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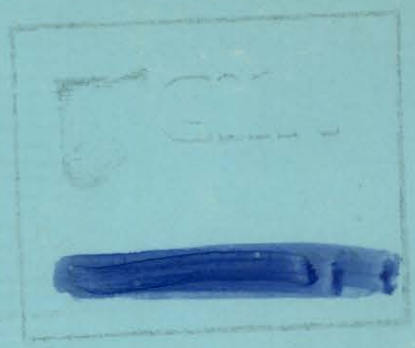

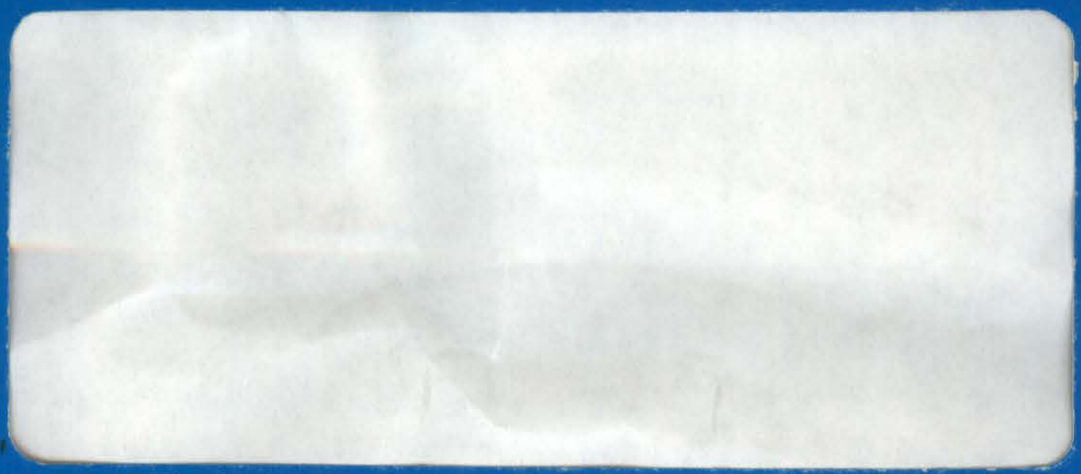

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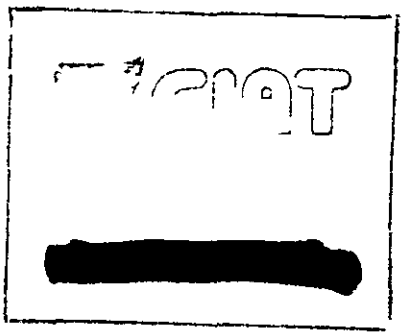

INTENSIFYING PRODUCTION AMONG SMALLHOLDER FARMERS THE IMPACT OF IMPROVED CLIMBING BEANS IN RWANDA

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PREFACE

This volume the twelfth in a working document series that serves research on common bean (*Phaseolus vulgaris*) in Africa is a summary of results from an assessment of research impact The assessment was carried out by the Centro Internacional de Agricultura Tropical (CIAT) in collaboration with the Division des Statistiques Agricoles of the Rwanda ministry of agriculture (MINAGRI) and the Institut des Sciences Agronomiques du Rwanda (ISAR) CIAT wishes to acknowledge the importance of these collaborative efforts

The Network on Bean Research in Africa serves to stimulate focus and coordinate research efforts on common bean The network is organized by CIAT through three interdependent sub-regional networks for the Great Lakes region of Central Africa for Eastern Africa and in conjunction with SADC for the Southern Africa region

Financial support for regional bean projects comes from the Canadian International Development Agency (CIDA) the Swiss Development Cooperation (SDC) and the United States Agency for International Development (USAID) Support for the study reported here was provided primarily by SDC

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

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Further information on bean research in Africa is available from

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The Banana-Bean Intercropping System - Bean Genotype x Cropping System Interactions Field Crops Research 31 (1993) 19-25
No 5 Contribution of Bean Morphological Characteristics to Weed Suppression Agron J 85(4) 840-843
No 6 The Dynamics of Adoption Distribution and Mortality of Bean Varieties among Small Farmers in Rwanda Agric Systems 41 (1993) 441-453

INTENSIFYING PRODUCTION AMONG SMALLHOLDER FARMERS THE IMPACT OF IMPROVED CLIMBING BEANS IN RWANDA

by Louise Sperling Urs Scheidegger Robin Buruchara CIAT
Pierre Nyabyenda ISAR and S Munyanesa DSA

Abstract

While bush beans (*Phaseolus vulgaris* L) have long been the protein staple of Rwandan agriculture improved climbing beans have been introduced within the last 10 years enabling farmers to intensify stabilize and better stagger production Through a nation wide survey of c 1050 households conducted during both principal growing seasons this study examines their adoption across regions and potential user groups Use of improved climbing beans by 500 000 households cross cuts farm size economic class and gender boundaries and is most intensive among the more disadvantaged Initial concerns with staking material how to obtain and manage it have posed relatively few problems for farmers and the surprising plasticity of improved climbers has encouraged research to more closely determine soil fertility demands A sharp rise in root rots (*Fusarium oxysporum*) and fear of reduced genetic variability on farm have resulted in the Institut des Sciences Agronomique du Rwanda (ISAR s) adopting targeted pathogen screening procedures and releasing many new cultivars simulta neously The success of improved climbers bringing Rwanda an additional US$ 8 to 15 million per year has stimulated promising R &D efforts in Kivu Zaire and southern Burundi and several other areas of Eastern African have been identified as prime for climbing bean introduction

Index words Central Africa climbing beans intensification small farmer agriculture

INTRODUCTION

Beans (*Phaseolus vulgaris* L) are a central crop in Rwandan agriculture They are grown by 95% of farmers in all major regions of the country (from 1000 2200 meters) and provide 65 % of the protein and 32 % of the caloric intake (MINIPLAN 1988) Beans are the meat of the Rwandan countryside

Until recently the bush bean was by far the most prominent of bean types *P coccineus* has been grown in small isolated pockets of the mid west (Zaire/Nile Divide) and local climbing beans were restricted to the northwestern part of the country (prefectures of Gisenyi and Ruhengeri) While in this northern region local climbing varieties give about twice the yield of local bush cultivars (Brewster 1988) elsewhere farmers stressed what they perceived as the climbing bean s disadvantages they need to be staked take about a month longer to mature and demand more fertile soils Surveys in 1986 in southern and central Rwanda showed only 5% of farmers growing climbing beans and then only in tiny plots (CIAT 1987)

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Research on improved climbing bean cultivars can be traced to the early 1970s at the Institut des Sciences Agronomiques du Rwanda (ISAR) (Nyabyenda 1982 1985 Rubaduka 1987) Station trials examined varietal options cultivar spacing types of staking material and stake length Research on improved climbing beans intensified with the formation of the Swiss Development Cooperation (SDC) sponsored regional network on beans a network of the national programs of Rwanda Burundi and Zaire and the International Center for Tropical Agriculture s (CIAT) Bean program Table 1 summarizes major themes addressed from 1984 to the present While efforts were spearheaded by the regional network [in 1992 anointed RESAPAC or Réseau pour l Amélioration du Haricot (*Phaseolae*) dans la Région de l Afrique Centrale] and ISAR many other partners were implicated in climbing beans R&D seed services development projects (e g Sperling et al 1990 Niang and N Diaye n d) extension specialists (INADES n d) as well as a large group of farmer experimenters

The history and extent of climbing bean research has been well described elsewhere (see Graf et al 1991 for overview) This paper focuses on analysis of national trends in improved climbing bean use its geographic extent its spread among user groups and the benefits and costs of climbers While select studies have indicated pockets of high adoption (Graf 1991 Sperling et al 1990) this report represents the first nation wide analysis of improved climbing bean impact

Table 1 Main themes in climbing bean research in Rwanda since 1984

Dates	Activities	Select sources
1984 86	Diagnostic survey of bean p od ng eg o s Su vey of farmer management of local climbing varie ties	Graf et al 1991 CIAT Ann Rep B n P ogram 86
1986 90	On farm trials with several climbing cultiva s	Voss and Graf 1991 ISAR 1989
1986 90	Focused research on staking material options particularly agroforestry species	Nyabyenda et Ga na 1992 Niang and N Diaye n d ISAR 1990
1986 90	Focused research on fertilizat on payoffs	FAO 1987
1990	Adoption and diffusion studies	Spe ling et al 1990 Graf 1991

METHODS

The survey was conducted from February to June 1992 (season 1992B) and again from September 1992 to January 1993 (season 1993A) These A and B seasons represent the two main growing periods in the Rwandan agricultural calendar with the A season considered more favorable for bean production due to its less intensive rains

To achieve a randomized sample and avoid the bias of bean researchers trying to promote their technologies ISAR/CIAT scientists joined efforts with the Division des Statistiques Agricoles (DSA) located within Rwanda s Min stry of Agriculture This department created in 1981 is responsible for the permanent monitoring of the agricultural economy i e 93% of Rwandan households DSA regularly collects data on agricultural and livestock production

farm size density of crops demographic characteristics and household income and expenditures (MINAGRI/DSA 1991)

The sample selected for this study comprised that used by DSA for its standard monitoring 1248 households stratified along two criteria agro ecological zone and administrative unit (MINAGRI/DSA 1991) During 1992B data was collected from 1191 households of which 1043 (87 6%) grew beans during the season in question Remaining households were not reached either because they were located in the intensive combat zone (41 cases) or because the interviewer fell ill (16 cases) During 1993A data was collected from 1045 households of which 1004 (96 1%) grew beans Ten households (5 in Cyangugu and 5 in Gisenyi) were not reached for miscellaneous reasons A significantly large number however were not interviewed due to escalation of a civil war Surveys were neither carried out in the entire Prefecture of Byumba (N = 144) nor in three communes of Ruhengeri (N = 49) Both are areas where adoption of improved climbing beans has been high Hence improved climbing bean use may be slightly underestimated for season B but markedly underestimated for season A

It is important to note that DSA switched its monitoring sample between the seasons 1992B and 1993 for the second time in its history Thus the same farmers were not interviewed over two consecutive seasons although each set is said to be representative of the national population as a whole At present DSA has accompanying income data only for its older (i e 1992B) sample

During both seasons four types of data were collected 1) Farmers were interviewed on bean practices e g number of fields types and sources of cultivars cultivar names 2) fields were measured (N = 3432 for season B and 4348 for season A) and density of associations noted 3) production was assessed (green bean and green seed being expressed in dry seed equivalent) and 4) improved varieties were identified using standard samples and by reference to seed source

FINDINGS

Overall use Over forty percent of Rwandan bean farmers 480 000 to 500 000 households each season are now growing improved climbing beans (Table 2) As could be expected a relatively high number of farmers are adopting in areas where climbing beans have traditionally been grown that is the prefectures of Ruhengeri and Gisenyi Adoption has also been high in Gikongoro and Kibuye areas of generally low soil fertility which contradicts the usual assumptions about climbing bean demands (see below) Butare hosts the national institute ISAR and both Butare and Gikongoro have benefitted from extensive climbing bean research as well as seed diffusion experiments and activities within their zone (Graf 1991 CIAT 1991 Sperling et al 1991)

While the average area a household devotes to improved climbing beans is small 430m^2 and 370m^2 for B and A seasons respectively families are already managing several improved climber plots (1 92 on average with the high range at 9 separate parcels) Nationwide improved climbing beans now occupy between 10 and 20% of the total bean area which extrapolating from nationwide production area amounts to more than 15 500 hectares each season (Table 3)

Table 2 **Farming households (%) sowing each type of bean 1992B and 1993A by prefecture**

Prefecture	Season 1992B			Season 1993A		
	improved climbers	local climbers	bush beans	improved climbers	local climbers	bush beans
Ruhengeri	70	36	55	80	23	67
Gisenyi	54	36	17	45	76	44
Byumba	47	9	97	n/a	n/a	n/a
Gitarama	21	16	92	25	8	92
Gikongoro	80	0	66	82	1	96
Kibuye	63	6	75	52	13	89
Butare	56	3	90	47	3	100
Kibungo	12	2	100	15	1	100
Cyangugu	26	8	87	28	6	92
Kigali	21	10	89	14	11	99
Rwanda	43	13	79	41	15	88

Table 3 **Area sown to improved climbing varieties by prefecture 1992B and 1993A**

Prefecture	Season 1992B		Season 1993A	
	% Total bean area	Hectares	% Total bean area	Hectares
Ruhengeri	39	5769	58	6370
Butare	13	876	4	687
Byumba	4	589	n/a	n/a
Cyangugu	9	433	8	769
Gikongoro	48	356	21	1437
Gisenyi	82	3781	25	2497
Gitarama	8	767	8	1301
Kibungo	2	261	1	347
Kibuye	37	1669	21	1854
Kigali	6	1071	2	513
Rwanda	17	15572	10	15775

Key advantages of climbing beans In addition to its generally higher yields improved climbing beans have had a number of advantages for smallholder farmers particularly in land scarce areas On average soils a typical climbing bean plot of about 400m^2 gives some 75 kilos or three baskets of beans versus a single basket for the bush type Figure 1 more precisely compares this production versus land area ratio for climbing beans in one region north of Kigali (N = 116 households in the communes of Tare Rushashi and Musasa)(Sperling et al 1990) and shows how relatively small plots e g 130m^2 for season A are able to produce a good share of the bean harvest enabling farmers to intensify production

Fig 1 Relative contribution of improved climbers Kigali Nord 1990

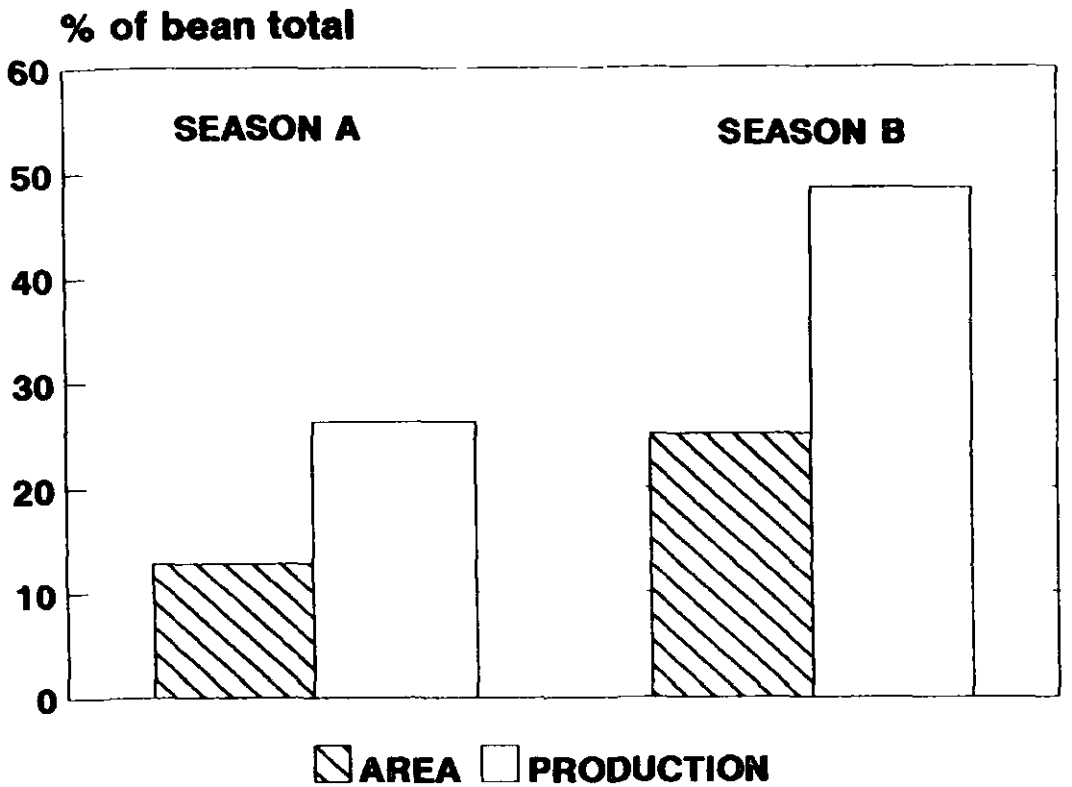


Table 4 drawing data again from sites north of Kigali additionally shows the relative stability of the improved climbing beans (here with the variety Umubano) During the season of heavy rains bush beans yields are nearly cut in half while climbers lose less than a fifth of their prime season production The more aerated canopy makes climbers more tolerant of foliar diseases and their longer cycle enables them to better recover from sharp and transient stresses Finally many farmers also appreciate the staggered development of climbing variet s green leaves an important source of vitamin A can be consumed for up to 6 weeks (versus 2 3 weeks for bush varieties) and risks (particularly theft) are partly diffused

Table 4 Bean yields from the region of Kigali Nord 1985 1990

Type	Season A		Season B	
	kg/ha	% increase	kg/ha	% increase
Bush beans	600	166	350	286
Umubano	1600		1350	

User groups Poorer farmers are often portrayed as the least innovative hence the decision by most development projects in Rwanda to work with the more progressive (i e wealthier) In addition climbing bean technology has been described as both labor demanding (Brewster 1988) and capital *demanding (Graf* 1991) Our findings cast some doubt on both these assumptions Figure 2 indicates percentage of bean farmers adopting climbers according to farm size even the largest category farms over 2 ha is very small when compared to most other farming areas in the world Results show adoption to be relatively high among all categories (over 35%) with the highest rate 48% among those with total farm sizes smaller than 0 25 ha

Fig 2 Rwanda wide survey 1992b

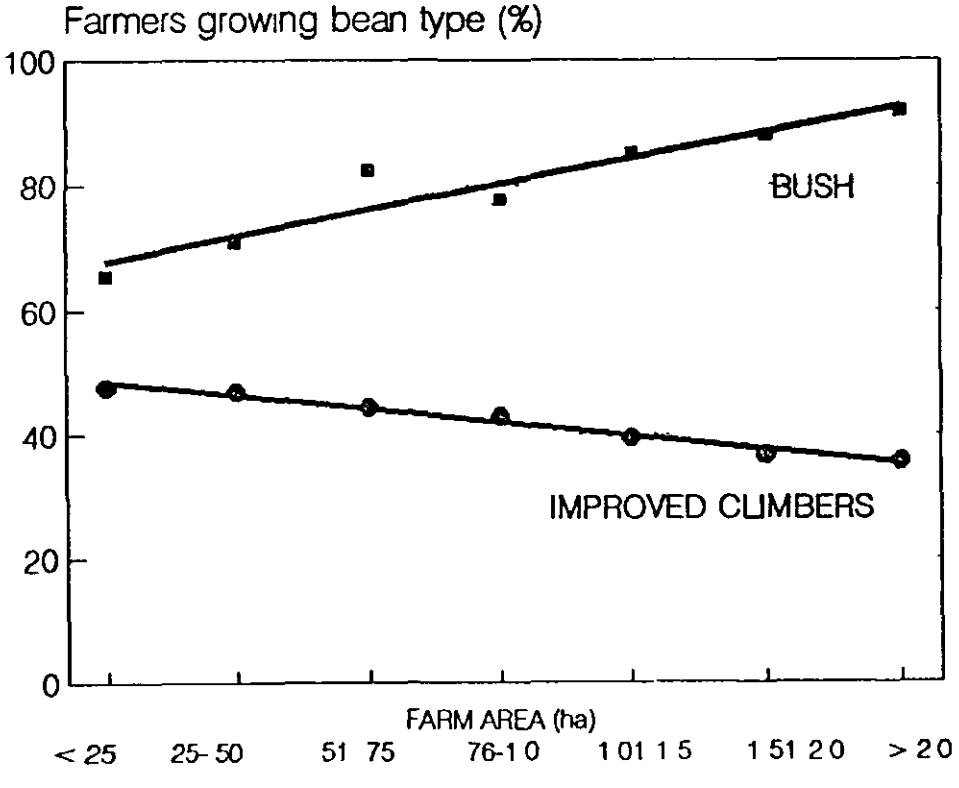
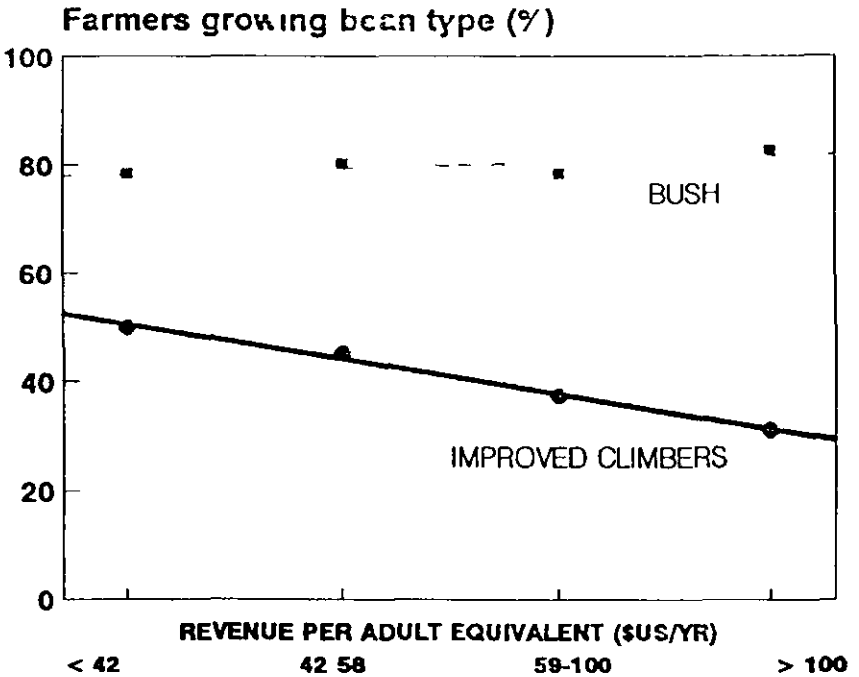


Figure 3 charts adoption according to annual income again with even the highest category greater than 12000 Frw/adult equivalent or US$ 92 being relatively low by world standards Adoption proves to be significant across all categories of bean farmers above 30% with the highest rate 50% being found among the very poorest those with an annual income per adult equivalent of US$ 38 (or US$ 190 for the average family of 5) Finally adoption was analyzed according to sex of head of household Within the survey sample 79 5% of households are nominally headed by men with 20 5 / by women Among households adopting improved climbers 79 3 were male headed with 20 7 female headed hence female headed households were just as likely to adopt the new technology as those headed by men Note that such female headed households are among the most disadvantaged both in terms of resource availability and access to extension services In summary the climbing bean technology appears to be scale neutral wealth neutral and gender neutral

Fig 3 Rwanda wide survey, 1992b



Cost Benefits The calculation of the costs benefits of climbing bean technology is sensitive to certain key assumptions To address possible variability Table 5 suggests a number of realistic scenarios 1) climbing beans replacing bush beans where the latter are in significant stress as in Gikongoro) 2) climbing beans replacing bush beans where the latter are under less stress as in Kigali Nord and 3) climbing beans replacing several crops soybeans and local climbing beans (in Gikongoro and Kigali Nord respectively) Yield data have been drawn from several sources (Graf 1991 Sperling et al 1990) with labor manure and staking costs taken from Graf s (1991) synthesis Our assumptions are conservative for instance we have valued labor at 100 FRw/day when there are indications that the opportunity cost or market value may be considerably lower in many areas Similarly stakes and manure have been given relatively high market values Taking the most common situation climbers replacing bush beans our analyses indicate that the new technology brings an additional 1000 2125

kilos per hectare of beans with a net benefit of US$ 272 to US$ 499 depending on the site (Table 5) Given the survey finding of at least 15 500 hectares under climbing bean cultivation per season the use of improved climbing beans annually brings 31 to 66 thousand additional tons of beans for Rwanda equivalent to an extra US$ 8 to 15 million in income for Rwandan farmers [2]

Table 5 Comparison of improved climbing beans with other legume crops

Reference crop	Bush	Soy	Bush	Local Climbers
Geographic zone	Gikongoro		Kigali Nord	
Additional yield (kg/ha)	2125	1825	1000	580
Additional return ($/ha)	930	752	438	254
Additional costs ($/ha)	431	477	166	0
Additional net return ($/ha)	499	275	272	254

sou ce adapted from Graf 1991

notes Labor is valued at 100 FRw per worki g day
The costs of stakes are 0 5 FRw/pcs fo *Pennisetum pu pureum* They l st 2 3 seaso s with a cost of 0 167 FRw per stake and season
Bean seed is valued at 50 FRw per kg soybean seed at 40 FRw per kg
Bean harvest is valued at 35 FRw soybeans at 40 FRw p r kg

SUSTAINABILITY CONCERNS

The extent of climber adoption across regions and economic classes has been unexpected However there remain a number of concerns briefly addressed here which will affect the stability of the technology as well as its prospects for further expansion

Genetic variability The majority of farmers using improved climbers are growing the variety Umubano upwards of 55 % for both seasons (Table 6) Moreover in terms of climbers about 80% are growing but a single variety Such genetic narrowness can compromise production stability and if yields of improved climbing cultivars are to remain high research should put strong emphasis on releasing many and diverse cultivars ISAR has actively responded to this challenge (see large number of releases Table 6) and now has a handful of highly appreciated climbing cultivars on farm particularly Flora Vuninkingi and Ngwinurare This progressive release strategy should be continued Fortunately farmers continue to sow both bush bean mixtures and local climbing bean mixtures with only 6% of bean growers planting improved climbers exclusively Thus considering all bean types overall genetic variability on Rwandan farms remains high

Table 6 **Households (%) using specific improved climbing bean cultivars among farmers growing improved climbing beans Rwanda**

Variety	Use 1992B	Use 1993A
	N = 448 households	N = 409 households
Umubano (G2333)	57	58
Vunirikingi (G685)	22	30
Cajamarca	11	10
Decelaya	4	3
Gisenyi 2 Bis	4	2
G2338	4	< 1
Snap Beans V078	2	3
Ngwinurare	2	1
Puebla	2	
RWV 78	2	
Mwirasi	1	2
Urunyumba	1	< 1
Flora	< 1	2
AFR 13	< 1	2
C 10	< 1	< 1
Gisenyi 6	< 1	
Muhondo 6 (G858)	< 1	
Zav 83052		1
AND 10		< 1
G2331		< 1

Percentages surpass 100 as about a f fth of f me s grow two or more improved climb ng var eties

Staking options It appears that Rwandan farmers have largely been able to alleviate what was originally perceived as a staking shortage A 1991 nation wide survey (den Biggelaar 1994) indicates that 88% of farmers now obtain stakes from their own farms having learned both to plant fast growing trees as well as recycle stakes more efficiently Table 7 indicates primary woods used and suggests that the local species rather than the introduced agroforestry options remain preferred (*Sesbania Calliandra* and *Leucaena* do not even appear on the list) Note that both farmers and researchers have been experimenting with other staking possibilities use of live stakes (particularly maize or manioc) and weaving trellises of banana cord The use of multiple options for staking should be promoted by extension rather than focusing as now solely on wooden stakes and particularly on novel agroforestry material [3]

Table 7 **Major woods used in staking material Rwanda wide survey 1991** (N = 987 households)

Species	/ Households
Eucalyptus sp	29
Pennisetum purpureum	18
Ricinus communis	7
Acacia mearnsii	6
Vernonia amygdalina	5
Markhamia lutea	5
Grevillea robusta	4
Cupressus lusitanica	4
Arundinaria alpina (bambou)	3
Cassia siamea	2
Euphorbia tirucalli	1
Senecio mannii	1
Pinus spp	1
Ficus thonningii	1
Draceana afromontana	1
Morus alba	< 1
Manihot spp	< 1
C aurantium	< 1
Erythrina abyssinica	< 1
Olea africana	< 1
Persea gratissima	< 1
Acacia sieberiana	< 1

sou ce den Biggelaar 1994

Root rots In 1991 the popular variety Umubano showed severe wilting resulting in yield losses of 50 to 100 / on certain farms in the Prefectures of Butare and Gikongoro The causal organism was identified to be *Fusarium oxysporum* f sp *phaseoli* New screening procedures confirmed that several of the varieties already being diffused Flora Vuninkingi and Puebla showed resistant reactions to the pathogen and happily farmers in affected areas are already shifting towards these cultivars (for example see Table 8 for Vuninkingi upswing) Researchers now routinely evaluate cultivars for their reaction to *Fusarium* The case of Umubano also shows how critically important it is to h ive multiple varieties in diffusion at any one time farmers lost but a single season s climbing bean harvest as other cultivars were already known and available to them

Table 8 **Use of the four major climbing bean cultivars (% of households) among those growing improved climbing beans Rwanda 1993A**

Prefecture	N	Cajamarca	Deceleya	Umubano	Vuninkingi
Butare	67	1		45	48
Cyangugu	25			92	4
Gikongoro	75	7		81	23
Gisenyi	49	37	41	55	8
Gitarama	36			50	50
Kibungo	17		6	6	
Kibuye	46	9	4	76	4
Kigali	19	5		74	26
Ruhengeri	75	17	11	40	56

Soil fertility demands Research in the past has asserted that climbing beans demand more fertile soils (Nyabyenda 1987 Voss and Graf 1991) and select development projects have gone so far as to advise that climbers need both DAP and NPK (This in a country where 2 3% of farmers use mineral fertiliser) (MINAGRI 1985) The more recent release of relatively plastic climbers as well as the edge of many climbers in the face of root rots (which appear most often on poorer soils) suggest that the fertility exigencies of climbing varieties are not clearcut Certainly farmers seem to be growing improved climbing varieties on a range of soils Targeted research on the relationship between climbing varieties and soil fertility is underway at sites in both Rwanda and Burundi (see RESAPAC ms) Until results are synthesized both research and extension should refrain from setting agronomic guidelines for the technology which many farmers simply cannot fulfill

FUTURE PROSPECTS

On the African continent climbing beans are indigenous only to northern Rwanda north Kivu Zaire a small sector in southern Burundi and pockets in north and south Malawi However the potential for introducing improved climbers is widespread southeastern Uganda western Kenya North and South Kivu Zaire northeastern and southwestern Tanzania central Madagascar etc The Zairian national program in Mulungu (South Kivu) is already reporting rapid adoption (Musungayi et al n d) and surveys in Burundi show improved climbers to be spreading in both traditional and non traditional climbing bean areas (Walls et al 1993) Improved climbers have the best chances for finding wide acceptance when socioeconomic pressures for intensification are strongly felt farmers in land scarce areas welcome a technology which brings evident production benefits in just a season s time Our experience in Rwanda clearly shows that 1) farmers are able to adopt such multicomponent technologies within relatively short periods and that 2) research can have significant impact with such resource poor farmers under low input conditions

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NOTES

1 Representat ves of the Div sion des Stat t ques Ag coles of the MINAGRI of Rwanda aided with the data collection and analyses for this study While ot involved th s adopt o urvey ISAR ese che s partic la ly Dr Pierre Nyabyenda and Gaspar Gasana spearheaded nation w de research a d development efforts promoting imp oved climb g be ns S e al re we s hav sh p ed this repo t ncluding Chr toffel de B ggelaar Rob n Buru h a Rog K kby Jul K egay U S he degge and W y e Youngq t

2 Improved climb ng bea s r pl c g soyb n n p t 100% of th ses would g ve benefits between the alues l ted Taking an equ lly ext em umpt o that imp ov d l mbing b n eplace loc l l mbers the n th of Rwand 100% of the cas would l o g e ben f t b tween the values listed

3 Among the w d sed fo tak ng m te al *Acac a mearns* d *Grevillea robusta* rep esent local agrofo estry spec es