ASSESSING THE IMPACT OF BUSH BEAN VARIETIES ON POVERTY REDUCTION IN SUB-SAHARAN AFRICA: EVIDENCE FROM UGANDA

Soniia David, Roger Kirkby and Sarah Kasozi

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PREFACE

This volume, the thirty-first in a series that serves research on common bean (*Phaseolus vulgaris*) and its smallholder production systems in Africa, complements several previous publications in this series. Achievements in disseminating new bean varieties through better understanding and more effective use of seed systems have been documented in several papers (Nos. 15, 19 and 21). The effect of improved climbing beans upon production intensification in Rwanda (No. 12) was the Network's first significant impact, and probably still its most dramatic.

Yet, bush beans are much more extensively grown and researched in Africa, and evidence accumulating from local adoption studies by collaborators in many countries suggest that more modest gains in these production systems amount to extensive economic impact affecting millions of small farmers. This strategic study, carried out by CIAT as part of its contribution to the overall effort, aimed to examine this hypothesis at household level in one area of Uganda for which the importance of bush beans in the farming system and domestic economy was already well understood (see No. 28).

The Network on Bean Research in Africa serves to stimulate, focus and coordinate research efforts on common bean, the systems within which it is produced and the people who consume it. 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 Southern Africa 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); the United States Agency for International Development (USAID); and the African Development Bank through SACCAR, the Southern Africa Development Conference (SADC)'s sector coordinating unit for agricultural research.

This Occasional Papers series includes bibliographies, research reports and network discussion papers. These publications are complemented by two associated series: Workshop Proceedings and Reprints. Further information on bean research in Africa is available from:

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

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

Coordinator, Southern Africa Bean Research Network, Chitedze Research Station, P.O. Box 158, Lilongwe 3, Malawi.

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ASSESSING THE IMPACT OF BUSH BEAN VARIETIES ON POVERTY REDUCTION IN SUB-SAHARAN AFRICA: EVIDENCE FROM UGANDA[1]

Summary

This paper investigates the impact of two modern bush bean varieties, K132 and K131, on income, food security and consumption patterns and gender relations through a longitudinal study of a rural Ugandan community. The discussion provides a cross-sectional and historical perspective of change and assesses impact by household wealth status. In just 4 years, the new varieties accounted for 74% of bean area among a sample of 100 adopters. Though adopters did not show significant income gains in the first season of 1998, per capita bean consumption increased significantly over figures recorded before the introduction of the varieties. Some, if not most, of this increased consumption can be attributed to the higher productivity of both varieties. While impact was wealth and gender neutral, the greatest benefits went to households of average wealth who have the necessary resources (land, labor) to take advantage of yield increases. The paper concludes that modern bean varieties can contribute importantly to poverty alleviation, although gains in quantitative measures of welfare such as income and per capita food consumption may be modest in the case of bush types (climbing beans were not used in the study area). The paper also explores the general issue of mechanisms for enhancing the research-poverty linkage.

Introduction

The common bean (*Phaseolus vulgaris* L.) plays a paramount role in human nutrition and market economies throughout rural and urban areas of Eastern Africa. Eastern Africa has the highest bean production in sub-Saharan Africa at 1,297,000 t per annum (Wortmann et al., 1999). The largest producing countries include Kenya, Uganda, D.R. Congo, Burundi, Tanzania, Rwanda and Ethiopia. While beans are considered a low status food, the "meat of the poor", they provide the second most important source of protein after maize and the third most important source of calories after maize and cassava (Pachico, 1993). Beans are also highly valued by the poor because all parts of the plants can be consumed: the grain is eaten fresh or dried, the leaves are used as vegetables and the stalk is used to make soda ash. In some parts of Eastern Africa bean grain consumption exceeds 50 kg per person per annum (David, 1999, Jaetzold and Schmidt, 1983) but is likely to drop with increased income.

Although beans are largely produced for subsistence, mainly by women farmers, approximately 40% of production in sub-Saharan Africa is marketed at a retail market value of $452 million (Wortmann *et al*., 1999). The short maturity of beans (3 months on average), ease of handling and storability make them a coveted cash crop for small-scale farmers. Presently, the high dependence of poor rural and urban East Africans on beans is threatened by reduced average farm size due to rapid population growth, unsustainable efforts to intensify resource use and serious secondary results of soil fertility decline such as increased crop susceptibility to certain diseases and pests. Due to various factors, including the predominance of cultivars susceptible to numerous biotic and abiotic stresses and dependence

[1] Paper presented at the workshop "Assessing the impact of agricultural research on poverty alleviation", San Jose, Costa Rica, September 14-16, 1999.

on beans as both a food and cash crop, many rural producers are not self-sufficient in beans (David, 1999).

The response to this situation by bean researchers has been commendable: between 1992 and 1996, 69 cultivars were released and disseminated in eight Eastern African countries (David, 1997). Estimates from adoption case studies indicate that the cumulative impact of new bean varieties now exceeds US$ 150 million (Wortmann and Johnson, forthcoming). This paper complements that approach to impact assessment in Eastern Africa by exploring the contribution of bean research to poverty alleviation. We ask three basic questions in the context of a specific community in Uganda: can modern bush bean varieties improve the welfare of small-scale African farmers and if so, how and to what extent? The discussion examines impact at three levels: on household income, food security and consumption patterns and gender relations. Additionally, we explore factors that enhance or reduce the contribution of varietal improvement to poverty reduction.

Bean research and poverty reduction in Uganda

Bean research in Uganda and Eastern Africa generally, as implemented under the umbrella of the Uganda National Bean Program (UNBP) and the Pan-African Bean Research Alliance (PABRA)[2] has the broad goal of "contributing to poverty alleviation and the incomes of rural populations in Africa and, for both rural and urban populations, improving food security including protein availability" (CIAT, 1998). PABRA seeks to increase the productivity and commercialization of beans through the adoption of sustainable production technologies with the basic assumption that higher production of beans will translate into higher incomes and improved food security (Table 1). In the PABRA context then, the definition of poverty is limited to a rather narrow focus on inadequate income and consumption compared with the more comprehensive perspective popular in current development circles which sees poverty as "the absence of a secure and sustainable livelihood" (Lipton and Maxwell, 1992).

Uganda represents both an anomaly and a representative case for assessing the research-poverty linkage in Eastern Africa. Fifteen years of civil strife up to 1986 resulted in the destruction of the economy including the agricultural research system. Uganda in the 1990s is acclaimed as a development "success story" due to macroeconomic stabilization, sustained economic growth over a decade, relative socio-political stability, modest gains in social provision and progress towards achieving democratic governance. Although there is recent evidence of modest declines in absolute poverty (UNDP, 1999), Uganda remains a poor country.

In 1995/96, 50% of 16 million rural Ugandans were poor, meaning they could not meet their food requirements (UPPAP, 1999). Nationally, 26% of the population could not obtain sufficient food nor non-food essential requirements (e.g. shelter, clothing, health care and basic education). The main material indicators used by local people to measure poverty are: lack of sufficient food and income, lack of livestock, inability to educate children, insufficient or lack of land, poor housing and clothing (UPPAP, 1999). Non-material indicators included

[2] PABRA consists of three institutions: the Eastern and Central Africa Bean Research Network (ECABREN), of which Uganda is a member, the Southern African Bean Research Network (SABRN) and CIAT. Membership of the two networks is drawn from national bean research programs, universities, NGOs and the private sector in the respective regions.

poor health, idleness, having no one to help with problems and a sense of helplessness. Despite improved statistics on poverty, a recent study reports that local people feel that poverty is increasing (UPPAP, 1999). According to UNDP (UNDP, 1999), the major causes of poverty in Uganda can be grouped into four categories: institutional constraints (lack of social and economic infrastructure such as favorable marketing facilities, inappropriate structural organizational systems), lack of requisite resources (land, credit, agricultural inputs etc.), political instability, epidemics and natural disasters and socio-cultural practices and belief systems which retard human development.

In the 1960s, Ugandan health officials identified a high incidence of malnutrition among children (pers. comm., F. Opio). The Ministry of Agriculture responded by initiating bean research at Kawanda Research Station. The bush variety K20, released in 1968, was the first product of bean research activities and is currently widely grown in Uganda, Kenya and Tanzania (Grisley, 1994) for its marketability and yield stability. In 1994, twenty six years after the release of K20, the Uganda National Bean Program released two CIAT bred lines: K132, a Calima seed type similar to K20, and K131, a Carioca seed type, previously unknown in Uganda. K132, a determinate bush type (Type 1), characterized by dark red mottled, large seeds, though highly marketable, is susceptible to many production constraints. K132, an indeterminate bush type (Type II), characterized by small beige seeds mainly preferred in the east and north of Uganda, has resistance to bean common mosaic virus (BCMV), a moderately important production constraint in some regions.

No precise figures are available on the amount of seed distributed by formal institutions, but estimates suggest 450 t of K132 and 600 t of K131 by 1999 (PABRA, 1999). Adoption studies show and predict modest uptake of K132 in most parts of the country (David et al., 1997; ADC/IDEA, 1996) but low adoption of K131 in the south and central regions (Kato, forthcoming; David et al., 1997). However, observation suggests a higher rate of adoption for K131 in the east and north. In the absence of nation-wide adoption studies, extrapolations based on seed sales and knowledge about diffusion offer estimates of impact for the two varieties (PABRA, 1999). By 1998, K132 was sown on an estimated 4,100 ha with a production increase of 290 t valued at $87,000 (farm gate price). K131 was sown on an estimated 45,000 ha with a production increase of 6,303 t having a farm value of $1, 891,000.

Table 1. Poverty related aspects of PABRA's research strategy for beans

General strategy	Poverty-related goal
Alleviate biotic and abiotic production constraints through resistant/tolerant varieties	Increase production and productivity leading to higher incomes and food security
Rapid release of varieties of multiple seed types and traits (e.g. quick cooking, early maturity)	Meet the needs of a diversity of user groups
Participatory approaches in breeding	Incorporate preferences of marginalized groups, especially women and the poor
Varieties released for regional and export markets	Increase commercialization and income of small-scale farmers
Improved farmer access to market information	Increase commercialization and income of small-scale farmers
Development of post-harvest technologies (e.g. bruchid control)	Reduce post-harvest losses, a problem specifically affecting women and the poor
Development of soil improvement technologies and decision support systems	Provide low cost approaches for improving soil productivity
Decentralized seed production, and promotion/dissemination of new varieties through diverse channels	Widely disseminate seed in a sustainable manner to all categories of producers, especially women and the poor

The setting

The study is set in the maize-based farming system of Eastern Uganda in Mbale District. Mbale and surrounding areas rank as the fifth major bean producing area (Wortmann and Eledu, forthcoming). Biophysical and demographic information on Nabongo Parish, the study community, appear in Table 2. This parish was selected to represent high potential areas of the country where small-scale farmers grow beans both for food and sale. With the decline of coffee in the early 1980s, bean production in Mbale became more commercialized in response to demand from neighboring Kenya and urban centers in Uganda. Groundnuts and maize are other important income earners. Beans are sown during two seasons (Season A: February-June; Season B: August-November), although the February season is considered more favorable.

Table 2. Selected characteristics of Nabongo Parish, Uganda

Altitude (m)	1200
Dominant soil type	Nitosols
Rainfall (mm)	1222
Households in study villages (1998)	283
Population density (km^2)	186
Main crops	Maize, beans, bananas, sweet potatoes, cassava, groundnuts, millet, cotton
Accessibility	Good

Source: Republic of Uganda, 1992; David, 1999

In 1994, K20 was the major variety sown in Nabongo, accounting for 74% of a total of 40 ha of beans sown by surveyed households. Major production constraints include bean leaf beetle (*Ootheca* sp.), common bacterial blight (CBB), angular leaf spot, bean stem maggot and bean root rots. In Nabongo, beans may be grown on both household plots and plots belonging to individual men or women. Women provide much of the labor in field and post-harvest activities but male participation in field activities, both on household and personal plots, and sales has increased with commercialization (David, 1999).

Methods

Seed distribution and research activities concentrated on three neighboring villages (Bwighonge, Bunywaka and Bumulaha) between 1995 and 1999. To achieve rapid adoption, nearly 400 kg of seed of K132 and K131 was sold in the study sites over three seasons (1995-1996) through women's groups and individual sellers. The seed was priced at Ush 600-800/kg[3] and buyers were limited to purchasing one kg per variety.

The impact of new bean varieties was assessed through a longitudinal study using a combination of quantitative and qualitative data collection methods (Table 3). This paper mainly draws on results from a 1998 survey of 100 adopters (henceforth the impact sample), although reference is made to baseline surveys conducted in 1995 and 1996 (David, 1999), a 1998 adoption study conducted in 3 non-study villages (henceforth the adoption sample) and a 1998 food security survey. Most respondents in the impact and food security surveys were women or farm couples. The reference period for yield, income and other quantitative data is the first season of 1994 and 1998[4] The discussion provides both a cross-sectional and historical perspective of change in bean production on both household and personal plots between 1994 and 1998 by drawing on baseline data collected in 1995.

[3] The rate of exchange was US$1=Ush960 in 1994 and US$1=Ush1265 in 1998. Seed was sold at the official price set by the Uganda Seed Project.

[4] Farmers considered bean yields during both seasons to be moderate too high. The El Nino weather phenomenon did not have a major adverse effect on crop production in Nabongo in 1997b and therefore bean yields in 1998a were considered normal

Table 3. Summary of formal data collection methods

Type of survey	General baseline during a post-harvest period	Food consumption baseline during a period of moderate food shortage	Assessment of independent women bean farmers	Food security during a period of severe food shortage	Impact	Adoption
Month/year	June 1995	September 1996	May 1997	April 1998	September 1998	September 1998
Sampling procedure and sample size	Random, stratified by wealth and village, N=80	Random, stratified by wealth and village, N=40	Purposive, N=20	Random, stratified by wealth N=21 adopters; N=22 non-adopters	Random among adopters, stratified by wealth and village, N=100	Simple random, N=100

Note: Qualitative and informal methods used include: matrix ranking, group interviews impact diagramming, wealth ranking, key informant interviews and case studies.

Characteristics of survey respondents

A predominant proportion of the sample was drawn from average (42%) and poor households (44%), while the rich and above average represented 4% and 10% each. The main wealth indicators identified by key informants are summarized in Table 4. Eighty one percent of households were headed by a resident male; female headed households (14% of the sample) were disproportionally drawn from the average and poor wealth groups. The mean age of heads of households was 46 and household size ranged from 4-7. While all households regularly cultivated beans, 44% considered it their highest source of crop income. It is significant that a relatively higher proportion of poor households (51%) compared to wealthy (43%) and average households (38%) depended on beans as a principal source of crop income.

An important demographic difference worth noting between adopters and non-adopters in the food security survey is that poor and female-headed households comprised a larger proportion of the sample of non-adopters compared to adopters.

Table 4. Summary of wealth indicators for Nabongo Parish

	Rich	Above average	Average	Poor
Amount of land owned (ha)	3+	0.4-1.6	0.1-0.4	≤ 0.1 or landless
Average bean area (ha)	0.69	0.57	0.39	0.27
Number of cattle	10+	2-3	0	0
Type of house	Brick/ Permanent	Tin roof	Grass thatch	Grass thatch, often homeless
Education of children	All children in school	All children in school	Educate up to primary, some to secondary level	Unable to send children to school
Occupation/source of income	Salaried employment, trader, sells major crops	Trade and petty business	Sells major crops	Works as hired labor
Other comments	Eats meat regularly, owns ox-plow, hires labor	Owns ox-plow, hires labor	May have to buy food after selling food crops	Not self-sufficient in food, some are drunkards, not married

Adoption pattern and productivity of the new varieties

As Table 5 shows, households in both the impact and food security surveys preferred K132: 98% and 100% of the households sampled in the impact and food security sample sowed that variety in 1998 compared to 47% and 43% for K131. High adoption rates in neighboring non-study communities (72% for K132 and 22% for K131) suggest that the introduction of the varieties as part of a research activity did not artificially stimulated adoption. Adoption was influenced by wealth: poor and average households were more likely to adopt only one variety (usually K132) and a higher proportion of wealthy households (64%) compared to average (43%) and poor (45%) households adopted K131. The preference for marketable varieties can be explained by the greater dependence of poorer households on beans as a source of income. Nearly all farmers who discontinued growing a new variety (51%) dropped K131 mainly due to lack of market (67%).

Table 5. Adoption of K132 and K131 by 1998 (percent)

	Impact sample (N=100)	Food security sample (N=21)
Both varieties	45	43
K 132 only	53	57
K 131 only	2	0

The majority of survey respondents were early adopters, first sowing the new varieties in the first seasons of 1995 and 1996. In most cases (81-84% in 1997b and 1998a), both varieties were sown only on household plots; the rest sowed the variety on both personal and household plots. The decision to adopt K132, the more marketable variety, on household plots was jointly made by men and women in 31% of cases, while women made the decision to grow K131 on household plots on their own in 52% of cases.

Only seven seasons after introduction, the two bean varieties accounted for 74% of total bean area sown on household plots by surveyed households (Table 6). K132 was the major variety sown in 1998a; others included Kanyebwa (a mottled pink landrace), K20 and Buwanga (various white haricots). Total bean area, as well as area planted to both new varieties, differed significantly by wealth due to a few wealthy households that sowed 1 acre or more of the new varieties (Table 7).

Table 6. Area sown to specific bean varieties on household plots in 1998 and 1994

Variety	Season 1998a		Season 1994a	
	Area (ha)	Total (%)	Area (ha)	Total (%)
K132	19.3	62	-	-
K131	3.8	12	-	-
All modern varieties	23.1	74	-	-
Kanyebwa	5.4	17	5.2	13
K20	2.3	7	30	74
All local varieties	8.2	26	-	-
Total	31.3	100	40	100

Table 7. Area (ha) sown to bean varieties on household plots by wealth status, first season 1998

	All bean varieties		K132		K131	
	Mean	Range	Mean	Range	Mean	Range
Mean area	0.36	0.03-1.2	0.23	0.01-0.69	0.13	0.01-0.85
Wealthy	0.61	0.17-1.2	0.39	0.14-0.69	0.44	0.03-0.85
Average	0.39	0.01-0.93	0.26	0.03-0.57	0.06	0.02-0.13
Poor	0.27	0.03-0.61	0.17	0.01-0.61	0.11	0.01-0.28
Significance level for differences among wealth groups	ns	-	0.001	-	0.001	-

The farmgate value of production in the first season of 1998 was $2833 for K132 and $287 for K131. Area sown to K132 and K131 in the minor growing season was significantly less: 15.4 ha in 1997b and 16.7 ha in 1998b. In most cases, both varieties were intercropped with maize. It is also notable that total bean area among the households surveyed in 1998a was 5% larger compared with 1994a, although average bean area was 0.36 ha, a decline from 0.49 ha in the first season of 1994 (David, 1999). A major factor that could account for decreased

bean area in 1998 were cattle raids in April, which interrupted planting and caused many farmers to flee their villages. A few adopters also reduced the amount of bean seed sown due to better germination (9 cases), the need to sow K132 at a wider spacing (7 cases) and the higher yields of the new varieties (3 cases).

Mean yields (Table 8) were high for intercropping. The lower than expected yields of K131 (11% less than K132) may have been due to a mid-season dry spell, which depressed yields of this longer maturity variety. The yield advantage of the two modern varieties over the dominant local varieties indicates that K132 and K131 brought about significant productivity increases on farms where they have been adopted.

Table 8. Comparison of mean yields of K132 and K131 with local cultivars, first season 1998

Variety	Mean yield (kg/ha)	Percent increase over local cultivars	
		K20	Kanyebwa
K132	680	38 (n=14)	35 (n=48)
K131	724	79 (n=5)	69 (n=14)

Performance characteristics which encouraged adoption of K132 included: high yields (100%), marketability (92%), fast cooking time (93%), high grain density (85%), drought tolerance (83%) and taste (80%). The major disadvantage of the variety mentioned by 71% of adopters was the need to plant at wider than normal spacing to discourage common bacterial blight[5]. Resource poor households more frequently mentioned this problem, together with late maturity (20%) and susceptibility to diseases (13%). K131 was appreciated for its high yields (93%), taste (89%) and drought tolerance (54%), but disliked because its grain stays whole when cooked (83%) and it has a limited market (70%). Disadvantages of the new varieties specifically mentioned by women are discussed later.

Adoption of modern varieties is often accompanied by change in the cropping system. In Nabongo, over half (55%) of adopting households stopped growing one or more local bean varieties; the most frequently discarded variety was K20 (95%). Low yields (56%) and poor drought tolerance (55%) were the major reasons for dropping a variety. We recorded a total of 7 varieties compared with 8 in 1994, suggesting that at the community level, bean varietal diversity had not changed. Notably however, compared to 1994, fewer households sowed minor landraces and areas sown had reduced.

Sixty six percent of adopters that sowed the new varieties on household plots in 1998 (n=86) changed some aspect of bean cropping or agronomic practice since 1995. In 75% of cases the higher productivity and market value of K132 motivated increased bean production and hired labor (number and frequency). Reasons for reductions in seed rate were mentioned earlier.

Impact on income

Eighty eight percent of adopters of K132 reported income gains due to higher productivity and price. Middle category households perceived increased income as most important,

[5] Only 6 households growing K132 expanded area as a result of sowing at wider spacing

whereas a higher proportion of the poorest and wealthiest households emphasized the food security and health benefits of K132 despite their greater dependence on beans as a source of income (Table 9). K132 was quickly accepted by traders, and by 1997 had captured the market for Calima types, commanding a premium price of Ush150-500/kg in 1998, Ush 50-100 above the price of K20. Kanyebwa fetched the highest farm-gate price for beans (Ush. 200-700/kg). There was no change in bean farmgate prices between 1994 and 1998.

Table 9. Farmers' ranking of positive impacts of K132 by wealth status (percentage)

	Wealthy (n=14)	Average (n=41)	Poor (n=43)
Most important			
More food	29[b]	34[b]	**47**[a]
More money	29	**56**	30
Better health	**36**	2	9
Second most important			
More food	**50**[c]	**41**[c]	**35**[a]
More money	21	24	33

[a] rainy season mainly; [b] dry season mainly; [c] both seasons equally
χ^2=27.4; P <.001

On average in the first season of 1998, adopters sold 92 kg of K132 at a farm-gate value of Ush 26,169 compared with 48 kg for all other bean varieties combined, valued at Ush 17,400. K132 provided 90% of bean earnings in the major season of 1998. It is unclear why, despite the higher productivity of K132, mean average bean sales were significantly lower in 1998 compared to 1994 (97 kg compared to 137 kg). In both years, there was a statistically significant relationship between bean sales and wealth. But whereas wealthy households had the highest sales in 1994 ($P \leq .02$), in 1998 households of average wealth sold the most beans: 208 kg compared with 170 kg for the wealthy and 129 kg for the poorest group ($P \leq .06$).

Due to lower bean sales in 1998 compared with 1994, the data show no income gains among adopters generally (Table 10). In fact, bean earnings showed a slight drop in actual value and a significant drop in 1994 values. It is significant however that only the average wealth group recorded income gains, a finding corroborated by farmers' perception of impact (Table 9), though not by their ranking of income sources.

Table 10. Bean income from household plots in the major season of 1994 and 1998 by wealth status (medians in parentheses)

	1998 (actual values)	1998 (adjusted to 1994 values)	1994
Overall mean	29,154 (15,500)	22,098	29,226 (20,000)
Wealthy	30,928 (15,500)	23,443	46,671 (37,000)
Middle	39,017 (26,000)	29,575	25,184 (20,000)
Poor	18,176 (8,000)	13,777	22,092 (11,000)
Significance level for differences between wealth groups	0.07	-	0.02

Farm families used income gains from K132 for both short-term consumption and productive investments including: household items (soap, paraffin, candles, sugar and salt)(88%), food (69%), medical expenses (68%), clothes (66%), personal items (e.g. bicycles, radios) (39%), school fees (28%), livestock (23%), renting land (18%), hiring farm labor (17%), building materials (e.g. iron sheets) to improve or expand houses (14%) and paying taxes (11%). Household items were the most important area of expenditure for the poor and average wealth groups (44% and 49% respectively), while school fees topped the list for wealthy households. Food was the second most important area of expenditure for all wealth categories.

Impact on household food security and consumption patterns

Beans, eaten fresh or dried, are an important and highly valued protein source in Nabongo since few households regularly consume animal protein. Groundnuts and an assortment of domesticated and wild vegetables (including bean leaves) are the other major sauce ingredients that accompany the principal staples of maize, cooking bananas and sweet potatoes. Food consumption patterns differ significantly by wealth and season, with the poor eating fewer meals than better off households at certain times of the year, particularly January to April and September to December (David, 1999).

Improved food security and health were important benefits mentioned by adopters of both varieties, although the relative importance varied by wealth, variety and season. Wealthy and poor adopters of K132 were more likely to mention food security and health benefits, while households of average wealth stressed financial benefits. The major benefit of K131 for all wealth groups was improved food security. As expected, more farmers reported impact on food security in the dry season compared to the rainy season for both varieties. Adopters reported various improvements in food security (Table 11). K131 had a greater impact on bean availability, especially during the dry season, while a significant number of K132 growers were able to diversify their diet in the dry season with sale earnings and increased bean consumption.

Table 11. Impact of K132 and K131 on bean availability and food security by season (percent)

	K132 (n=98)		K131 (n=49)	
	Dry season	Rainy season	Dry season	Rainy season
Have beans in store, before had none	24	1	57	0
Eat more beans per meal	26	62	55	51
Eat beans more often	48	36	71	35
Use earnings to buy food	45	35	0	0

Both quantitative and qualitative data confirm higher bean consumption from 1995 levels among adopters. Change was greatest in the dry season. Compared with non-adopters, adopters across all wealth categories were more likely to have a larger amount of beans in store and consume more during periods of food shortage (Table 12). On average, households growing the new varieties ate beans at 5 meals per week during the dry season compared to two for non-adopters and prepared mixture dishes (which require larger quantity of beans) more often. Increased frequency of bean consumption during the dry season was reported by 48% of K132 growers and 71% of K131 growers. Since bean availability and consumption may be determined by a multiplicity of factors not related to production, such as the food choices made by individuals, marketing vs consumption decisions and emergency situations forcing a household to sell much of their harvest, it is implausible to attribute change among adopters exclusively to the introduced varieties. However, four factors strongly suggest that the varieties contributed directly and significantly to improving food security among adopters: improvements across wealth groups, the higher productivity of K132 and K131, limited opportunities to market K131 and anecdotal evidence.

Table 12. Availability of beans among adopters and non-adopters, April 1998 (percent)

	Adopters (N=21)	Non-adopters (N=22)	Significance level
Beans in storage[a]	76	54	-
Amount of beans in store (kg)	33	13	0.35
Stored beans sufficient for >3 months	31	0	-
Consumption (g per capita per meal)	222	220[c]	0.001

[a] With the exception of one case, all stored beans were harvested on-farm

At 214 g, the median value for per capita bean consumption in September 1998, a period of moderate bean insecurity, was significantly higher than the 166 g recorded among non-adopters in September 1996 for all wealth groups. A significant proportion of adopters reported increased bean consumption (Table 13), although it appears that the largest consumption gains went to the wealthy and average groups. Increased bean consumption is expected to contribute to improved nutrition and health, although measuring nutritional impact was beyond the scope of the study. Farmers' perceptions of health benefits provide some evidence of impact. Fifty nine percent of K132 growers and 74% of adopters of K131 growers mentioned improved health as a positive change resulting from increased bean consumption.

Table 13. Bean consumption by household wealth status in September 1998 and 1996

	September 1998	September 1996
	median values, in grams per capita	
Overall median	214	166
Wealthy	243	151
Average	224	152
Poor	200	192

An important impact on food security related to increased yields of both varieties was a reduction in the time women spent foraging for wild vegetables during the dry season. It is significant that a higher proportion of poor households mentioned a reduction in foraging as a secondary benefit of growing modern varieties. No quantitative data are available however on the amount of time saved, a positive impact for women, unknown nutritional implications caused by a less diversified diet. Although both varieties improved bean availability, fewer opportunities for selling K131 meant that this variety was more likely to be stored during the dry season. In response to an open-ended question regarding impact, 30% of K131 adopters surveyed in September compared to 21% of K132 growers reported spending less time foraging for wild vegetables. Half of the farmers interviewed for the food security survey reduced the time they spent foraging: 55% of K132 growers and 50% of K131 growers. However, 35% of K132 growers and 19% of K131 growers reported no change in this area. It is also significant that a higher proportion of K131 growers (13% compared with 5% of K132 growers) stopped foraging altogether.

Impact on gender relations

The introduction of higher yielding varieties of beans, a traditional "female crop", had both beneficial and negative impacts on the organization of production and gender relations. We expected that women would show greater interest than men in sowing K131 on personal plots because of this variety's food security value. Women noted an increase in their workload caused by three factors associated with growing K132: increased bean area, the need for more careful weeding to avoid diseases and frequent redrying of seed to reduce weevil infestation. The majority of adopters sowed both varieties only on household plots but, contrary to expectation, more women than men sowed both K132 and K131 on personal plots each season during the study period. In the major season of 1998, women farmers sowed a larger total area than men to all bean varieties and to K132 (Table 14). But contrary to our expectation that women would show a stronger interest in K131, mean areas for K131 were similar for both sexes (0.25 for men and 0.23 for women), with men sowing a larger total area to that variety. In the first season of 1998, K132 covered 60% and 61% of bean area sown by women and men respectively, while K131 covered 19% and 17% of women's and men's bean area. We discuss three areas of gender-related impact: changes in women's and men's personal production between 1994 and 1998, differences between men's and women's bean incomes and increased conflict over bean earnings.

Table 14. Area sown to new varieties on men's and women's personal plots and income earned, first season of 1998

	Men's personal plots (n=12)	Women's personal plots (n=15)
Total bean area (ha)	4.4	5.3
Total area sown to K132 (ha)	2.7 (n=11)	3.2 (n=14)
Total area sown to K131 (ha)	1.0 (n=3)	0.76 (n=4)
Mean income from K132 (Ush)	67,577	29,475
Mean earnings from beans (Ush)	80,633 (61,119)	27,120 (20,556)

Since 1995, there were a number of important changes in women's and men's personal production of beans. Women sowed larger bean plots in 1998 compared to 1996: a mean of 0.4 ha compared to 0.2 ha in the major season. Varietal diversity on women's plots did not change, remaining 2.0 on average, with 4.0 as the maximum. Bean area and varietal diversity increased among male farmers in 1998; men sowed 1.7 varieties on 0.4 ha compared to 1.0 variety on 0.3 ha in 1994. Farmers indicated that much of this expanded production was in direct response to the new varieties. Half of the independent women farmers (n=20) increased the amount of beans sown mainly in response to the higher productivity of the varieties, while half of the male farmers (n=14) sowed more seed and increased the number of plots. As a result, the significant gap observed in 1994-96 in mean area sown to beans on men's and women's plots was less apparent in 1998. Both new varieties represented similar proportions on men's and women's personal plots.

What are the implications of increased independent female bean production? Although the data do not allow us to quantify impact from this development, we infer some plausible outcomes. Since women farmers grow beans on personal plots to meet both food security and income objectives, whereas men concentrate more on the latter (David, 1999), increased female production is likely to result in higher household consumption as well as higher earnings, both of which contribute to improving household welfare. This conclusion is supported by data showing that while the majority of men and women farmers used K132 grown on personal plots in the major season of 1998 to feed their families, women were more likely than men to use a larger amount for home consumption. Yet, it is surprising that men and women sowed the same area to K131, a variety with limited market value. The gender implications of higher earnings are discussed below.

Though on average there was little difference between men and women in bean area, in the major season of 1998, men's sales and earnings from beans generally and from K132, were significantly higher than women's (Table 14). Men sold a mean of 276 kg of beans of all varieties and 214 kg of K132; women sold an average of 92 kg of beans and 99 kg of K132. Average bean incomes increased significantly for men and women: by 103% for men (over 1994 figures) and 63% for women (over 1996 figures). The gender division of responsibility might account for gender differences in bean sales and earnings. Women's greater responsibility to provision their households means that a higher number (6 out of 14 compared to 2 out of 11 men) did not sell K132 in the first season of 1998. Gender differences in the proportion of the harvest sold were noted above.

Informal discussions, rather than formal surveys, proved more appropriate for exploring other impact areas of concern to women, notably the extent of income-related marital conflict caused by the new varieties. Some women complained that higher bean earnings encouraged their husbands to take greater control over income from both household and personal bean plots. An impact diagram drawn by farmers shows that increased income from K132 caused more drinking among both men and women, which lead to more domestic violence, divorce and sexual infidelity and ultimately an increase in the incidence of AIDS (Figure 2). Conversely, a perceived benefit of K131 was the absence of marital conflict over earnings (Figure 3).

Conclusions

This paper provides evidence of the significant contribution of two modern bean varieties in just four years to food intake, nutritional status and health in a rural Ugandan community. Our findings suggest, however, that modern bush bean varieties are likely to bring about modest though important impact in the areas discussed. While the data drawn from one season did not show income gains over the baseline reference season, the higher price and productivity of K132 plus farmers' reports of higher earnings suggest that adopters received significant financial gains. Additional economic benefits, from reduced labor requirement and lower use of firewood among others, were not quantified in this study. This case study showed that although the varieties were appreciated for different reasons (K132 for its income and food value and K131 nearly exclusively for its food security value), better-off households were more likely to grow both and sowed a larger proportion of total bean area to K131. Households in the average and poor wealth categories were less likely to cultivate K131 or sowed small amounts. While impact of the new varieties was wealth neutral, the evidence nevertheless suggests that the greatest benefits went to households of average wealth. Probably due to lack of land, labor and other resources, the poorest households were unable to increase production significantly. Women farmers were as likely as men to adopt the varieties. Overall, both varieties appear to have bettered women's lives by improving household welfare, increasing both household and personal income and reducing their labor, despite the negative implications of expanded bean area and increased marital conflict reported by some households.

We pose two related questions of broad theoretical importance: what factors reduced or enhanced the positive impacts of K132 and K131? Is this impact success story likely to be replicated elsewhere in Uganda? Income benefits from the new varieties were reduced by low farm-gate bean prices, while food security benefits were lessened by farmers' high dependence on beans as a cash crop, which results in a selling-rebuying cycle. Appropriate solutions to the pricing dilemma could include direct sale of crops by farmer trading cooperatives to traders rather than through middlemen, improving farmer access to information on markets, and communal level interventions that promote crop storage until prices are higher while providing farmers with a cash advance. Bean availability at the household level would also be improved by the introduction of high value cash crops.

We maintain that three major factors enhanced the impact of the new varieties in the study community:

Access to markets: K132 fetched a relatively high price in Mbale because, in addition to its superior market characteristics (e.g. good color, grain density), it is a known seed type both in Uganda and neighboring Kenya. Its location on a main highway (being tarmaced at the time of writing) makes Nabongo highly accessible to traders from both countries. Elsewhere in Uganda, access to markets varies considerably.

High yields per hectare: Due to moderate to high soil fertility, Nabongo farmers realized yields of K132 and K131 comparable to on-station yields even when the varieties were intercropped. In much of Uganda, soil fertility is moderate to low compared to Nabongo.

Access to seed and seed quality: In a situation where farmers, especially the poor, find it difficult to retain bean seed, a reliable seed supply system enhances adoption and consequently impact. Seed quality has important implications for impact through its effect on germination and disease levels. It is therefore notable that during the course of the study, farmers' complaints about the level of seed borne diseases (notably CBB) increased. In response to continued high demand for seed and to improve seed supply and quality, a group of four farmers in Nabongo set up a business on their own initiative to produce good quality seed of K132 and K131. For small-scale farmers elsewhere in the country, regular access to good quality seed of new bean varieties at an affordable price continues to be problematic despite the commendable seed distribution efforts of research, NGOs and the formal seed sector. Some mechanisms and avenues for strengthen the agricultural research-poverty linkage include: improvement of the extension system, use of non-traditional approaches and channels for technology dissemination, stronger linkages between agricultural and health care institutions, policy changes, micro enterprise development and credit facilities, improvements in farmer access to information on local, regional and export markets and development of appropriate organizational structures.

No single community can be considered "representative" for assessing the impact of an innovation. We maintain that impact results reported here may be extrapolated to high potential mid-elevation commercialized areas of Uganda and Eastern Africa, but are less relevant to areas where farmers grow bush beans primarily for subsistence or where the very high yielding climbing varieties have been adopted. Since more extensive impact studies are unlikely to be conducted on K132 and K131 when there are so many other bean impact stories warranting investigation in the region, this study serves as a model for showing their probable impacts in other areas of Uganda. We recommend this "impact monitoring site approach" particularly for national research programs with limited human and capital resources and, to avoid issues of "representativeness", advise that studies are undertaken simultaneously in several sites in agro-ecological zones with diverse socio-economic and demographic profiles. Selecting sites that are useful to several programs or technologies should reduce overall costs.

Figure 1. Map showing study county

Figure 2. Impact of K132 in Nabongo Parish, May 1999

Figure 3. Impact of K131 in Nabongo Parish, May 1999

(see separate file for graphics)

References

CIAT. (1998) The Pan-African Bean Research Alliance (PABRA): Strengthening collaborative bean research in Sub-Saharan Africa. Project Proposal presented to CIDA, SDC, USAID.

David, S. (1999) Beans in the farming system and domestic economy of Uganda: a tale of two parishes. Network on Bean Research in Africa, Occasional Publications Series, No. 28, CIAT, Kampala, Uganda.

David, S. (1997) Dissemination and adoption of new technology: a review of experiences in bean research in Eastern and Central Africa, 1992-1996. Network on Bean Research in Africa, Occasional Publications Series, No. 21, CIAT, Kampala, Uganda.

Grisley, W. (1994). The bean revolution, Ceres 149 (5), 27-30.

Jaetzold, R. and H. Schmidt (1983) Natural conditions and farm management information. Ministry of Agriculture, Kenya in cooperation with the German Agency for Technical Cooperation (GTZ).

Kato, E. (forthcoming) An analysis of factors affecting the adoption of K131 bean variety by women farmers in Luuka County, Iganga District, Uganda. MSc thesis. Makerere University, Kampala, Uganda.

Lipton, M. and S. Maxwell (1992) The New Poverty Agenda. Institute of Development Studies Discussion Paper 306. Institute of Development Studies, Brighton, U.K.

Pachico, D. (1993) The demand for bean technology, In G. Henry (ed.) Trends in CIAT's Commodities, CIAT Working Document no. 128: 60-73, Cali, Colombia.

Pan African Bean Research Alliance (PABRA) (1999) Current and projected impact of some new bean varieties in Eastern Africa. Draft document. Kampala, Uganda.

Republic of Uganda (1999) Uganda Poverty Status Report. Draft. Ministry of Finance. Kampala, Uganda.

Republic of Uganda (1993) Report on the Uganda National Integrated Household Survey, 1992-93, Vol. 1. Ministry of Finance and Economic Planning. Entebbe, Uganda.

Republic of Uganda (1992) The 1991 Population and Housing Census District Summary Series, Mbale. Ministry of Economic Planning. Entebbe, Uganda.

Uganda Participatory Poverty Assessment Project (UPPAP). 1999. Briefing for the Plan for Modernisation of Agriculture. Kampala, Uganda.

UNDP, 1999. Uganda Human Development Report 1998. UNDP, Kampala, Uganda.

Wortmann, C.S. and C.A. Eledu (forthcoming) Uganda's agroecological zones database. CIAT, Kampala, Uganda

Wortmann, C.S., C.A. Eledu and S. David (1999) Common bean as a cash earner in sub-Saharan Africa. Report of the Bean Improvement Cooperative, Vol. 42:103-104.

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M. S. Nahdy. 1994b. An Additional Character for Sexing the Adults of the Dried Bean Beetle *Acanthoscelides obtectus* (Say)(Coleroptera: Bruchidae). J. Stored Prod. Res. 30 (1): 61-63.

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