taken during the present survey, the average bean (all types) plot is estimated to be 0.11 ha. (Kayiso, 1993). The vast majority of farmers in both parishes indicated growing beans, both bush (95% in Bugitimwa and 55% in Bubentsye) and climbing types (86% in Bugitimwa and 98% in Bubentsye), specifically for the market. While farmers in Bugitimwa sell beans both dry and "fresh" (i.e. non-dried, physiologically mature) beans, due to their proximity to Mbale Town farmers in Bubentsye tend to specialize more in the sale of fresh climbing beans. Generally, any type of beans intended for sale is planted on better soils, and typically, climbing beans are planted on better soils than bush varieties. Unlike Rwanda, however, in Mbale climbers are not planted on the fertile soils around homesteads.

In the mountains of Mbale, beans are largely sown as sole varieties; mixtures are rare (David, 1994). Bean leaves (both bush and climbers) and fresh beans are widely consumed in both parishes. Beans are sown during two growing seasons, but a minority of farmers who own land near streams plant beans a third time. Farmers give inconsistent answers with regard to which season is considered better for bean production, possibly reflecting the

considerable climatic variation in mountainous localities. The seasons for planting climbing beans are less clearly defined than for bush beans, especially in Bubentsye, where planting may be continuous when rainfall is sufficient. In the first season (season A) both bush and climbing beans are planted between March and April. Bush beans are harvested in June/July, while climbers are harvested between July and August. Bush beans are planted again in July and harvested in October (season B). Climbing beans are planted between September and November and harvested between January and March.

Production constraints

Farmers in Bugitimwa[8] mentioned several problems associated with bean production and ranked them for the two most commonly grown varieties, K20[9] (a bush variety) and Kanyebwa climber[10] (Table 4).

Table 4: Ranking of problems encountered in growing two bean varieties at Bugitimwa

PROBLEM	Kanyebwa climber	K20
SEASON A		
Shortage of stakes	1	-
Low market price	5	7
Need for frequent weeding	6	3
"Burnt" leaves	7	6
Undersized seeds	7	5
Beans do not dry well	7	4
SEASON B		
Few & small pods	2	1
Stunted plants	3	2
Aphids	4	6
Weevils in storage	7	8

Note: 1 = most important problem

[8] Ranking of production constraints was not done in Bubentsye.

[9] K20 (known in the study localities as Kawanda or Tanzania) is a bred line released by the Uganda National Bean Program in 1968. It is estimated to be the most widely sown bean variety in Eastern Africa, with 40% and 50%, respectively, of the total hectarage planted to beans in Kenya and Uganda sown with this variety (Grisley, 1994).

[10] Since a bush variety of the same name exists, the climbing variety will be designated in this document as Kanyebwa climber.

The major production constraint common to both varieties is diseases. Judging from the symptoms described, farmers are probably referring to several possible diseases: few and small pods and stunted plants result from bean common mosiac virus (BCMV) and halo blight, while "burnt" leaves may refer to ascochyta and anthracnose[11]. Certain problems such as stunting, few pods and aphids are experienced during the second season, while several of the problems encountered during the first season are attributed to heavy rainfall. It is notable that farmers did not mention poor soils or root rots as constraints to bean production, presumably because the soils in the study localities are still relatively fertile.

Production estimates

In the absence of bean plot measurements, production estimates are based on farmers' estimates of the amount of seed sown and harvested of the most widely grown climbing bean variety: Kanyebwa climber (Table 5). The range in the amount of seed planted and harvested is considerable due to high production by a few individuals. The likely explanation for the larger mean quantity of seed sown in Bugitimwa is the limited cash cropping options available to farmers, so that they compensate by planting a larger area to beans. By contrast, farmers in Bubentsye plant slightly less beans and a greater number of other cash crops. On average, yields were lower in Bugitimwa compared to Bubentsye probably due to diseases, which appear to have a lower incidence in Bubentsye (see discussion of varietal erosion).

Organization of production and sexual division of labor

Beans are typically planted on household plots (66%), but two additional modes of organizing production were observed: personal bean plots cultivated by wives and/or husbands in addition to a household plot (17%) and personal plots in the absence of a household plot (17%). Most personal bean plots in both monogamous and polygynous households were cultivated by women. The organization of production for beans differed little between parishes. In most households in the sample of "other" farmers (74%), the largest proportion of beans consumed is harvested from the household plot. Since men's personal plots only provided most of the beans consumed by the household in 5% of cases (compared to 21% from women's personal plots), it appears that harvests from the former plots are primarily intended for sale. Subject to further investigation, one extension strategy might be to target women's personal bean plots for the introduction of certain improved varieties as a means of improving household food security, women's income and household welfare generally.

Both men and women are involved in all field tasks in bean production, but women generally contribute more labor in planting, weeding and all post-harvest activities. The collection of stakes and staking is done by both women and men, although men's labor contribution is generally higher in these tasks. To some extent, the gender division of labor in bean production depends on market orientation, with men generally contributing less labor to beans intended for home consumption. Men are the main sellers of beans when sold in bulk, but the decision to sell is typically jointly made by the farm couple. In addition, women often sell small quantities of beans to obtain money for provisioning their households.

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[11] According to Wortmann and Allen (1994), at high altitudes in Mbale District the important bean diseases are anthracnose, halo blight, aschochyta, angular leaf spot and bean common mosaic virus.

Table 5: Mean quantities (kg) of Kanyebwa climber sown and harvested in 1995

	Bugitimwa		Bubentsye	
	1995a	**1995b**	**1995a**	**1995b**
Mean quantities planted	9.2	9.7*	6.3	5.1
Range	0.2-50	1.5-40	2-22	0.5-618
Mean quantities planted by wealth category:				
Rich	12.8	12.7	4	3.7
Average	7.6	10*	6.3	4.6*
Poor	8.7*	8.4	7.2*	6
Mean quantities harvested (in dried equivalent[12])	78.6		112.5	
Range	7-522		7.3-638	
Mean quantities harvested fresh 1995a (in dried equivalent)	53		97	
Range	8.6-222		2.3-518	
Mean quantities harvested dried, 1995a	32.1		17.8	
Range	1.5-300		2-120	

* Difference between wealth group means: $p \leq .05$

Staking

Farmers in the study localities rely on a range of tree species for staking climbing beans: bamboo, *Markhamia platycalyx* ("zisora"), *Vanonia spp.* ("zinyiriyi", "zisopo") and *Croton spp.* ("zimpalahalu"). Of these species, only *Markhamia platycalyx* was introduced and promoted by the MECDP. In Bugitimwa, the two most widely used staking materials were bamboo (81%) and *Vanonia spp.* (56%), while in Bubentsye, *Vanonia spp.* (64%) and *Markhamia platycalyx* (48%) were common (Appendix B). More staking options were recorded in Bubentsye compared to Bugitimwa. Notably, the use of bamboo stakes in Bubentsye appears to have stopped due to strict enforcement of forest regulations by the MEDCP. Agroforestry species commonly used by Rwandan farmers as stakes (e.g. *Sesbania spp.*, napier grass and eucalyptus) were rarely mentioned by Mbale farmers. According to farmers, coffee branches make the most durable stakes (lasting for up to 6 seasons), followed

[12] A rough estimate was calculated to obtain the dry weight of fresh beans.

by bamboo, while other types of stakes only last for 1-2 seasons. Used stakes are burned for fuel.

Since shortage of stakes is viewed as a major constraint to the production of climbing beans by the majority of farmers (58% in Bugitimwa and 73% in Bubentsye), the introduction of new fast-growing tree species might encourage the spread of the technology. The example of Rwanda suggests however that when farmers appreciate the technology they resolve the staking issue themselves without external intervention. Stakes are purchased and collected on-farm or, in Bugitimwa only, from the forest (Table 6). Fewer sources for obtaining stakes, due to the strict prohibition on cutting trees from the forest in Bubentsye, may account for the higher proportion of farmers in that parish who complained about the shortage of stakes. As expected, farmers who obtain stakes from woodlots (9% in Bugitimwa and 28% in Bubenstye) tend to be of above average wealth. Farmers of all socio-economic categories purchase stakes, mainly at the start of season A (84%). In Bugitimwa, the most commonly purchased wood for stakes was bamboo (86%); in Bubentsye *Vanonia spp.* was preferred (38%). At a seasonal cost of U.S.$0.20-0.98 for 100 stakes (see Appendix C), stakes are inexpensive, although more costly than in Rwanda[13].

Table 6: Sources of staking materials for climbing beans (percent of farmers)

	Bugitimwa	**Bubentyse**
Purchased	81	73
Collected from own farm	65	91
Collected from forest	42	0

VARIETAL DIVERSITY

The findings of a postal survey of district agricultural officers in 29 of the 34 districts of Uganda revealed that 135 bean landraces and cultivars were in common use (Grisley and Sengooba, 1993). Our findings show considerable varietal diversity in beans in the mountains of Mbale District, as depicted in Appendix B. A total of 23 seed types, representing 28 varieties and landraces, was grown by households in the survey sample[14]. Of these, the number of bush and semi-climbing varieties[15] nearly doubles the number of climbing varieties

[13] In 1992, Graf et al. (1991) estimated a cost of $US 0.13 for 100 *Pennisetum* stakes per season (FRw 0.167 per stake and season).

[14] A total of 31 landraces/varieties are depicted in Appendix B. The discrepancy between the number of landraces reported in Table 7 and Appendix B reflects differences in the perceptions/definitions of the authors and farmers. Table 7 is based on farmers' perception of landraces, while Appendix B is based on the authors' perceptions. For example, although two types of Kanyebwa climbing beans were observed, farmers do not recognize them as being distinct. Similarly, Okubimba, a mix of three different seed types, is considered by farmers to be a single variety.

[15] What farmers consider to be semi-climbers corresponds to Types II and III in CIAT's classification system.

(Table 7). This inventory is obviously not exhaustive as many other varieties were observed among non-surveyed farmers and as contaminants in farmers' seed stocks.

Table 7: Number of bean landraces and varieties usually planted by surveyed households

	Observations	**Bugitimwa (n=43)**	**Bubentsye (n=44)**	**Sample total**
Bush	Total	6	10	11
	Household mean	1.28	1.77	1.52
Semi-climbers	Total	6	11	11
	Household mean	0.30	1.02	0.66
Climbers	Total	3	6	6
	Household mean	1.02	2.29	1.65
All types	Total	15	27	28
	Household mean	2.60	5.10	3.82

The landraces collected during the survey represent a moderate range of seed types: 10 each of large and small seeded types and three medium seeded varieties, contradicting the commonly held assumption that Ugandan farmers shun small seeded bean varieties. The range of colors represented in this collection also show that black and light colored (i.e. white, beige and yellow) seed types are acceptable to Mbale farmers. Our data confirm the popularity of Calima and Kanyebwa types in the study localities, as documented by other studies (Grisley and Sengooba, 1993; David, n.d). Farmers reported that Kanyebwa climber first appeared in Mbale in the mid-1980s and replaced another climber (Bulangeti), suggesting that the climbing bean system is highly dynamic.

Despite the considerable genetic resources in beans in Mbale District, individual farm households surveyed grow a relatively small number of varieties, as Table 7 shows. Farmers' observation that a greater number of bean varieties are presently grown than in the past can be explained by their greater exposure to more materials with the development and expansion of the bean marketing system. The number of bean varieties grown by households is not significantly associated with wealth, farm size or farming experience. Varietal diversity

in climbing beans is more limited compared to bush beans and semi-climbers.

A more diverse genetic profile existing among Bubentsye households compared to Bugitimwa households for all types of beans ($p \leq .000$). The more limited household level varietal diversity in Bugitimwa may be attributed to two factors: 1. farmers' desire to concentrate on a few commercial varieties, given their dependence on beans as one of only a few cash crops and 2. limitations imposed by biotic constraints (diseases) on farmers' varietal choices. By comparison, Bubentsye farmers are less restricted by market and biotic constraints and therefore they plant, on average, a smaller quantity of beans representing greater varietal diversity. Evidence from Uganda (David, 1994) and Malawi (Ferguson and Mkandawire, 1993) supports our hypothesis that strong market orientation in bean production is often accompanied by varietal erosion when the market only supports a narrow range of seed types.

Varietal Erosion

An investigation of factors contributing to varietal erosion, including local seed mechanisms, helps to explain the existing level of household varietal diversity in beans in the mountains of Mbale. The majority of farmers surveyed in Bugitimwa (91%) had lost or deliberately discontinued growing (i.e., disadopted) a bean variety since starting to grow that crop, compared to 39% of farmers in Bubentsye. For the most part (74% of cases in Bugitimwa and 65% of cases in Bubentsye) the loss was deliberate, but 63% of respondents, mainly in Bugitimwa, reported accidentally losses. Because a high proportion of Bugitimwa farmers experienced unintentional loss, loss in Bugitimwa was positively correlated with years of farming experience. All Bugitimwa households with 20 or more years of farming experience had lost one or more bean varieties compared with 88% of those with 6-19 years of farming experience and none of the households involved in farming for less than 5 years. Since Bubentsye farmers were more likely to deliberately stop growing a variety, years of farming experience was not significantly associated with varietal erosion. Bugitimwa households with 6-19 years of farming experience lost a mean of 3.4 varieties compared with a mean of 4.6 varieties for households who had farmed for 20 or more years. The mean number of varieties lost in Bubentsye was one for households with 6-19 years of farming experience, compared with two varieties for households with a longer farming history.

Mutike, a medium red seeded bush variety, was the most frequently disadopted variety (70% of respondents). Among farmers who deliberately stopped growing that variety, 65% and 80% of farmers in Bugitimwa and Bubentsye, respectively, cited lack of market as the reason[16]. Farmers in Bugitimwa dropped Mutike for various other reasons including disease susceptibility (ascochyta and anthracnose)(12%), displacement by another variety (usually K20) and low yields (6%, respectively), while the only other reason cited by Bubentsye farmers was displacement by another variety (20%). The same reasons were cited for the deliberate loss of other bean varieties.

Unintentional varietal loss, reported by 71% of Bugitimwa farmers and 52% of Bubentsye

[16] Mutike, one of 8 varieties commonly sold in Kampala markets, fetches a low price due to its slow cooking time and poor taste.

farmers, was attributed to two main factors: in Bugitimwa, diseases (79% of farmers who lost Mutike and 32% of those who lost other varieties); in Bubentsye, it was due to declining harvests (25% of farmers, in each case, who lost Mutike and other varieties). Declining harvests could be caused by several factors that were not specified by farmers, namely, diseases, storage pests and adverse climatic conditions. The mean number of accidental varietal losses in Bugitimwa surpassed that in Bubentsye: 1.3 compared to 0.43. Differences between parishes in reasons for both varietal disadoption and accidental loss suggest that diseases are a more important constraint to bean production in Bugitimwa compared to Bubentsye. Consequently, the impact of stress-resistant cultivars is likely to be greater in Bugitimwa and other areas with similar agroclimatic conditions.

SEED SOURCES

Traditionally, a Mugisu bride brings bean seed (and seed of other crops) with her to her new home (David, 1994). More seasoned farmers rely on a number of sources to obtain initial seed of new varieties. Due to their relatively isolated location, farmers in Bugitimwa who sowed Kanyebwa climber and K20 for the first time between 1986 and 1995 relied mainly on on-farm seed distribution mechanisms (gifts, purchases for other farmers) for seed (Table 8). By contrast, Bubentsye farmers take greater advantage of off-farm seed sources, depending on the variety[17]. Access and convenience are therefore two important factors in farmers' decisions regarding seed sourcing.

Table 8: Source of initial seed of two local bean varieties, 1986-1995

	Kanyebwa climber		**K20**	
	Bugitimwa (n=19)	**Bubentsye (n=33)**	**Bugitimwa (n=15)**	**Bubentsye (n=29)**
Purchased from farmer	37	39	20	14
Gift from farmer	42	18	47	21
Purchased from local market/shop	16	3	20	0
Purchased from Mbale market	0	36	0	59
Other	5	3	13	7

In 1995 the vast majority of farmers in both parishes relied on their own stock for seed of Kanyebwa climber (Table 9), especially in the second season due to higher production in the first season and the lesser likelihood of loosing seed in the short interval between the first and second season. Since few farmers (10% or less in each season) obtained seed from

[17] The reason for these differences between varieties in Bubentsye is unclear.

multiple sources, it appears that most Bugitimwa farmers were seed secure. The rest tapped local networks of seed exchange and sale to avoid tedious travel to larger towns. The one third of Bubentsye farmers who purchased all of their seed from commercial sources and other farmers had probably been attracted by high prices and sold the entire season B harvest. Poorer farmers were not more likely to purchase seed than average or better-off farmers. Seed sourcing differences between the two parishes imply that efforts to distribute new cultivars should concentrate on non-market channels in remote areas and focus on market channels in more commercialized, accessible localities.

Table 9: Percent of farmers using major seed sources in 1995 to obtain seed of Kanyebwa climbing bean

	Season A (n=41)		Season B (n=35)	
Seed Source	**Bugitimwa**	**Bubentsye**	**Bugitimwa**	**Bubentsye**
Own stock	78	67	90	81
Purchased from farmer	9	17	5	19
Purchased from market/shop	4	28	0	6
Gift	9	0	5	0
Exchanged for labor	4	0	5	0

Note: Percentages do not add up to 100% as some farmers obtained seed from several sources

MARKETING OF BEANS

Despite a high varietal profile in beans, only two varieties, K20 and Kanyebwa climber, were commonly sold in the mountains of Mbale District. A white haricot (Buwanga) and Kanyebwa (bush) were the only other marketed varieties mentioned by farmers. The frequency, amounts and types of beans sold are presented in Tables 10, 11 and 12. Bubentsye farmers are more specialized in the sale of fresh beans, with only a minority of farmers selling climbing dry beans regularly (Tables 10 and 11). Fresh beans are sold immediately after the harvest to traders who come from Mbale Town, Kampala and other parts of Uganda. In both parishes, most dry bean sales after season A are made immediately after the harvest to traders from Uganda and Kenya but in Bugitimwa, most sales after season B (60%) are made at planting time. Since respondents reported an equal proportion (33%, respectively) of sales from the harvest of season B to traders and farmers or both, much of these beans are probably used as seed for planting in season A. Interestingly, most farmers who buy dry beans in Bugitimwa come from low altitude areas of the District, presumably in response to availability or in search of better quality seed. Farmers noted, however, that there is little demand for seed from the local population at the start of the second planting season.

Table 10: Frequency of selling fresh Kanyebwa climbing beans (n=43)

	Bugitimwa		Bubentsye	
	Season A	**Season B**	**Season A**	**Season B**
Every season	59	36	90	90
Sometimes	0	9	0	5
Never	41	55	10	5

Table 11: Frequency of selling dry Kanyebwa climbing beans (n=43)

	Bugitimwa		Bubentsye	
	Season A	**Season B**	**Season A**	**Season B**
Every season	55	59	5	10
Sometimes	9	0	9	0
Never	36	32	95	90

Table 12: Mean quantities (kg) of Kanyebwa climber sold from the harvest of 1995a

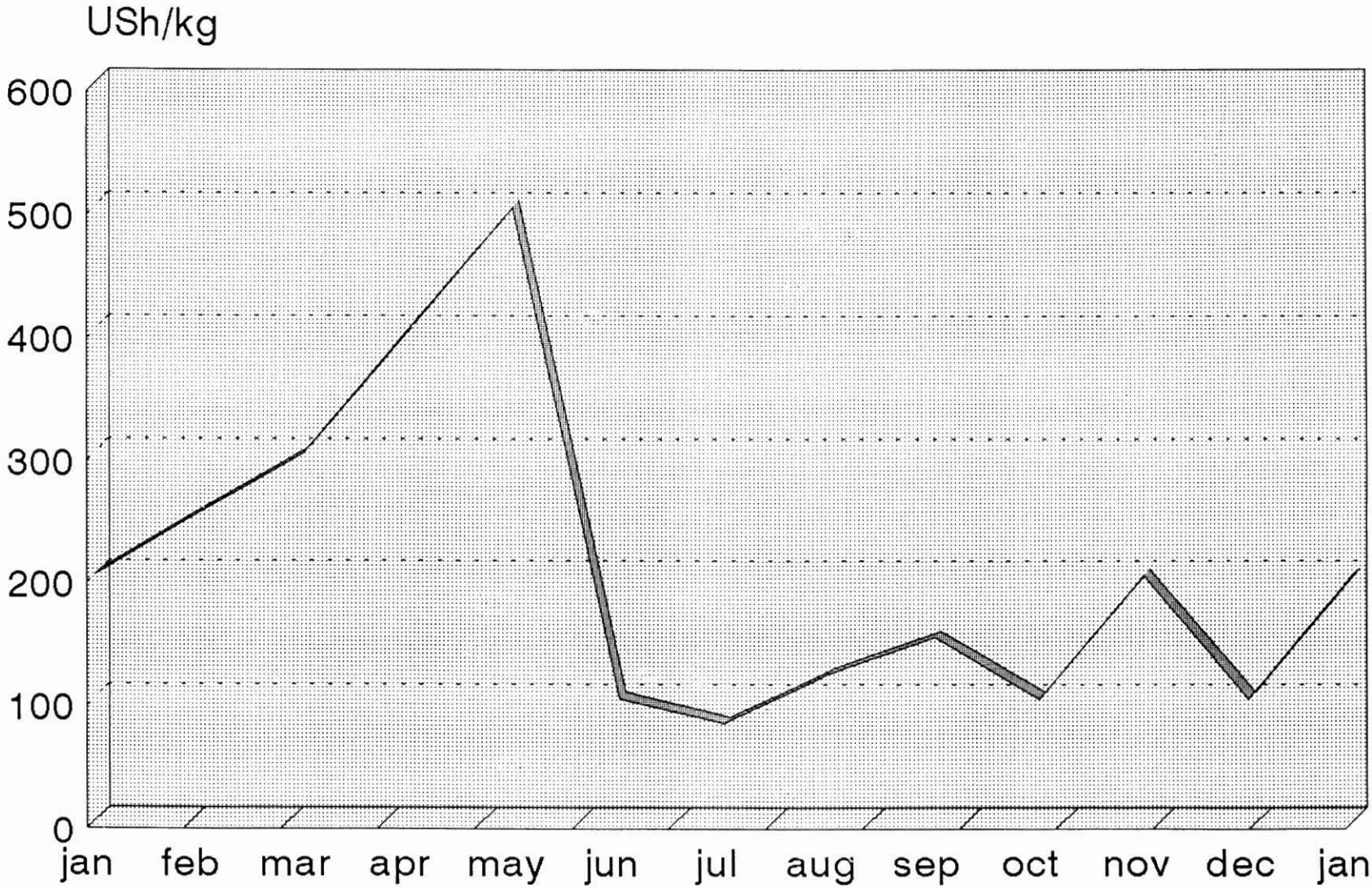
	Bugitimwa			Bubentsye		
	Fresh (n=10)	**Dry (n=8)**	**Total sales (in dried equivalent)**	**Fresh (n=12)**	**Dry (n=3)**	**Total sales (in dried equivalent)**
Quantity	200.2	52.8	69.6	344.3	41.7	107.5
Range	20-700	7-260	5.8-461	20-1800	10-100	5.8-618.4

The farm-gate price for beans reflects supply and demand and consequently fluctuates throughout the year depending on the variety and whether sold dry or fresh. K20 fetches a high price of Ush. 350-500/kg[18] at the start of the season (March-April, August-September) and a low price of Ush.150-200/kg immediately after harvest. Kanyebwa climber, sold dry, fetches a premium price of Ush.700/kg in March-April and Ush. 250/kg in November. The price of Kanyebwa climber sold in fresh state is lower and fluctuates more (Figure 2)[19].

[18] In 1995/96 the rate of exchange was US$ 1 = Ush 1016.

[19] As indicated in Figure 2, the price of fresh beans, expressed in kilos, is lower than that of dry beans. However, since fresh beans are sold in bulk (pods measured in bags or tins) rather than by weight, earnings are higher relative to dry beans.

Fig.2: Monthly prices of fresh Kanyebwa climbing beans (Ush/kg.), 1995



ADOPTION OF NEW CLIMBING BEAN VARIETIES

In 1995b, three and four years (6-8 seasons) after initial seed distribution in Bugitimwa and Bubentsye, respectively, the majority of farmers who had ever planted a new variety were still sowing it or had retained seed for future use (Table 13). Umubano was the most widely adopted of the three varieties followed by Gisenyi and Urunyumba. The rate of adoption in 1995b for new varieties was higher among farmers who had obtained seed through the informal diffusion process (with the exception of Urunyumba) for two likely reasons: first, these farmers had grown the new varieties for a shorter time compared to the initial seed recipients (see Table 15), and hence were less likely to have involuntarily lost seed as a result of agro-environmental stresses, and secondly, since they obtained seed through their own efforts, they are likely to be strongly motivated to grow the new variety.

Table 13: Percent of farmers sowing or retaining seed of the new climbing bean varieties in 1995b

	Umubano	**Gisenyi**	**Urunyumba**
All farmers who ever sowed new variety	88 (n=59)	50 (n=14)	45 (n=20)
Direct seed recipients	73 (n=11)	43 (n=7)	46 (n=11)
Indirect seed recipients and other farmers	92 (n=48)	57 (n=7)	44 (n=9)

Adoption of the new varieties was motivated by farmers' appreciation of several characteristics, as listed in Table 14. The only negative characteristics mentioned by a significant number of farmers were poor market, low yields and poor soup quality. Only a minority of farmers had sold the new bean varieties: six sold Umubano, three sold Gisenyi and one sold Urunyumba. Umubano was nearly always sold fresh. Farmers noted that Umubano has an unreliable market due to its small seed size; traders only buy it when preferred varieties are in short supply. In Mbale District, where most farmers want a variety that they can both eat and sell, lack of market is likely to be a constraint to the wider adoption of this variety in the short-term. However, the evidence that market demand for unknown and unappreciated seed types can develop in 3-5 years, provided that cultivars have other positive characteristics (e.g. good taste, short cooking time), suggests that adoption may pick up with time, with or without external intervention.

Among the farmers who sowed or retained seed of the new variety in 1995b, more than half had kept seed for three or more seasons, showing appreciation for the varieties (Table 15). For all varieties, as expected, farmers who received seed from farmers collaborating with the MECDP had retained seed for a shorter period compared with the latter.

Table 14: Varietal characteristics mentioned by >20% of respondents (percent of respondents)

	Umubano (n=38)	Gisenyi (n=10)	Urunyumba (n=16)
High yielding	97	70	50
Low yielding	0	20	38
Good market	0	10	6
Poor market	53	30	25
Disease resistant	50	30	0
Tasty	63	60	56
Fast cooking	40	40	63

Although adoption in 1995b was not determined by household resources, as adopters were represented in all wealth categories and had different farm sizes, the data suggest that ability to retain seed of the new varieties is associated with wealth. Better-off and average farmers (72% in each case) who had planted Umubano were more likely than poor farmers (38%) to retain seed of Umubano for three or more seasons ($p \leq .05$). No significant association between wealth and the adoption of the other two varieties was found, probably due to small sample sizes.

Table 15: Percent of adopters in 1995b who retained seed of the new varieties for a given number of seasons

Period of retention	Direct seed recipients			Indirect seed recipients/other farmers		
(seasons)	Umubano (n=8)	Gisenyi (n=3)	Urunyumba (n=5)	Umubano (n=40)	Gisenyi (n=3)	Urunyumba (n=3)
One	0	0	0	23	0	0
Two	0	0	0	25	33	33
Three	100	100	100	53	67	67

Production

Although the new varieties are generally higher yielding than traditional climbers, only 11% of farmers surveyed observed the need to use more robust stakes. The new cultivars therefore do not appear to increase labor or otherwise change farmers' current practices. Most farmers sowed the new varieties individually, but a minority in Bugitimwa mixed seed of Gisenyi and

Urunyumba with Kanyebwa climber[20]. Since the green pods of these varieties resemble Kanyebwa climber (unlike Umubano), they can be mixed and sold fresh without traders being aware of the new variety. Umubano was only sown in a mix with another new variety by one farmer.

On average, in both seasons of 1995, farmers planted smaller quantities of the high yielding Umubano (Table 16) compared to Kanyebwa climber (Table 5). Contrary to the situation with Kanyebwa climber, both the mean amounts harvested fresh and dried in Bugitimwa surpassed the means for Bubentsye (though not significantly), a situation which can probably be attributed to the variety's disease resistance[21].

Table 16: Mean quantities (kg) of Umubano sown and harvested (dried equivalents) in 1995

	Bugitimwa		**Bubentsye**	
	1995A	**1995B**	**1995A**	**1995B**
Mean quantities sown	2.3	1.2	2.0	2.1
Range	0.2-10	0.1-3	0.3-10	0.5-8
Mean quantities sown by wealth category:				
Rich	0.7	1.1	1.8	3.1
Average	3.3	1.7	2	1.3
Poor	0.5	0.8	2.2	1.8
Mean quantities harvested	29.2		29	
Range	4-128		1-112	
Mean quantities harvested fresh, 1995a	25		22.6	
Range	7.2-108		2-86	
Mean quantities harvested dry, 1995a	11		9.3*	
Range	4-28		0.5-60	

* Difference between parish means: $p \leq .05$

[20] We distinguish between mixtures (a deliberate composition) and varietal mixes, which often result from farmers' failure to sort seed for various reasons.

[21] Per unit area yield data from varietal trials in Bugitimwa and Bubentyse are unavailable.

Varietal mortality

Most farmers who had stopped growing the new varieties by 1995b had accidentally lost seed as a result of crop failure and a multitude of other reasons such as accidentally mixing the new variety with another one, insufficient labor to cultivate beans in successive seasons and to harvest on time, poor storage facilities and inadvertently eating the seed (Table 17). The main reasons for deliberate disadoption were lack of market and the perceived poor performance of the varieties. Despite the small number of observations, reasons for varietal loss varied by variety. Most farmers who no longer sowed Umubano dropped the variety due to its poor marketability, whereas adoption of Gisenyi and Urunyumba was hampered by agro-environmental and a range of socio-economic constraints. It is notable that poor marketability was only cited by Bubentsye farmers. Irrespective of the variety, the majority of non-adopters had only sown the new variety for one season, reflecting the high incidence of accidental seed loss.

Table 17: Reasons for non-adoption and disadoption of new climbing bean varieties (number of observations)

	Umubano (n=7)	**Gisenyi (n=7)**	**Urunyumba (n=11)**
No market	4	1	1
Crop failure	0	1	4
Poor performance	0	1	2
Other deliberate reasons	0	0	2
Other unintentional reasons	3	4	2

Diffusion

By 1995, the majority of seed recipients had diffused seed of the new varieties (Table 18). Notably, direct seed recipients had been instructed to do so by the extension agent who distributed the seed. In Bubentsye, but not in Bugitimwa, wealthier farmers were more likely to diffuse seed of Umubano compared to other classes of farmers. Reasons for these differences between wealth and diffusion behavior between parishes and varieties are unclear. Although the exact amount of seed shared by farmers is unknown, amounts were probably small, 500 grams or less. Most farmers shared seed with up to three others, but a minority were more altruistic, giving seed out to four or more farmers (Table 19). Direct seed recipients diffused Umubano to significantly more farmers than indirect recipients (a mean of 6.2 compared to 1.8; $p \leq .01$), but no significant difference was observed for diffusion of the other two varieties.

Table 18: Percent of seed recipients who diffused seed of introduced climbing bean varieties

	Bugitimwa	**Bubentsye**
Umubano (n=38)	80	61
Gisenyi (n=5)	100	100
Urunyumba (n=18)	36	75

Table 19: Percent of seed recipients who diffused seed of new climbing bean varieties to a given number of other farmers

Number of recipients	**Umubano (n=26)**	**Gisenyi (n=5)**	**Urunyumba (n=8)**
1	19	20	0
2-3	50	20	12
>4	31	60	88

In 1995, the new varieties were fairly well established in the areas surveyed: 65% of "other" farmers in Bugitimwa and 75% of those in Bubentsye had seen one or more of the new varieties growing in farmers' fields. Of those farmers, 27% in Bugitimwa and 67% in Bubentsye had requested seed because they were impressed by the high yields or liked the seed. Farmers who were not directly given seed by MECDP mainly obtained seed as gifts from trial or other farmers (Table 20). Seed of Umubano and Urunyumba had acquired a market value, as some farmers had bought it.

Table 20: Initial source of seed reported by indirect seed recipients and others farmers who sowed new climbing bean varieties (percent of farmers)

	Umubano (n=47)	**Gisenyi (n=7)**	**Urunyumba (n=9)**
Gift from farmer	68	57	22
Gift from trial farmer	13	14	44
Bought from farmer	13	0	11
Other/unknown	6	29	22

DISCUSSION

Indigenous Production System

A dynamic bean production system exists in the mountains of Mbale District, involving a diversity of seed types of various growth habits. Farmers are clearly responsive to market opportunities in the production of both bush and climbing beans; this raises concerns about varietal diversity and erosion in the future. Although at present Mbale farmers grow certain varieties for home consumption and others specifically for the market, greater land fragmentation in future and other factors may result in farmers growing a few varieties that have commercial value.

As our results suggest, the threat posed to varietal diversity by biotic stresses might be alleviated by the regular introduction of improved cultivars which are well regarded and adopted by farmers. However, the occasional release of new materials into a dynamic system such as found in Mbale will have little impact on increasing varietal diversity given the tendency for local materials to be pushed out by new ones. In the changing environmental and market climates of Eastern Africa, bean research programs in Uganda and elsewhere face the challenge of providing their clients (i.e. farmers) with a wide selection of new, preferred genetic materials on a regular basis, either through national or regional research efforts. Indeed, the Mbale case provides an important success story of regional germplasm/ technology exchange supported by the Eastern and Central Africa Bean Research Network (ECABREN)[22]. Once cultivars are released, researchers and development agencies are faced with problems of technology delivery.

Seed Dissemination Approach

The Mbale experience has provided several valuable lessons about approaches to collaboration between researchers and NGOs in on-farm testing and technology transfer. Difficulties experienced by CIAT scientists in ensuring proper implementation of trials and compilation of trial results were noted. Monitoring of adoption and diffusion also proved problematic. Since the involvement of researchers in regular monitoring of trials is not always possible, clear guidelines for trial implementation and monitoring of seed movement should be specified to NGOs in kits containing forms to ensure concise reporting. A follow-up survey to document adoption should be a routine activity built into any seed dissemination effort from the start to ensure proper record keeping on seed recipients.

Several factors, including the variety's high productivity, its popularity with farmers and the targeting of wealthier farmers, may account for the modest adoption rates and relatively rapid diffusion of Umubano from the initial distribution of an insignificant amount of seed. While it is not possible to assess the relative importance of each contributing factor, the deliberate strategy of targetting richer farmers merits comment. Our finding of longer seed retention (hence higher adoption rates) by better-off farmers is corroborated by data from several studies showing relatively greater self-sufficiency in seed of local varieties among wealthier

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[22] Member countries of the ECABREN are: Burundi, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Sudan, Tanzania, Uganda and Zaire.

farmers (David and Sperling, 1997). Although this study provides some evidence that richer farmers were more likely to diffuse seed of Umubano than poorer farmers, this finding is not conclusive. A wealth-biased, "trickle down" distribution strategy for introduced new bean cultivars may therefore only have merit in certain extreme situations, e.g. where seed supply is extremely limited.

Adoption of New Varieties

The Rwandan varieties, particularly Umubano, have been adopted by a moderate number of Mbale bean farmers and have been successfully incorporated within the existing production system. Several factors are likely to curtail widespread, speedy adoption of the new climbing varieties. These include, most notably in the short-term, the lack of a regular supply of seed from research institutions and reliable markets, particularly for Umubano. Although this study cannot ascertain whether demand for seed of the new varieties surpasses supply, the high percentage of purposively selected respondents who obtained seed through their own efforts suggests that demand exists for the varieties which could be further stimulated by the existence of a regular supply of seed. In the meantime, seed distribution coordinated by the MEDCP, another NGO and the extension system continued in the first season of 1995 in three parishes (Bumasufwa, Bugitimwa and Buwundu) with seed of Umubano supplied by researchers. District-level, community-based seed multiplication activities could address the seed supply constraint in a sustainable manner.

Lack of market is no doubt a temporary constraint, as is frequently the case with new or unappreciated seed types. In any event, most farmers who grew Umubano were not discouraged by this problem. Future prospects for the spread of improved climbers in Mbale District therefore appear favorable and might be hastened by active promotion through various avenues and, given the restrictions on tree cutting in the Mount Elgon National Park, the introduction of fast growing agroforestry species for staking materials.

CONCLUSIONS

Beans, an important food and cash crop in the mountains of Mbale District, are grown in dynamic production systems by farmers who are highly responsive to market forces. In some parts of the District, farmers specialize in growing climbing beans to sell fresh pods which supply a fresh shelled bean market in urban areas. Despite considerable genetic resources in beans in the study sites, individual farm households sow relatively few varieties; this appears to be as a result of biotic stresses and a narrow profile of marketed seed types. Considerable impact is likely to be achieved if efforts are made by the UNBP and its NGO collaborators to promote the three varieties earlier introduced to the District. The UNBP should continue to take advantage of regional research activities on climbing beans to introduce other improved cultivars of popular market classes to Ugandan farmers, even though its research program places priority on bush beans.

The Mbale experience suggests that with careful planning and a clear delineation of roles, NGOs and research institutions can collaborate effectively in delivering new technology to farmers, each building upon their institutional strengths. A four-stage program should be designed with the following objectives and roles for each partner:

Stage 1: on-farm trials and technology evaluation conducted jointly by researchers and NGO staff to assess farmer acceptability.

Stage 2: initial technology dissemination involving NGO staff in conjunction with researchers; seed of new varieties is provided by researchers; acceptability studies are conducted by both partners.

Stage 3: full-scale technology dissemination involving NGO staff; seed of new varieties and other technological components are supplied by the NGO.

Stage 4: Adoption and impact assessment studies are conducted by researchers and NGO staff.

APPENDIX A

METHODOLOGY

FIELD DATA COLLECTION METHODS USED

Data collection method	Locality	Number of farmers involved
Key informant interviews and PRAs	Bumasifwa sub-county (Bugitimwa Parish)	Four farmers; one group
	Wanale sub-county (Bubentsye Parish)	Three farmers; one group
Formal survey	Bumasifwa sub-county (Bugitimwa Parish)	43 farmers: 20 seed recipients; 23 bean growing households
	Wanale sub-county (Bubentsye Parish)	44 farmers: 24 seed recipients; 20 bean growing households

STATISTICS

Chi square tests were performed to measure association between variables. Non-parametric tests (Mann-Whitney and Kruskall-Wallis) were used to compare sample means between groups.

APPENDIX B

Climbing bean landraces commonly sown by households surveyed in the mountains of Mbale District

Color	Seed size	Seed pattern	Number of land-races observed	Local name	Percent of farmers usually sowing (N=87)
Pink/ purple	Large	Mottled	2[1]	Kanyebwa	97
		Mono-colored	1	Unknown	18
Brown/ yellow	Large	Zebra striped	1	Nangolo	28
		Mono-colored	1	Unknown	1
Grey	Large	Speckled	1	Nabufu / Bulan-geti	16
Black	Large	Mono-colored	1	Mumali	5

[1] Two types of Kanyewa are often grown in a mix, although farmers do not recognize them as separate varieties.

Bush bean landraces commonly sown by households surveyed in the mountains of Mbale District

Color	Seed size	Seed pattern	Number of land-races observed	Local name	Percent of farmers usually sowing (N=87)
Red/pink	Large	Mottled	1	Tanzania/ Kawanda[1]	93
Red/pink	Medium	Mottled	2	Kanyebwa	17
				Mutike	10
White	Small	Mono-colored	1	Buwanga	14
White	Medium	Mono-colored	1	Buwanga	6
Yellow	Small	Mono-colored	1	Unknown	3
Mixture	Large	Mono-colored, mottled	3	Okubimba/Inola	3
Beige	Large	Mottled	3	Mazolaye	1
				Unknown	1
				Unknown	1
Grey	Large	Speckled	1	Nabufu	1

[1] Purity of this variety (K20) is questionable.

Semi-climbing bean landraces commonly sown by households surveyed in the mountains of Mbale District

Color	Seed size	Seed pattern	Number of land-races observed	Local name	Percent of farmers usually sowing (N=87)
Red/pink	Small	Mono-colored	2	Butandafu	11
				Unknown	2
		Speckled	1	Nabufu	6
Black	Small	Mono-colored	1	Bumali	16
White	Small	Mono-colored	1	Buwanga	11
		Black striped	1	Nangolo	1
		Black ring around hilum	1	Buwanga	1
Brown/ beige	Small	Mono-colored	2	Unknown (dark color)	8
				Unknown (light color)	2
Brown/ yellow	Small	Mono-colored	1	Unknown	5
Red/pink	Medium	Mottled	1	Unknown	2

APPENDIX C

Woods most commonly used for staking climbing beans in Mbale (percent)

Species	**Bugitimwa (n=42)**	**Bubentsye (n=44)**
Bamboo	67	0
Vanonia spp. (zinyiriyi)	7	39
Markhamia platycalyx	10	16
Coffee	12	9
Vanonia spp. (zisopo)	5	11
Croton spp.	0	11
Sesbania spp.	0	2
Eucalyptus	0	2

Per season cost of 100 stakes in Mbale (US$)

	Bugitimwa	**Bubentsye**
Bamboo	0.25	na
Coffee	0.20	0.98*
Vanonia spp./Croton spp.	0.72	0.72

* based on the answer of a single farmer

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