Bean/Cowpea CRSP
EAST AFRICA REGIONAL WORKPLAN/ANNUAL PROGRESS REPORT
October 1, 2000-September 30, 2001

I. REGIONAL PROJECT WORKPLAN/ANNUAL PROGRESS REPORT FOR FY 2001

I.A. Constraint #1: Insufficient NRM and Production Technologies

I.A.1. Research area: Institutionalization and coordination of bean nurseries in the region

I.A.1.a. Background: Sharing germplasm can lead to more rapid progress in obviating constraints. As such, exchanging nurseries for specific objectives are a means of coordinating and institutionalizing this process. Each participating program enters lines into a nursery, then this is provided to all programs, who can then evaluate the material for adaptation and performance at their location. Yield trials coordinated through the Southern Africa Bean Research Network (SABRN), Rowland Chirwa (coordinator), have been institutionalized in the region, and are exchanged with members of SADC, but there is a need for other nurseries directed towards specific objectives. Drought tolerance is one such objective. Since nearly all beans in East Africa are grown under rain-fed conditions, both intermittent and terminal drought can be a production constraint. Drought tolerant materials were obtained from the LAC region (Mexico and Honduras), CIAT, Tanzania, and other programs, and were increased by Bunda College. The lines were distributed to the Tanzania programs (National and CRSP programs) and to South Africa (National program). Bunda evaluated 36 lines at one location in Malaŵi. The study indicated that some materials were able to produce substantially better yields under moderate moisture stress. Bean lines from the Malaŵi drought nursery were grown in an observational trial and to produce seed in Tanzania. Seed yield of these lines ranged from 586 to 1453 kg/ha. New sources of germplasm need to be identified, and testing needs to be continued. Traits associated with drought tolerance need to be identified.

I.A.1.b. Proposed research area workplan and subsequent annual progress report

I.A.1.b.(1) Activity #1: Regional drought nurseries--screen materials and analyze traits associated with drought tolerance
I.A.1.b.(1)(a) Priority: Essential
I.A.1.b.(1)(b) U.S. researchers:
I.A.1.b.(1)(c) HC researchers: Rweyemamu (Tanzania), Mkandawire* (Malawi)
I.A.1.b.(1)(d) Methodology: In Malawi, more materials will be contributed into the breeding schemes of the two countries and evaluated in advanced trials in the drought-prone areas to confirm their better performance compared to the released and local checks. More materials will be identified to complete a new set of the drought nursery. The new nursery will be packaged and distributed to Tanzania, Zimbabwe, South Africa and Mexico. A parallel activity will be to identify characteristics that confer tolerance in the selected materials. These characteristics will be valuable to breeders for evaluation of materials in general for better performance in drought-stressed environments.

In Tanzania, two experiments will be conducted during the study period. The first experiment will be conducted under screen-house conditions, while the second experiment will be conduced under field conditions. Three bean cultivars (resistant bruchid lines) will be planted in optimal and moisture stressed treatments. Water requirements will be calculated using FAO procedures. Data will be collected on soils and weather, plant growth, yield and yield components and calculation of various physiological traits as affected by the applied treatment combinations.
I.A.1.b.(1)(e) Anticipated (1 year) results of activity: Additional sources of drought tolerance identified. Traits that can be selected by breeders will be identified.

I.A.1.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers able to obtain higher yields with less than optimal precipitation	2001 and thereafter	Genotypes identified in drought nurseries and used in crosses. Drought tolerant advanced lines developed

I.A.1.b.(1)(g) Budget:

Malawi	$0 (included in I.A.2.b.4)
Tanzania	$2,500
Total (Direct Costs only)	$2,500

I.A.1.b.(1)(h) Major changes: No changes in Malawi. Due to problems experienced during the past season in Tanzania, (i.e., 1999/2000) the experiments were scheduled to begin at the end of September 2001. However, irrigation has not been possible due to water shortage at the experimental site. The preliminary preparations (land preparation, field layout) are already in place. Once the water supply system installed at SUA starts to work (end of October 2001), the experiment will be planted/begun.

I.A.1.b.(1)(i) Progress during the past year: (Malawi) The National Drought Nursery was grown at Bunda, Champhira, and Thyolo. The trial included materials from the Tanzania, Uganda and Malawi National Programs; RSA, SAZBEN, and SAZBYT. Drought severity was greatest at Champhira and least at Bunda. Four of the entries (Lyamungu 90, A197, DC95-170 and DC96-95 were among the five top yielding entries at two sites. An additional drought nursery with 10 entries was grown at Ng'onga. Drought intensity was extremely severe, resulting in mean yield for the trial of just 175 kg/ha. Highest yielding entry was Negro 150 (214 kg/ha).

Tanzania: A preliminary trial was conducted for 35 drought resistant materials during the short rain season (Oct.-Dec.) of 2000. See also section I.A.1.b.(4) for further discussion of performance.

In a second set of experiments, data analysis of last year's experiment was completed and selection of bean cultivars to be used in the 2001/2002 experimental work has been made. Results from both trials were presented at the bean workshop in Arusha in January 2000.

I.A.1.b.(1)(j) Current status of the project: The project work is ongoing but has been delayed due to water unavailability. Water supply is expected to be normal at SUA by the end of October 2001.

I.A.1.b.(1)(k) Documented impact: None at present.

I.A.1.b.(2) Activity #2: Dissemination of bruchid resistant (arcelin containing lines)

I.A.1.b.(2)(a) Priority: Essential

I.A.1.b.(2)(b) U.S. researchers: Myers*

I.A.1.b.(2)(c) HC researchers: Bokosi, Chirwa, Nyirenda (Malawi); Nchimbi-Msolla, Misangu (Tanzania)

I.A.1.b.(2)(d) Methodology: Five bean lines developed at SUA with resistance to *Zabrotes subfasciatus* will be evaluated in on-farm trials in Malaŵi, and in three villages in Tanzania for varietal release. In addition to evaluation of plant traits, farmers will store seeds for periodic sampling by researchers to determine the efficacy of *arcelin 1* in preventing bruchid damage under field conditions. The material will also be trialed by national programs in the region.

Malawi: bruchid resistant lines received from SUA were increased in the greenhouse then planted in the field in 2000. Lines were poorly adapted to central Malawi, and further evaluation was not pursued. To generate useful materials for the Malawi breeding program,

these lines will have to be crossed to elite breeding lines. These findings support the need for multiple breeding programs in separate regions of the Bean/Cowpea CRSP.

I.A.1.b.(2)(e) Anticipated (1 year) results of activity: Bruchid materials evaluated by researchers around region. Release of a variety in Tanzania.

I.A.1.b.(2)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Willingness and ability of farmers to store beans for longer periods of time	2001 and thereafter	Farmers testing and/or using arcelin lines; Yield performance of arcelin lines higher than local lines
Increased household food security	2002 and thereafter	Households storing resistant varieties

I.A.1.b.(2)(g) Budget:

Tanzania	$2,500
Total (Direct Costs only)	$2,500

I.A.1.b.(2)(h) Major changes: Tanzania: Release of two *Arcelin 1* lines has been delayed until 2002 to obtain additional on-farm trial data and to conduct preference studies.

I.A.1.b.(2)(i) Progress During Past Year: (Tanzania): Seed multiplication of bean lines resistant to *Zabrotes subfasciatus* continued. Presently, there is enough seed of these lines that can be used in on-farm trials for yield potential and storability studies under farmers' conditions. Nine farmers have been given samples of these lines for storage under their farming environment. The study will provide information on the storability of *Arcelin 1* lines compared to the bean varieties grown by the farmers. Two lines are slated for release next year. The on-farm trials and farmers' preference evaluations has been done, and seed has been submitted to TOSCA for evaluation. See section A.1.2.b.(4) for further discussion of evaluation of the bruchid resistant advanced breeding lines in Tanzania.

I.A.1.b.(2)(j) Current Status: (Tanzania) Studies are underway to compare bean lines with *Arcelin1* resistance with bean lines lacking arcelin.

I.A.1.b.(2)(k) Documented impact: None yet.

I.A.2. Research area: Pest and disease control through agronomic means

I.A.2.a. Background: Common bacterial blight (CBB) and halo blight (HB) caused by *Xanthomonas campestris* pv. *phaseoli* (Xcp) and *Pseudomonas syringae* pv. *phaseolicola*, respectively, are serious diseases of beans in Tanzania and many other parts of the world where beans are grown. Both bacteria are seed-borne and seed-transmitted. Therefore, they pose a serious threat to bean seed production and seed trade locally and internationally. Africa is apparently a center of genetic diversity for HB. In addition, the European union (EU) requires testing of African produced bean seed for the absence of both CBB and HB before bean imports are allowed into any of the EU countries. Most of the varieties grown in Tanzania and Malawi are susceptible. Previous work on the pathogen has mainly addressed CBB. Using PCR, studies have shown that some level of CBB pathogen-host co-evolution, particularly in regard to the consistent association of *X. campestris* pv. *phaseoli* var. fuscans (Xcpf) with Mesoamerican materials and the high level of pathogenicity of Xcpf but very low level of Xcp on these materials. These results suggest that Xcpf may have co-evolved with Mesoamerican materials, and this may have been in the direction of increased pathogenicity, possibly favoring high rates of seed transmission and survival.

Although previous Bean/Cowpea CRSP efforts have addressed CBB only, HB and ALS continue to be important bean diseases in cool highland areas in Tanzania. Both pathogens are seed-borne. Losses due to HB in Tanzania have been as high as 37 percent. Pathogenic variation

in the HB organism is well known. Such variation has also been reported in *Phaeoisariopsis griseola,* the causal agent of ALS on beans. Pathogenic variations in these pathogens make it difficult to control HB and ALS by breeding for resistance. Most of the indigenous bean cultivars grown in Tanzania are susceptible to these diseases; however, resistance to ALS occurs in SUA90. Therefore, more efforts are needed to further characterize HB and ALS pathogens for breeding programs.

The development of PCR has enabled quick progress in the development of highly sensitive and accurate methods for characterization and detection of pathogen and plant material. PCR is very rapid and costs much less than classical methods that require pathogenicity tests. The CRSP has invested funds to establish PCR laboratories in Tanzania and Malawi, in order to expand regional capacity for pathogen detection in bean. For example, PCR primers for common blight bacteria have been tested and shown to detect all African strains tested. Thus, PCR should be a very useful tool for detection of CBB. In order to take further advantage of these labs, they need to be strengthened.

The extent, types, prevalence and status of BSM and other bean insect pests are largely unknown in Malawi. A survey begun in FY 98 needs to be completed.

The activities under this constraint are directed toward development of bean varieties that have high, stable yields, multiple disease resistance, and are fast cooking. Two cultivars were developed and released in Tanzania. SUA 90 and Rojo are BCMV and rust resistant, generally stand up well to other fungal and bacterial diseases, and are adapted to low elevation growing environments. SUA 90 in particular is drought resistant. A bruchid resistant Rojo type should soon be released. In Malawi, Kalima has been released and is finding acceptance. Cultivars with different seed types and additional attributes need to be developed. As such breeding programs are needed to integrate the research on pests, diseases, and abiotic stresses into the development of improved cultivars.

I.A.2.b. Proposed research area workplan and subsequent annual progress report

I.A.2.b.(1) Activity #1: CBB--breeding for resistance, co-evolution studies
I.A.2.b.(1)(a) Priority: Essential
I.A.2.b.(1)(b) U.S. researchers: Gilbertson*, Temple (Malawi), Myers (Tanzania)
I.A.2.b.(1)(c) HC researchers: Bokosi, Chirwa,(Malawi); Mabagala, Nchimbi-Msolla (Tanzania)
I.A.2.b.(1)(d) Methodology: Continue with CBB work, emphasizing screening for sources of resistance and initiate similar work on Halo Blight; initiate crosses with selected material from both Malawi and Tanzania. Also, six VAX lines (originally from CIAT) will be used as parental material for introgressing resistance into African bean lines. Finalize characterization of genetic diversity of CBB in relation to gene pools and initiate similar work on HB building on the work on races done by Teverson. In Malawi, continue advancing disease resistant materials already bred by the U.S. program.
I.A.2.b.(1)(e) Anticipated (1 year) results of activity: Sources of resistance to CBB and HB identified for breeding programs; data on characterization of CBB available for use by breeders in the region.
I.A.2.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
CBB and HB-resistant material will be available, reducing the use of chemicals and contributing to safe environment and	2002 and beyond	Advanced lines resistant to CBB, HB and ALS available for release

increasing income of farmers		

I.A.2.b.(1)(g) Budget:

Malawi	$0 (included in I.A.2.b.4.)
Tanzania	3,500
UCD	38,500
Total (Direct Costs only)	$42,000

I.A.2.b.(1)(h) Major Changes: None

I.A.2.b.(1)(i) Progress during past year in Tanzania: Advanced bean lines that are promising for release (EG10, EG13, EG21, EG40, EG44, [Kablanketi crosses] RAZ*EP3-2, RAZ*EP4-4, RAZ*C11, RAZ C12 and RAZ*SUA 90) [bruchid resistant crosses] were screened for resistance to CBB and HB under screenhouse conditions. Canadian Wonder was included as a susceptible control. Two strains of *Xanthomonas campestris phaseoli* (one Xcpf and Xcp) and one strain of HB were used. A Randomized Complete Block Design (RCBD) arranged as a split-plot and a RCBD were used for common and halo blight experiments, respectively.

Most of the bean lines gave an intermediate reaction to *X.c.* pv. *phaseoli* and *P.s. phaseolicola.* However, disease severity varied among the bean lines. Bean lines evaluated for resistance to CBB showed significant difference ($P \leq 0.01$) in disease severity, but no significant difference ($P \leq 0.01$) was noted in the case of halo blight. Bean line EG 44 significantly showed low disease severity (4.6) compared to all other bean lines evaluated for CBB resistance. There was no significant reaction in disease severity among the rest of the bean lines (Tables 1 and 2).

Table 1. Foliage reaction of various bean breeding lines to *Xanthomonas campestris* pv. *phaseoli* under screenhouse conditions.

Bean line	Disease severity	Bean line	Disease severity
Canadian Wonder	8.8972[c]	RAZ*C12	5.333[ab]
EG21	5.750[ab]	RAZ*EP4-4	5.083[ab]
EG10	5.625[ab]	RAZ*SUA90	5.042[ab]
EG13	5.458[ab]	EG40	4.792[ab]
RAZ*C11	5.458[ab]	EG44	4.583[b]
RAZ*EP3-2	5.333[ab]		

Means followed by the same letter within a column are not significantly different ($P<0.01$). Values are means of two experiments.

Table 2. Foliage reaction of various bean breeding lines to *Pseudomonas syringae* pv. *phaseolicola*, (strain $11b_1$).

	Mean score per bean line per replication			
Bean line	Replication	Replication 2	Replication 3	Mean score
	1			
EG10	6.0	4.50	5.0	5.167[a]
EG13	6.25	4.50	4.50	5.167[a]
EG21	5.75	4.00	4.75	4.833[a]
EG40	4.75	6.25	4.25	5.083[a]
EG44	5.75	5.75	4.50	4.667[a]
RAZ*EP3-2	4.00	5.50	4.50	4.667[a]
RAZ*EP4-4	7.00	5.00	5.50	5.833[a]
RAZ*C11	6.25	5.00	5.50	5.833[a]
RAZ*C12	5.00	5.00	4.75	4.917[a]
RAZ*SUA90	4.50	5.50	5.75	5.250[a]

Canadian Wonder	7.50	8.75	8.00	8.083[b]

Means followed by the same letter within a column are not significantly different (P<0.01). Values are means of two experiments.

Plant recovery from the disease as new foliage developed and the number of pods produced were also studied. Plant recovery and the average number of pods per bean line varied between the two pathogens and also between the strains of *X.c.* pv. *phaseoli*. The percentages of plant recovery of bean lines inoculated with (Xpcf and Xcp) were 36% and 67%, respectively, while plant recovery for *P.s.* pv. *phaseolicola* was 97%.

In addition, surveys were also conducted in Morogoro, Kilimanjaro, Iringa and Arusha regions to collect bean leaf samples and leaves infected with *P.s.* pv. *phaseolicola*. Isolation and purification and characterization was done to determine the identity of the isolates using pathogenicity tests, physiological and biochemical tests, hypersensitive reaction on tobacco (variety Xanthi), Biolog and PCR. A total of 15 isolates were identified as *P.s.* pv. *phaseolicola* characterization of isolates into races for use in the continuing co-evolution studies.

UC-Davis

Common Bacterial Blight (CBB): The simple isolation of yellow pigmented bacteria from common bean leaves or seeds on semi-selective medium MXP is not conclusive evidence of the presence of common blight bacteria (i.e., *Xanthomonas campestris* pv. *phaseoli* [*Xcp*] or *X.c*. pv. *phaseoli* var. fuscans [*Xcpf*]) due to the presence of nonpathogenic xanthomonads. However, using the common blight bacteria-specific primers and rep-PCR, common blight bacteria isolates were reliably differentiated from nonpathogenic xanthomonads and other yellow bacteria recovered from bean leaves and pods. The rDNA from *Xcp* and *Xcpf* was amplified using general PCR primers for this region and the resulting fragments were sequenced. The rDNA sequences of *Xcp* and *Xcpf* were nearly identical (99% base homology), which is greater than that for distinct pathovars. But *Xcp* and *Xcpf* can be readily differentiated by rep-PCR and other methods. Together, these results are consistent with the idea that *Xcp* and *Xcpf* are distinct bacteria that are more closely related than distinct *X. campestris* pathovars.

Bacterial Strains and their Identification: During his 2001 visit to Malawi, Steve Temple collected 7 CBB samples from Malawi and Gilbertson collected CBB samples from 5 fields in Wisconsin, USA. For each of the leaf samples, a small piece of the tissue from the margin of lesions from fresh or dried symptomatic leaves was used to isolate bacteria onto a general media (523). For each leaf sample, four yellow xanthomonad-like colonies were selected and subcultured. After 2-3 days the colonies were checked and isolates were then classified as either *Xcp* or *Xcpf*, depending whether the strains produced the brown pigment characteristic of *Xcpf*. On this basis, only one of the seven strains from Malawi was *Xcp* and the rest were *Xcpf*. On the other hand, all the strains isolated from red kidney beans from Wisconsin were *Xcp*.

To rapidly confirm the identity of these strains as *Xanthomonas campestris* pv. *phaseoli* or *X.c.* pv. *phaseoli* var. fuscans, a highly sensitive and rapid PCR-based assay was used. This assay is based on the use of a PCR primer pair (X4c: 5′-GGC AAC ACC CGA TCC CTA AAC AGG-3′ and X4e: 5′-CGC CGG AAG CAC GAT CCT CGA AG-3′) developed from the partial sequence of a 3.4-kb *Xcp* plasmid DNA fragment. This primer pair directs the amplification of an ~700 bp fragment from CBB bacteria and not from nonpathogenic xanthomonads or other bacteria associated with common bean. The ~700 bp fragment was amplified from all of the suspected *Xcp* and *Xcpf* strains, confirming that they were *Xcp*/*Xcpf*.

PCR of Repetitive Bacterial Sequences: Polymerase chain reaction (PCR) amplification of repetitive bacterial sequences (rep-PCR) was used to generate fingerprints of bacterial strains in order to further ascertain their identity and establish relationships among the strains. Rep-

PCR is based on PCR amplification of repetitive sequences interspersed in the bacterial genome. The following primers were used: repetitive extragenic palindromic (REP)-PCR primers 1R (5′-III ICG ICG ICA TCI GGC-3′) and 2I (5′-ICG ICT TAT CIG GCC TAC-3′); enterobacterial repetitive intergenic consensus (ERIC)-PCR primers 1R (5′- ATG TAA GCT CCT GGG GAT TCA C-3′) and 2I (5′-AAG TAA GTG ACT GGG GTG AGC G-3′); and BOX element 1A (BOX)-PCR primer 1R (5′-CTA CGG CAA GGC GAC GCT GAC G-3′).

Of the seven strains isolated from leaves in the Temple collection of 2001 only one was an *Xcp* (collected from the Bunda Bean Improvement Program/ CIAT materials at Chitedze, Lilongwe), and its fingerprint was indistinguishable from that of the Puerto Rico strain, which has the New World *Xcp* fingerprint. Six strains were *Xcpf*. Interestingly, the fingerprints of *Xcpf* were distinguishable this time, indicating diversity in *Xcpf*, which we previously had not detected by rep-PCR. All the *Xcp* strains collected from Wisconsin had a rep-PCR fingerprint indistinguishable from that of the Puerto Rico strain. This corroborates our earlier finding that *Xcp* from the New World has an indistinguishable fingerprint from that of the Puerto Rico strain and that *Xcp* strains with the East Africa rep-PCR fingerprints do not seem to occur in the New World. Additional New World strains should be examined to ascertain this particular fact. All the isolates collected from Malawi and from Wisconsin were inoculated on the susceptible cultivar Topcrop in the greenhouse and they were all pathogenic.

Halo Blight

Bacterial Strains and their Identification: During Gilbertson's 2000 collection trip in East Africa and a 2001 collection trip in Wisconsin, USA, bean leaves with halo blight symptoms were collected and twenty-one (21) pseudomonad-like strains were isolated from leaves from Tanzania (Table 1.A.2.b.(3) 2) and twelve (12) from leaves from Wisconsin. For these isolates, the halo blight bacteria-specific primers HB14 (HB14F: 5′-CAA CTC CGA CAC CAG CGA CCG AGC-3′ and HB14R: 5′-CCG GTC TGC TCG ACA TCG TGC CAC-3′), which direct the amplification of an ~1.4-kb fragment from *Pseudomonas syringae* pv. *phaseolicola* (*Psp*), were used to confirm the identity of these strains as *Psp*. Four of the strains from East Africa and two from Wisconsin were determined not to be *Psp* based on lack of amplification of the 1.4-kb fragment. Upon inoculation on susceptible Topcrop the four strains from East Africa were not pathogenic on beans. However, one of the two isolates from Wisconsin was pathogenic. Due to the fluorescent nature of this isolate and the brown spots observed on the leaves from which it was isolated, it may be *Pseudomonas syringae* pv. *syringae* (*Pss*), causal agent of bacterial brown spot disease. All other 27 isolates were pathogenic.

PCR of Repetitive Bacterial Sequences: Polymerase chain reaction (PCR) amplification of repetitive bacterial sequences (rep-PCR) with REP primers 1R (5′-III ICG ICG ICA TCI GGC-3′) and 2I (5′-ICG ICT TAT CIG GCC TAC-3′) was used to generate fingerprints of bacterial strains in order to further ascertain their identity and establish relationships among the strains. Three fingerprint patterns were detected for the *Pseudomonas syringae* pv. *phaseolicola*, (*Psp*) isolates collected from Tanzania in 2000. This agrees with the earlier findings of Mabagala (1992), that genetic diversity exists among *Psp* strains in Tanzania. The strains 15-1, 15-2, 15-3 and 15-4 were all isolated from the weed *Neonotonia wightii* and had identical fingerprints. Strains isolated from this weed previously were classified as belonging to Race 1. Thus, it was tempting to speculate that this fingerprint might correspond to Race 1 *Psp* strains. A *Psp* strain from our collection had a fingerprint that was different from the three identified for the Tanzanian strains. If these fingerprints correspond to races of *P.s*. pv. *phaseolicola*, rep-PCR may represent an easier method for determination of races of this pathogen compared with the inoculation of differential cultivars. The use of differential varieties is time-consuming because of the need to grow, inoculate and then evaluate the plants. All the *Psp* isolates collected from Wisconsin had an indistinguishable rep-PCR

fingerprint that was different from the other four fingerprint patterns observed. The major differences among these four fingerprints were the presence and number of some small fragments that can easily be characterized.

Determination of Races of Psp: Two races of *Psp* (races 1 and 2) were initially described on the basis of the differential reactions on Red Mexican UI 3 (Walker and Patel, 1964). These races were subsequently shown to exist in Europe (Wharton, 1967; Taylor, 1970), New Zealand (Hale and Taylor, 1973), North America (Patel and Walker, 1965; Guthrie and Fenwick, 1967), Latin America (Buruchara and Pastor-Corrales, 1981) and Africa (Kinyua et al., 1981; Msuku, 1986). A third race was subsequently identified in Africa through a differential response on the cultivar Tendergreen (Taylor and Teverson, 1985; Mabagala and Saetler, 1992). More recently, Taylor et al. (1996) carried out race determination on 175 selected isolates of *Psp* and identified nine races. These nine races include the original three races. Mabagala and Saetler (1992) identified races 1, 2 and 3 in Tanzania. However, Taylor et al. (1996) showed the existence of races 2-8 in Tanzania, and races 2, 5 and 9 from Malawi.

The race designation of *Psp* strains collected from East Africa were determined on the basis of the response of five differential cultivars obtained from Harris Moran Seed Company, viz: Tendergreen, Canadian Wonder, ZAA54 (A52), ZAA12 (A43), and Red Mexican UI 3.

The five differential cultivars were grown in the greenhouse in February-April 2001. Representative strains of each *Psp* fingerprint pattern, 15-1, 7-5, 12-5, and E1, were used for inoculation. To prepare the inoculum, the isolates were streaked onto 523 media, allowed to grow for 48h and were then suspended in distilled water. Concentrations were adjusted to an OD_{600nm} = 0.20, which corresponds to $\sim 10^8$ colony forming units (cfu) per milliliter (ml). The cotton swab method was used for inoculation of the cell suspensions onto leaves of about two-week-old bean plants. The bacterial suspension was applied along the midrib of each of the three leaflets of the first fully expanded trifoliolate leaves of three plants per pot. The floor of the greenhouse was kept wet at all times to generate the humidity to favor development of halo blight symptoms. Symptoms were rated and recorded 10 days post inoculation.

The results of this study indicate and confirm the presence of races 1, 3 and 6 in Tanzania; and at least race 9 in Malawi. Race 1 (15-1) was indeed the one isolated from *Neonotonia wightii*. It is interesting to note that four races were identified and these correspond with the four fingerprint patterns identified by rep-PCR. This study, therefore, suggests the possibility of using rep-PCR fingerprinting for race designation of *Psp* races. Furthermore, rep-PCR fingerprinting takes a day to carry out compared with inoculation of differential varieties, which may take as long as a month. A similar test was done during August 2001 using two isolates of the Wisconsin HB strain. This strain was pathogenic on Canadian Wonder and A53. However, it was not pathogenic on A43, Red Mexican and Tendergreen. This differential response was similar to that described by Ariyarathne, Coyne, Vidavar and Eskridge (unpublished) for a strain they collected in Nebraska in 1990 and it was designated as race 11.

Pathogenicity Tests: Four susceptible U.S. bean varieties, Topcrop and White Kidney (Andean) and Black Turtle Soup and Sutter Pink (Mesoamerican), representing the two gene pools, were used. Andean materials from Malawi (22-2, 12-4) and Tanzania (Rose Koko, Canadian Wonder) and Mesoamerican materials from Malawi (1-1, 6-5, Namajengo) and Tanzania (Masai Red) were also used in the evaluation. Representative strains of each group of *Psp* [race 1 (15-1), race 3 (7-5), race 6 (12-5), and 9 (E1)] were used for inoculation. The methods used in inoculum preparation and evaluation were as explained previously.

Andean materials were more susceptible (2.8 on scale 1-5) to *Psp* than were Mesoamerican materials (1.8) across the three experiments. U.S. Andean beans showed moderate resistance to the race 3 strain (7-5), but were susceptible to the other three strains. Race 3 strain was the most pathogenic on East African Andean materials followed by races 6 and 9; race 1 was the least pathogenic. Generally, all races were more pathogenic on Andean materials compared with Mesoamerican materials. However, US and East African Mesoamerican materials were moderately susceptible to races 3 and 6. Consistent with previous results, race 6 was the most pathogenic of all *Psp* races. Races 1 (15-1) and 9 (E1), which have been found in East and Southern Africa as well as South America, were the pathogenic on both the US and East African Andean materials, but both US and East Africa Mesoamerican materials were fairly resistant to these races. These results confirm the differences amongst the four races in terms of their response on differential cultivars. More importantly, our results revealed the existence of another level of host-pathogen interaction, i.e. differential pathogenicity on the two bean gene pools. This suggests that there may have been coevolution between *Psp* and beans of the Andean gene pool followed by further evolution to result in races.

Gene Pool Determination: Leaves with symptoms of bacterial blight diseases were collected and were immediately sandwiched between paper towels and allowed to dry. From these leaves *Xcp*/*Xcpf* and *Psp* bacteria were isolated, and plant DNA was extracted for gene pool determination. A small amount of dried leaf tissue was placed in a 1.5 ml Eppendorf tube and ground in liquid nitrogen. DNA extraction was done using a modified Dellaporta method. To determine the common bean gene pool, the bean total genomic DNA was then used in the polymerase chain reaction (PCR) with primers J_1d_1 and J_1d_2. The PCR profile used was 1 cycle of 94°C for 2 min, 40 cycles of: 94°C for 30 sec; 58°C for 1 min; and 72°C for 2 min; and an extension cycle of 72°C of 5 min. The amplified DNA fragments were fractionated in 1.0% agarose gel with ethidium bromide in TBE buffer and were photographed with a gel imaging system. All the Temple *Xcp*/*Xcpf* isolates of the 2001 survey were derived from Mesoamerican materials, whereas all the Gilbertson *Psp* isolates of the 2000 survey in Tanzania were derived from Andean materials. The Temple isolates were collected at the end of March when most Andean materials had matured. Gilbertson *Psp* isolates were collected from Tanzania where Andean beans predominate in the cropping systems. The Gilbertson 2001 *Xcp* and *Psp* isolates were collected from red kidney beans, which are of the Andean gene pool.

I.A.2.b.(1)(j) Current Status: (Tanzania): Findings obtained from the screening work need to continue using strains of specific races of P.s. pv. *phaseolicola*. Studies to determine these races are in progress using differential bean cultivars developed by Dr. Dawn Teverson. Such information will assist breeders to come up with bean varieties with known reaction to specific races of P.s. pv. *phaseolicola*. Collection of more isolates of the halo blight pathogen need to continue in order to determine the race structure and the reaction of bean lines expected to be released soon. Such information is also crucial for the National Seed and Variety Release committees in order for CRSP bean varieties to be released.

UC-Davis: The findings on genetic diversity in HB and CBB confirms previous work, and suggests that Africa may be the original home for both of these seed-borne diseases. The association between certain races of the pathogens and beans from the two centers of origin is interesting and suggests viable strategies for breeding for resistance. PCR primers that can identify pathogenic isolates, perhaps even to the race level, would be very useful in disease diagnostic and seed certification programs.

I.A.2.b.(1)(k) Documented impact: Information generated on the reaction of bean breeding lines contributes to the information database needed for the Bean/Cowpea CRSP bean varieties to be

released by the National Seed Variety Release committees for use by farmers. Information about host-pathogen interactions has influenced breeder's choice of parents for introgressing resistance.

I.A.2.b.(2) Activity #2: ALS--PCR to characterize pathogen isolates; evaluate and develop resistant bean lines.
I.A.2.b.(2)(a) Priority: Essential
I.A.2.b.(2)(b) U.S. researchers: Gilbertson (Malawi), Myers (Tanzania)
I.A.2.b.(2)(c) HC researchers: Nchimbi-Msolla, Mabagala* (Tanzania), Mkandawire, Bokosi, Chirwa (Malaŵi)
I.A.2.b.(2)(d) Methodology: Markers previously developed at UC-Davis will be used to determine center of origin affiliation of strains of ALS present in Tanzania. The findings will be used to determine which sources of resistance to use for breeding. If markers become available for ALS resistance in beans, they will be used to facilitate breeding for resistance.
I.A.2.b.(2)(e) Anticipated (1 year) results of activity: ALS pathogen characterized for breeding purposes in Tanzania and resistant germplasm is identified.
I.A.2.b.(2)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers have more reliable bean crop production	2002 and beyond	Improved varieties with ALS resistance available to farmers

I.A.2.b.(2)(g) Budget:
Tanzania (included in activity 3) $0
Total (Direct Costs only) $0
I.A.2.b.(2)(h) Major changes: Due to slow growth and sporulation rate of P. *griseola*, characterization of isolates has been delayed and work continues.
I.A.2.b.(2)(i) Progress during past year: Bean leaf samples infected with the angular leaf spot (ALS) pathogen (*Phaeoisariopsis griseola*) and showing typical ALS symptoms were collected from Kilimanjaro, Arusha, Tanga (Lushoto/Muheza) and Morogoro regions, from May to July, 2001. Samples from each plant was placed between paper towel or newspapers, labeled and pressed dry before isolations were made. Following collection, the dried leaf samples were kept in the plant press and stored at room temperature (24-30°C) until isolations were made.

Isolations of *P. griseola* were attempted by first incubating individual leaf samples under high humidity in sterile petri plates containing moist sterile filter papers at 24-26^0 C for 48 hours. After incubation, ALS lesions were examined under the stereo-microscope, and where present, conidia were picked by gently touching synnemata tips with a very small (2.00mm) block of V-8 agar attached to the isolation needle. The agar blocks containing conidia were placed on V-8 agar plates and incubated at 22-26^{0}C for further purification.

Pathogenicity tests of isolates were conducted using the bean variety Canadian Wonder. Two seedlings were planted per pot in the screenhouse. The seedlings were spray-inoculated with inoculum prepared on V-8 agar and incubated at 22^{0}C for 10 to 12 days. Inoculated plants were incubated in polyethylene sleeves for 72 hours at 24-26^{0}C. Disease development was assessed 12-15 days after inoculation.

A total of 21 isolates of *P. griseola* were purified and characterized. Further confirmation of their identity will be done using the PCR technique. In addition, race determination will also be conducted.

Table 3. Strains of *Phaeoisariopsis griseola* isolated from various bean materials collected in Tanzania.

Strain No.	Location	Source	Pathogenicity (c/w)
01/1	Arumeru	Lyamungu 85	±
01/2	Morogoro	Canadian Wonder	±
01/3	Morogoro	Kablanketi	±
01/4	Mgeta	Canadian Wonder	±
01/5	Mgeta	Kablanketi	±
01/6	SUA	Rojo	±
01/7	Njombe	Local	±
01/8	Moshi	Lyamungu 85	±
01/9	Moshi	Lyamungu 85	±
01/10	Lushoto	Rojo	±
01/11	Lushoto	Local	±
01/12	Muheza	Local	±
01/13	Monduli (ARA)	Local	±
01/14	Monduli (ARA)	Canadian Wonder	±
01/15	Tengeru (ARA)	Lyamungu 85	±
01/16	Himo (Moshi)	Local	±
01/17	Himo (Moshi)	Local	±
01/18	Korogwe	Local	±
01/19	Korogwe	Lyamungu 85	±
01/20	Morogoro	Local	±
01/21	Matombo(Morogoro)	Canadian Wonder	±

I.A.2.b.(2)(j) Current status: (Tanzania): Pathogenic variation of *P. griseola* to Mesoamerican and Andean bean material has been documented. Therefore, the current study will assist breeders to determine affiliation of strains of ALS present in Tanzania to the two bean centers. Such information will be very useful for breeders to determine the appropriate sources of resistance to be used in the breeding program. Collaborative work with the US will allow availability of markers to be used to determine ALS resistance in breeding material, which will enhance breeding for resistance to *P. griseola*. Results from this study will provide information needed by breeders to properly deploy ALS resistance genes available in bean material (Mesoamerican and Andean) to produce beans resistant to various races of P. *griseola* that exist in the country. Such resistant material will reduce the use of chemicals needed to control ALS, thus contributing to reduced cost of production and environmental pollution.
I.A.2.b.(2)(k) Documented impact: None

I.A.2.b.(3) Activity #3: PCR laboratories--disease detection, fingerprinting, marker-aided selection
I.A.2.b.(3)(a) Priority: Essential
I.A.2.b.(3)(b) U.S. researchers: Myers (Tanzania), Gilbertson* (Malawi)
I.A.2.b.(3)(c) HC researchers: Mkandawire, Bokosi (Malawi); Mabagala, Nchimbi-Msolla (Tanzania)
I.A.2.b.(3)(d) Methodology: Support learning exchanges with US institutions and other CRSPs. Use the PCR laboratory to check seed under certification for infection by CBB and HB seed borne pathogens. Fingerprint released varieties and landraces to facilitate documentation of seed dissemination efforts and document genetic diversity in the region.
I.A.2.b.(3)(e) Anticipated (1 year) results of activity: Diagnostic tools for disease detection, a better understanding of genetic diversity and dissemination in the country.

I.A.2.b.(3)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Rapid pathogen characterization and disease diagnosis for farmers, researchers and seed agents	2002 and beyond	Service used by customers
Biotechnology trained personnel available in the region	2003 and beyond	Number of students trained

I.A.2.b.(3)(g) Budget:

Malawi	$5,000
Tanzania	5,000
Total (Direct Costs only)	$10,000

I.A.2.b.(3)(h) Major changes: None

I.A.2.b.(3)(i) Progress during past year: Tanzania: Promotion of the PCR laboratory continued by distributing locally printed flyers to potential customers in the Ministry of Agriculture and Food Security (Seed unit) and other agricultural institutions in the country. As a result, FAO, in collaboration with the Ministry of Agriculture and Food Security, opted to use our PCR laboratory to conduct a short course, "Strengthening Phytosanitary Services in Tanzania." The use of PCR and other biotechnological techniques in strengthening and improving phytosanitary services was included as a major topic, which was taught for two days. Both lectures and practicals were covered. The practical aspect involved isolation protocols for DNA from *Xanthomonas campestris* pv*, phaseoli* and *Pseudomonas syringae* pv. *phaseolicola* from bean seed for detection purposes using specific probes, operation of PCR and electrophoresis equipment, including photographing. On-farm produced bean seed samples were used for the practical training. Sixteen participants were involved in the short course.

Robert Mabagala was invited to represent SUA in the National Biotechnology Stakeholders' Workshop, held in May, 2001, at the Tanzania Commission for Science and Technology, Dar es Salaam. The workshop was planned jointly by The Commission for Science and Technology and the Office of the Vice-President. It dealt with key policy issues related with the development and utilization of biotechnology issues in the country.

The workshop was organized to address the needs for creating a mechanism to coordinate individual efforts by various institutions in the country undertaking research and development activities in biotechnology. It included taking an inventory of all key players in biotechnology creating awareness among the stakeholders and to stimulate public debate on appropriate strategies and policies for the development and utilization of biotechnology in a sustainable manner and the need for forming a National Biotechnology Committee. Major topics discussed were:

- Overview on the role of biotechnology for development in Tanzania.
- The need for biotechnology policy and biosafety guidelines, concepts, formulation and implementation.
- The application of biotechnology in agriculture: current national and regional initiatives.
- The potential of biotechnology research and development in medicine and public health.
- The role of biotechnology in environmental management in Tanzania.
- Regulations of the safe movement of germplasm and trans-boundary issues.
- Regional networking in biotechnology.

UC-Davis

Detection of CBB bacteria in seed samples: During 2000 and 2001, the PCR was used to monitor common blight bacteria on bean seed crops. Samples of fourteen (14) lots were sent to our laboratory in 2000 to be assayed for CBB bacteria. This seed had been produced in Wisconsin where there had been CBB outbreaks in fields from which the seed was harvested.

The seed from all lots was heavily infested with *Xcp* (up to $16.9x10^7$ cfu/g seed). Thus, all of these lots carried a high level of bacterial inoculum, certainly enough to initiate significant disease, especially under favorable conditions.

Some of this seed was planted in a number of fields in California in 2000. The beans were grown under two irrigation systems: sprinkler and furrow. The fields were inspected for disease on 08/08/00. The sprinkler-irrigated fields all had striking CBB symptoms. In some cases, the symptoms we observed were emanating and expanding from or around the sprinkler heads. In contrast, furrow-irrigated fields showed no such symptoms, although a few leaves with 'false CBB' lesions were observed in furrow-irrigated fields. Three other sprinkler-irrigated fields were surveyed and all had symptoms of CBB, with incidences ranging from 10-20% (some spots had much higher incidences). One of these fields had another type of symptom of circular lesions with brown borders, these were suspected to be bacterial brown spot caused by *P. syringae* pv. *syringae*. Leaves with symptoms were collected from four fields. No blight bacteria were isolated from leaves from the furrow-irrigated field, consistent with the lack of typical CBB symptoms in this field. However, from the other three fields, *Xcp* was consistently isolated from leaves based on colony appearance and detection with *Xcp*/*Xcpf* primers.

To determine whether these *Xcp/Xcpf* strains were brought in on seeds, we again employed the rep-PCR to determine the fingerprint of the *Xcp*. We found that the fingerprints of strains we recovered from the diseased fields were indistinguishable from those recovered from seed. Thus, the inoculum was likely to have come from the seed. The seeds from these fields were harvested in October 2000, and we assayed this seed for *Xcp* between December 2000 and January 2001. The seed was checked for the presence of common blight bacteria with a standard seed wash assay.

CBB bacteria were not recovered from seven of the eight lots sent to the laboratory. *Xcp* was recovered only from seed of Lot D2203, which came from a sprinkler-irrigated field that had CBB symptoms. Upon repeating the seed wash, CBB bacteria were again recovered from Lot D2203, confirming the contamination with *Xcp*. The putative *Xcp* strain we obtained from Lot 2203 was positive with the CBB primers. This *Xcp* strain (from Lot D2203) was then inoculated onto beans in the greenhouse and it was determined to be pathogenic. In conclusion, therefore, only Lot 2203 was contaminated, indicating a significant reduction in bacterial contamination in the California-grown seed, despite the presence of CBB in some sprinkler irrigated fields. This also shows that CBB will develop in California under sprinkler irrigation, which is a concern because more growers are using this irrigation method.

Where is blight bacteria located in association with seed? Previously, we reported on the use of Physan 20 to eradicate *Xanthomonas campestris* pv. *phaseoli* from the surface of bean seed. During 2001 the third replicate of this experiment was completed. In summary, $1.2x10^7$ and $1.9x10^7$ cfu of the bacteria were recovered per g of whole or crushed control (washed with sterile water) seeds, respectively. No blight bacteria were recovered from Physan-treated whole seeds, showing that this disinfectant removes bacteria from the seed surface. However, bacteria were still recovered from Physan-treated crushed seeds, indicating that this treatment was unable to eradicate the bacteria from inside the seed.

Because treatment with Physan 20 may not actually be economic on a large scale, (particularly in less-developed countries), we attempted to use hydrogen peroxide (H_2O_2) instead. Initially we received two batches of seed: H_2O_2-treated and untreated. Seed treatment with hydrogen peroxide had been done by a seed company. In the first wash, we were not able to recover any bacteria from both the untreated or treated batches. We recovered

bacteria amounting to $2.5x10^7$ cfu/g of bacteria in the control lot (D2203) indicating our assay was working. Very little bacteria were recovered in subsequent assays indicating that the seed lot was contaminated but at a low level. Thus, this experiment was inconclusive.

A more highly contaminated seed lot was received in order to evaluate the potential of H_2O_2 as a seed treatment for CBB bacteria. The H_2O_2 treatment consisted of diluted H_2O_2 (2:1) with sterile water and addition of 1% Tween 20. This treatment was compared with 5% Physan as in previous experiments. These two treatments were compared with a sterile water control. Beans were immersed in H_2O_2 either for 1 hour or 5 minutes, and compared with seed immersed for 5 minutes in either sterile water or 5% Physan. A known contaminated seed lot (Lot D2203) was used as an untreated control. The experiment was repeated three times. High populations of bacteria were recovered from D2203 when whole seeds were washed with sterile water. Even more bacteria were recovered when D2203 seeds were crushed. Similar results were obtained with the new seed lot, indicating a high level of contamination in this lot. Physan successfully eradicated the bacteria from the surface of whole seeds. However, bacteria were still recovered when crushed Physan-treated seeds were assayed. When seeds were treated with H_2O_2 for 5 min, $1.65x10^6$ and $2.17x10^7$ bacteria were still recovered from the surface and from the crushed seed, respectively. Surprisingly, even when seeds were treated with H_2O_2 for 1 hour many bacteria were still recovered from the surface and from the crushed seed in two of the three experiments. These results show the superiority of Physan over hydrogen peroxide at eradication of the bacteria from the surface. The results also confirm that surface treatment of bean seed will not eradicate internal contamination by CBB.

In order to determine the location of blight bacteria in association with seed, we had representative *Xcp*/*Xcpf* strains tagged with the green fluorescent protein (gfp). The expression of this protein enabled us to track the movement of these particular bacteria. After introduction of gfp we checked the *Xcp*/*Xcpf*-gfp with specific primers to confirm their identity as *Xcp*/*Xcpf*. This test was positive. We then did rep-PCR fingerprints and these fingerprints were indistinguishable from those of the original *Xcp*/*Xcpf* strains. We further tested these strains for pathogenicity. Their reactions were similar to the original reactions by these strains and they retained the gfp gene. Thus, we concluded that by tagging them with gfp we did not in any way change their biology.

These *Xcp*/*Xcpf*-gfp strains were inoculated onto susceptible Topcrop beans that had started pod-filling. Using a small syringe a bacterial suspension was introduced at the end of the pod nearest the raceme. The bacteria moved into each developing seed. Using the confocal microscope, the bacteria were located in the seed coat and had even moved further into the cotyledons. This would explain why eradication of *Xcp*/*Xcpf* by treatment of the seed surface was unsuccessful.

Bean Virus Detection Program: Our laboratory has continued to conduct a bean virus detection project in collaboration with the California Crop Improvement Association (CCIA). In this program, we use an indirect enzyme-linked immunosorbent assay (ELISA) to detect Bean yellow mosaic virus (BYMV), Bean common mosaic necrosis virus (BCMNV) and Bean common mosaic virus (BCMV). In special cases we also tested for Cucumber mosaic virus (CMV), Alfalfa mosaic virus (AMV), Clover yellow vein virus (CYVV).

The incidence of viruses in the 2001 bean crop was high. Many fields this year had viral problems and a couple of fields showed necrosis symptoms characteristic of BCMNV. A total of 252 samples were tested for BCMV, BCMNV, BYMV, CYVV, CMV, and AMV during 2001 and 33.7% of these samples tested positive for virus infection (Table 1.A.2.b.(3) 9). About 252 samples were

tested for BCMV and 54 (21.4%) tested positive. About 87 of these samples were also tested for BCMNV and only 2 (2.3%) tested positive. This low rate of field infection may be responsible for the Black Root incidence that was observed in some fields, particularly around Canario (yellow) bean fields. These Canario bean varieties are known not to possess BCMV/BCMNV resistance, but can serve as a reservoir for the viruses to subsequently be transferred to other bean varieties, thereby causing black root in varieties with the I-gene. We used these samples for rub inoculations on Topcrop (I + $bc1^2$) and BTS (unprotected I-gene) and Sutter Pink, which does not possess any resistance genes. None of the I-gene materials developed black root symptoms, indicating the absence of BCMNV. On the other hand, many samples were positive for BCMV. In addition, the infection and characteristic symptoms on Sutter Pink confirmed this fact. Thus, an alternative explanation is that a temperature sensitive necrosis-inducing strain was introduced with Canario seed. There also was at least one other virus that was clearly not BCMV. From one of the fields, we also obtained a virus that produced interveinal chlorosis only seen on Topcrop and mosaic on Black Turtle Soup. Results of ELISA tests on this virus indicated it was not CYVV, AMV or CMV. This new virus needs to be further characterized. None of the samples tested for BYMV were positive.

Microsatellites: Methodology and Results-In order to be able to differentiate genotypes within each gene pool, PCR-based methods can be used. Although the presence of microsatellite markers is very well documented in many plant species, information on microsatellites in beans has recently been made available by Yu et al. (1999). In order to assess the abundance and usefulness of bean microsatellites as genetic markers, 326 DNA sequences from the GenBank databases were searched. Sixty-one simple sequence repetitive DNA sequences with 23 different types of repetitive DNA motifs were identified as potential microsatellites. PCR analysis of 12 of the microsatellite-containing loci revealed that 11 of the 12 primer pairs could produce easily-scoreable fragments, or groups of fragments. Allelic variation of the 11 loci was then surveyed in 12 common bean inbred lines representing a diversity of germplasm. Seven of the 11 microsatellite loci were polymorphic and yielded 2-10 alleles.

Having, therefore, decided to use microsatellites for fingerprinting bean cultivars from East Africa, six primer pairs were selected based on the number of alleles that they showed in the above analysis. They were J04555 (PV-ctt001), U77935 (PV-gccacc001), X61293 (PV-at004), X74919 (PV-at006), X80051 (PV-at007), and M99497 (VA-ag001). The following Andean materials were used: White Kidney, Rose Koko, Canadian Wonder, 12-4 and 22-2 and Mesoamerican materials: Black Turtle Soup, Masai Red, 1-1, Namajengo and 6-5.

The ten genotypes were grown in pots in the greenhouse. First trifoliolate leaves were harvested and stored at −80°C until DNA was extracted. The DNA was extracted according to Yu et al. Twenty-five ng of this DNA was used in a 20ul PCR reaction with the following temperature profile: 94°C for 1 min denaturation, and 35 cycles of 94°C 25 sec denaturation, 47°C 25 sec annealing and 68°C 25 sec extension. The PCR products were then denatured at 94°C for 2min in 5ul of stop buffer (bromophenol blue and xylene cyanole). PCR products (2.5ul) were then analyzed on a 6% polyacrylamide gel. The gels were silver-stained to visualize DNA fragments.

For primer pair J04555 [(CTT)3(T)3(CTT)6], White Kidney, Canadian Wonder and 22-2 had indistinguishable fingerprints. Rose Koko and 12-4 both had different fingerprints. These five Andean materials had fingerprints that were distinct from Mesoamerican materials. For Mesoamerican materials, Namajengo and 6-5 had indistinguishable fingerprints, whereas Masai Red, 1-1 and BTS had different fingerprints. With primer pair U77935 [$(GCCACC)_5$] Canadian Wonder and 22-2 had indistinguishable fingerprints, whereas White Kidney, Rose Koko and 12-4 had different fingerprints. Namajengo and 6-5 again had indistinguishable

fingerprints. But Masai Red and BTS still had different fingerprints. The results obtained with primer pairs X61293 [$(AT)_{12}$], X74919 [$(AT)_5$]and X80051 [$(AT)_{12}$] were similar to those obtained with U77935. However, for primer pair M99497 [$(AG)_{12}(AAG)_2$] Namajengo, 1-1 and 6-5 all had indistinguishable fingerprints, which was rather surprising.

Differences were identified among multi-colored large-seeded Andean beans (Rose Koko and 12-4). However, differences were not identified among solid colored large-seeded Andean beans (White Kidney, Canadian Wonder, and 22-2). There is a need for microsatellites that can detect the differences between these materials. Alternatively, the AFLP technique may be used to show different fingerprints of these materials. The grouping of Namajengo and 6-5 together by all primer pairs is not surprising. Namajengo is a released variety that was identified from the 6-5 landrace accession. BTS and 1-1 were clearly distinguishable and could also be distinguished from Namajengo and 6-5. These results show how powerful the method is at identifying similar genotypes and revealing differences among materials within the same gene pool. Using microsatellites we were not able to clearly differentiate Mesoamerican from Andean genotypes due to the high degree of variability.

I.A.2.b.(3)(j) Current status of research: The PCR facilities at SUA were established in 1998. Their use for testing on-farm produced seed and bean seed from large producers, exporters and importers has been promoted though visits to potential customers and preparation and distribution of flyers. The Ministry of Agriculture and Food Security has already started using our PCR facilities to train phytosanitary inspectors and quarantine officers in order to strengthen phytosanitary services in the country. Testing of on-farm-produced seed for use as common grade seed has also been initiated. However, the power supply remains a constraint for the smooth running of the laboratory.

I.A.2.b.(3)(k) Documented impact: Tanzania: The PCR laboratory has started attracting users locally and from international organizations such GTZ and FAO as a training venue to strengthen phytosanitary services in Tanzania. It is further expected that such use will increase to include training graduate students in the use of PCR techniques for detection of seed-borne pathogen in beans and other crops.

UC Davis: Our virus detection program has been widely acclaimed in California as (1) helping to reduce the incidence of BCMV in California seed, (2) raising overall awareness about bean-infecting viruses in California, and (3) providing an early warning system for the appearance of new bean-infecting viruses in California. This is further evidenced by the leveraged funds we have obtained from CCIA to partially fund this program and the fact that CCIA has decided to have our laboratory as the center for the virus detection program.

I.A.2.b.(4) Activity #4: Varietal development

I.A.2.b.(4)(a) Priority: Essential

I.A.2.b.(4)(b) U.S. researchers: Temple (Malawi); Myers (Tanzania)

I.A.2.b.(4)(c) HC researchers: Bokosi, Chirwa (Malawi); Nchimbi-Msolla* (Tanzania)

I.A.2.b.(4)(d) Methodology: Evaluation of the ALS/BCMV crosses from UCD will be continued in Malawi with evaluation in breeding trials and on-farm. The breeding trials, which are split according to growth habit, will include preliminary, advanced and national trials. The preliminary and advanced trials will be located at Dedza, Bunda, and Champhira. National trials will be located at these sites but also at Matapwata, Thyolo and Ng'onga, Rumphi. These trials will be evaluated jointly with the Chitedze (National) Bean Program, which will contribute half the materials. The on-farm evaluations will be comprised of three best materials from the national trials and evaluation will be done based on farmers' and researchers' perceptions on production (i.e., yield and disease resistance) as well as consumption and marketing criteria.

In Tanzania, crosses between selected lines were done in the screenhouse.

Preliminary trials were conducted in the replicated trials in the field at SUA farm. The experimental design was a randomized complete block with 4 replications.

Advanced yield trials and national yield trials were conducted at SUA farm in replicated trials. The experimental design was a randomized complete block with 3 or 4 replications, respectively.

The national bean yield trials were composed of 16 bean lines/varieties. Selian Agriculture Research Institute (SARI) and Uyole Agriculture Research Institutes (UARI) each contributed 5 bean lines to the trial and SUA contributed 4 bean lines. The trial was conducted at 3 locations at SARI, SUA and Uyole. The trial at SUA included released varieties SUA 90 and Rojo as checks. Different checks were used at SARI and Uyole. Data for yield, yield components, and for disease reaction were taken and analyzed.

On-farm trials were conducted in Maharaka and Msongozi villages. Completely randomized design (CRD) was used. Ten farmers were involved and each farmer was treated as a replicate. The collaborating farmers were involved in the preparation of plots, planting, weeding and harvesting. They also contributed the seeds of the local check ("Kenya").

Two sets of on-farm trials were conducted – one was for the Kablanketi crosses and the other one for the arcelin-containing lines.

Evaluation for acceptability traits was done for the Kablanketi crosses in comparison with released varieties Rojo and SUA 90 and a local variety, "Kenya". Assessed traits included seed size, seed color, cooking time, palatability and suitability for market. Forty farmers were involved in this evaluation.

I.A.2.b.(4)(e) Anticipated (1 year) results of activity: New crosses made, evaluation of preliminary and advanced lines.

I.A.2.b.(4)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Improved disease resistant varieties will result in increased yields for small farmers due to reduced losses brought on by angular leafspot and BCMV, CBB and halo blight	2002 and beyond	Identification of bean lines with disease resistance and higher seed yield compared to local varieties. Commercially released varieties and their ultimate acceptance and use by growers.

I.A.2.b.(4)(g) Budget:

Malaŵi	$39,998
Tanzania	39,997
OSU	4,499
UCD	13,499
Total (Direct Costs only)	$97,993

1.A.2.b.(4)(h) Major changes: No Major Changes

1.A.2.b.(4)(i) Progress during the past year: Tanzania: Crosses were made between lines containing different arcelin variants and the improved variety Rojo, with the aim of combining *Zabrotes subfasciatus* resistance genes with those for *Acanthoscelides obtectus* resistance (using arcelin 4, *Arc-4*). The crosses made were as follows: Rojo x SMARC1–NN1, Rojo x SMARC2–PN1, Rojo x SMARC4-PN1. SMARC1-NN1 contains *Arc-1* (conferring resistance to

Z. subfasciatus), and is both phaseolin and lectin null. SMARC2-PN1 has *Arc-2* and is phaseolin null. SMARC4-PN1 has *Arc-4* and is phaseolin null. Reciprocal crosses were also made. These crosses are now in F_2 generation. They will be screened for bruchid resistance for those with adequate seed, and those crosses with few seeds will be advanced to F_3 generation before bruchid screening is done.

Another set of crosses was made between the drought-resistant line DN 34 (obtained from Malawi) and Rojo with *Arc-1*. [(Rojo x RAZ) x DN 34] This cross was done to improve the Rojo x RAZ lines for drought resistance. These crosses are now in F_2 generation and will be advanced to F_3 or F_4 generation before screening for drought and bruchid resistance is done.

The Kablanketi crosses (EG lines) were backcrossed to Rojo and Kablanketi in order to increase seed size of the two EG lines (EG 10 and EG 21). The results of on-farm trials indicated that these two lines, which are performing well in terms of yield and resistance to diseases, will be more acceptable if their seed size is larger than it is now. The F_1 seeds have been obtained and will be advanced to further generations before selection is performed.

Preliminary Yield Trial: A preliminary trial was conducted for 35 drought-resistant materials during the short rain season in 2000 (Oct. - Dec.). The data were analyzed statistically and the results presented during the Arusha Bean Research Workshop in January 2001. Most of the lines were susceptible to ALS. There were three lines that had lower scores for the four rated diseases (BCMV, ALS, CBB and rust). These lines were DN34, DN33, and HHL 30-75. DN 34 and HHL 30-75 were most promising in terms of yield and disease resistance. Since they have Type III growth habit (climbers), these lines can be suitable in Mgeta area (Morogoro region) to replace local variety Kibwebwe (a Type III bean variety), which is very susceptible to BCMV. It is recommended that these lines be tested in that area, and other areas where climbers are grown.

Advanced Yield Trial: An advanced yield trial for the Kablanketi crosses (EG lines) was conducted at SUA during the long rainy season (April-June, 2001). (Kablanketi is a low yielding, disease susceptible local variety that is highly preferred by consumers, as well as being a variety grown for its higher cash value in the markets.) The performance of these lines is shown in Table 1. Bean line EG 21 performed better than the check lines SUA 90. This line also showed resistance to BCMV, CBB and ALS. The other Kablanketi crosses performed better than the check (Rojo). From this trial, it appears that line EG 21 and EG 10 are the promising lines for release although seed size is smaller than Kablanketi. Both are of Kablanketi type (gray mottled).

Table 1. Performance of eight advanced bean lines (EG) at SUA Farm, 2001.

Bean line/ Variety	Days to 50% flowering	Days to 85% Maturity	Stand count at Harvest	Plant height (cm)	No. seeds/ pod	100 seed weight (g)	Seed yield (Kg/ha)	BCMV a	CBB a	ALS a
EG 10	32	78	72 a	56.2 b	10.0	31.1 de	1535 ab	1.0	1.3	1.3
EG 13	33	80	15 b	40.8 c	13.7	35.4 cd	506 d	0.7	1.3	0.8
EG 21	34	80	74 a	53.8 b	10.7	32.7 de	1783 a	1.0	1.0	1.0
EG 40	34	76	14 b	34.3 c	15.0	41.4 ab	471 d	1.0	2.3	3.3
EG 44	33	77	11 b	33.0 c	10.5	39.5 bc	348 d	1.1	1.4	1.2
SUA 90	33	84	61 a	53.0 b	12.7	29.2 e	1728 a	1.0	1.0	1.0
Rojo	33	77	27 b	38.1 c	11.3	44.9 a	836 cd	2.0	2.7	3.3
Canadian	32	78	63 a	65.1 a	13.0	43.9 ab	1212 bc	4.3	1.7	4.0

Wonder	32.9	78.9	42.5	46.8	12.1	37.26	1052.3	1.5	1.6	1.9
Mean	3.3	3.59	29.14	10.83	30.42	7.33	24.76			
CV (%)	n.s.	n.s.	7.151	2.9	n.s.	1.58	150.4			
SX										

[a] Scale of 1-9, 1 = least disease. Values followed by the same letter(s) are not significantly different at alpha = 0.05.

The national bean yield trial was also grown. It was composed of 16 bean lines/varieties as explained in the methodology. The results from SUA are shown in Table 2. The highest performer in seed yield was EG 21, a line from SUA, followed by SUA 90; Mlama 49 from Selian was the third. The results from two other stations (Uyole and Selian) have not yet been made available.

Table 2. Performance of 16 bean lines in national bean yield trial at SUA, 2001.

Bean line/ Variety	Days to 50% flowering	Days to 85% Maturity	Stand count at Harvest	Plant height (cm)	No. pods/ plant	No. seeds/ pod	100 seed weight (g)	Seed yield (Kg/ha)	BCMV a	CBB a	ALS a
722 ANT 48	31	72	82	46.6	13.0	3.7	53.9	983	1.0	1.5	5.8
393-CP006-92-6	33	82	96	47.0	9.7	4.2	41.6	1059	1.0	1.3	5.3
407 FOT 17	32	76	79	41.6	13.7	4.2	45.4	1062	1.3	1.0	1.5
Mlama 49	33	76	62	46.7	11.0	4.0	38.9	1191	1.0	1.8	4.0
Selian 97	32	77	83	43.8	11.5	4.5	43.3	1011	1.0	1.5	5.2
Uyole 96	33	79	72	95.5	9.0	4.2	51.2	1136	1.0	3.0	2.0
TM (J_1 J_2)	33	81	80	42.2	12.5	5.0	42.5	656	1.0	1.0	2.5
PBS Wanga	32	81	73	49.3	10.7	4.7	44.3	1180	1.0	1.3	3.8
Line 74	31	76	102	56.6	8.0	5.0	47.5	441	1.0	1.0	1.0
Uyole 84 x Kablanketi	36	83	79	114.2	6.5	4.2	36.5	247	2.8	1.0	1.0
EG 10	35	81	68	42.8	7.5	5.5	30.4	1112	1.0	1.8	2.3
EG 21	30	73	84	45.6	14.0	4.7	34.1	1293	1.0	2.3	1.3
EG 40	32	75	94	34.4	8.8	4.2	44.8	639	1.0	1.0	4.8
EG 44	32	74	57	46.2	7.5	4.5	42.2	935	1.0	3.3	3.3
Rojo	31	75	86	43.6	11.5	5.0	41.9	1069	1.0	2.0	4.0
SUA 90	33	76	88	45.3	9.7	5.5	25.4	1198	1.0	4.3	1.5
Mean	32	77	81	52.6	10.29	4.59	41.56	950.8	1.1	1.8	3.1
CV (%)	3.4	3.8	25.1	19.2	28.4	13.5	14.2	28.7	47.5	55.9	41.4
SX	0.56	1.47	10.11	5.02	1.46	0.31	2.95	136.4	0.267	0.50	0.61

[a] Scale of 1-9, = least disease

On farm trials: Kablanketi crosses (EG lines) were evaluated in on-farm trials in Msongozi and Maharaka villages, while the bruchid resistant lines were evaluated only at Msongozi village. The results of the trials are shown in the following table. Yield performance at Maharaka village was lower than at Msongozi village mainly because of the dry spell that occurred when plants were in the field. At Maharaka village all of the Kablanketi crosses had higher seed

yield than the checks SUA 90, Rojo and the local variety, 'Kenya'. At Msongozi village all the Kablanketi crosses performed well except for the EG 13. This suggests that EG 13 may tolerate drought, but may not show a linear response to better environments. The disease rating was generally low at Maharaka village, probably due to dry conditions. These trials reveal that EG 10, EG 21 and EG 44 are promising lines for release in terms of seed yield and disease resistance.

Table 3. Performance of Kablanketi crosses in the on-farm trials in Maharaka and Msongozi villages, 2000-2001.

	Maharaka			Msongozi		Average Yield Over locations
Bean line/variety	Seed yield (kg/ha)	CBB[a]	ALS[a]	Seed yield (kg/ha)	CBB[a]	(kg/ha)
EG 10	385	1.6	1.3	1145	1.5	765.0
EG 13	507	1.3	1.4	938	1.0	722.5
EG 21	448	1.4	1.4	1124	3.0	786.0
EG 40	432	1.6	2.0	1036	2.0	734.0
EG 44	449	1.3	1.1	1373	1.0	911.0
Rojo	365	1.2	1.8	845	1.5	605.0
SUA 90	381	1.7	1.1	1076	4.0	728.5
Kenya	204	1.6	1.4	1311	2.5	757.5
Mean	396.5	1.46	1.46	1106	2.06	
CV (%)	34.2	42.3	51.0	48.5	42.7	
SX	20.5	0.26	0.30	379.0	0.6	

[a] Scale of 1-9, 1 = least disease

Preference evaluation by farmers of several seed traits gave the following results: Based on seed color, the local variety (Kenya) appeared to have the most acceptable color since 65% of the respondents scored it as "very good" and 25 % as "good." Bean line EG 44 ranked next with a score of 35% as "good." Bean lines EG 10 and Rojo were ranked "fair." In terms of cooking time, the Kablanketi cross EG 10 was one of the best; 65% of the respondents ranked it as very good for cooking. In terms of taste and production of good broth assessment among the Kablanketi crosses, EG 21 was ranked the highest where 52.5% of the respondents ranked it as having very good taste. SUA 90 was also assessed by 45% of respondents as having very good taste. In terms of suitability for market, farmers were assessing the beans based on seed color and seed size. Among the Kablanketi crosses that were identified to be suitable for the market were EG 13 and EG 44, both having red seed color. Since the farmers were assessing these beans for the first time, they indicated that they need to be given seeds so that they can assess other traits on their own.

Among the bruchid-resistant lines tested in the on-farm trial, RAZ x SUA 90 had the highest seed yield followed by RAZ x EP 4-4 (bruchid resistant Rojo) although this line was slightly susceptible to CBB (Table 4). These lines were not evaluated for other traits (for example, cooking) because of limited seed; this will be done in future studies.

Fourteen lines from nematode resistance crosses were sent to the nematologist at TPRI in Arusha for screening for nematode resistance. The same lines are currently evaluated at SUA farm for yield and disease resistance. These lines are: ESBSIA, ESBSIB, NS4A, KC10A, IMC4A, IMC6A, SUE 3, SC1, SC6, NR2A, NR4B, NR14A, NR5A, NR 22. These lines will be harvested in mid November.

Table 4. Performance of bruchid resistant lines in on-farm trials at Msongozi, 2002/2001 seasons.

Bean Line/Variety	Plant stand at harvest	No. Pods/ plant	No. seeds/ pod	100 seed weight (g)	Seed yield (kg/ha)	CBB[a]
RAZ x EP 3-3	18 b	13.0 ab	8.5 a	27.8 bc	383 bc	1.0 b
RAZ x EP 4-4	38 a	14.0 ab	5.5 ab	36.1 ab	1041 ab	4.0 a
RAZ x C11	36 a	14.0 ab	5.5 ab	40.0 a	853 abc	1.5 b
RAZ x C12	18 b	8.0 b	5.5 ab	38.3 a	294 c	1.5 b
RAZ x SUA90	33 a	17.0 a	6.0 ab	33.5 ab	1116 ab	1.0 b
SUA 90	37 a	15.5 a	5.5 ab	23.3 c	690 abc	1.0 b
Rojo	40 a	13.5 ab	5.0 b	37.2 a	1432 a	2.5 ab
Canadian Wonder	39 a	16.5 a	5.88	33.2 ab	1078 ab	4.0 a
Mean	32.19	13.94	21.34	33.64	861	2.1
CV (%)	15.55	18.48	0.886	10.51	34.24	40.75
Sx	3.540	1.821		2.499	208.4	0.593

[a] Scale of 1-9, 1 = least disease.

Malawi

Advanced Bean Yield Nurseries: The ABYT I (advanced bean yield trial for bush types) was grown at two locations (Champhira and Dedza). The trials contained varieties from African Bean Yield and Adaptation Nursery (AFBYAN), Southern African Regional Bean Yield Trial (SAZBYT), and Southern African Zonal Bean Evaluation Nursery (SAZBEN) regional nurseries, in addition to B/C CRSP lines, and entries from CIAT and the Uganda National Program. Kalima was used as a check variety. In general, yields were much higher at Dedza compared to Champhira. CAL 98 a Kalima seed type from the AFBYAN was the best performer at Champhira, and B2 (a B/C CRSP entry), was ranked second for yield. B2 is resistant to both BCMV and ALS. Panmeko, a red kidney type from the AFBYAN, was the only entry to yield in the top five in this season and last. At Dedza, ZPV 292 (Kaulesi type from SAZBEN) was the highest yielding. The same entry performed second best in the 1999/2000 season. Experimental lines beat the check (Kalima) in both seasons at both locations. The ABYT II (advanced bean yield trial for climbers) was also grown at Champhira and Dedza. This trial was composed of entries from Bunda, and the Uganda National Program, with Bunda 93 included as a check variety. The best entry at Dedza was MCR 2505, which was second best at Champhira. Ugandan entries DC86-306 and DC86-263 also performed well at both locations. Both are of a red kidney type.

National Bean Yield Trial: This trial was grown at Dedza and Ng'onga. Of the two locations, yields were much higher at Dedza compared to Ng'onga. Entries in the trial included those from Malawi, Uganda and Tanzania National Programs, SAZBEN, SAZBYT, and RSA. Best performer at Dedza was DC95-170 (purple-gray sugar from Uganda) followed closely by Lyamungu 90 (Kalima type from Tanzania). Also in the top five was 'Napirira', a Kalima type from the Malawi National Program. This entry was also the only one found in the top five in this and the prior (1999/2000) seasons. At Ng'onga, A197, a large beige kidney type from SAZBYT, was top performer. Third ranked OPS-RS (sugar bean, Malawi National Program) and fifth ranked Napirira were the only two lines that made it into the top five in 2000/2001 and 1999/2000.

Improved BCMV and ALS Resistant Materials: The performance of F_3BC_3 materials received from UC-Davis was evaluated at Bunda College, Chitedze Research Station, and Dedza. Joint selections were made by Drs. Steve Temple, James Bokosi, and Rowland Chirwa. The selected progenies were sent to UC-Davis for BCMV confirmation. The seed from UC-Davis is expected to be planted in the 2001/2002 season for further evaluation and selection. These materials are in preferred seed types and show good resistance to both BCMV and ALS.
1.A.2.b.(4)(j) Current Status of the Project: (Tanzania) The crosses were made and will be advanced for more crosses and selection. Preliminary trials will continue for one more season before the lines are put into the advanced yield trials. Selection will be made for the best-performing lines in the advanced yield trials and on-farm trials. Some of the lines from these trials are already in the on-farm trials. The on-farm trials will continue for one more season before the best-performing lines are presented to the varietal release committee for consideration for release. Trials on the nematode-resistant lines are continuing and the results will be obtained in late 2001.

From the preliminary trials, some of the promising bean lines have been identified and will be advanced into yield trials later. From the advanced yield trials, two Kablanketi crosses, EG 21 and EG 10, appear to be most promising. These lines have also been evaluated in the on-farm trials and the results shows that they are performing well. Initial studies on acceptability indicated a moderate to high level of acceptability for various traits, based on 52 to 72 farmers. More studies need to be done on the acceptability of these lines to confirm the results.

Malawi: The most promising lines for release are Lyamungu 90, a Calima type kidney from Tanzania, ZPV906, a bush white kidney that entered the breeding program through the Southern African Zonal Bean Yield Trial, and 15P/8, a small red-seeded climber with HB and anthracnose resistance. Release will be pursued in 2002.
1.A.2.b.(4)(k) Documented Impact: None yet.

I.A.2.b.(5) Activity #5: Bean stem maggot--evaluate potentially resistant lines; study prevalence of BSM and farmers' cultural practices
I.A.2.b.(5)(a) Priority: Essential
I.A.2.b.(5)(b) U.S. researchers:
I.A.2.b.(5)(c) HC researchers: Nyrienda* (Malawi)
I.A.2.b.(5)(d) Methodology: The objective in Malawi in FY 01 was the same as that in FY98, namely, continue the surveys started in FY98 in major bean growing areas in Kasungu, Zomba, Balaka, Mangochi, Ntaja rural of Machinga Agricultural Development Division (ADD), and remaining parts of Lilongwe ADD. Small plots were marked (about 10m x 10m) on smallholder farmers' fields. Farmers controls and other practices used by farmers will be determined and documented for incorporation into Integrated Pest Management (IPM) programs to be developed in the future. To explain/demonstrate how to conduct the surveys on farmers' fields and at the Ecological Planning Area demonstration sites, the course included identification of insects, their damage and how to fill out forms.
I.A.2.b.(5)(e) Anticipated (1 year) results of activity: Control strategies used by farmers in relative areas will be known.

I.A.2.b.(5)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers reduce crop losses to BSM, increasing productivity and profit	2003 and beyond	Lines with tolerance identified. Trait crossed into improved materials
Farmers will plant more beans in different environments due to use of improved cultural practices that decrease the incidence of severity of BSM	2005	Change of planting dates and other cultural practices to avoid BSM. Greater adoption of resistant varieties to BSM
Reduced incidence of BSM and other insect pests due to adoption of recommended cultural practices	2005 and beyond	Increased percentage of farmers adopting recommended practices; increased bean yield in these farmers' fields
Improved understanding of recommended IPM cultural practices for BSM among extension or cooperating NGOs	2005 and beyond	IPM cultural practices appear in ADD and NGO extension/NGO reports; participation of extension staff, NGO staff and farmers in workshops on BSM management

I.A.2.b.(5)(g) Budget:

Malaŵi	$3,000
Total (Direct Costs only)	$3,000

I.A.2.b.(5)(h) Major changes: No major changes.

I.A.2.b.(5)(i) Progress during the past year: Forty-one extension workers incorporating the field assistants, development officer, senior technical officers, a principal and a farm manager at Mponela attended a demonstration course at Mponela Residential Training Centre. The course was opened by the program manager and ran from August 26-28, 2001. A field guide produced by CIAT was distributed during the course.

I.A.2.b.(5)(j) Current status of the project: Similar courses are still to be held at Zomba Residential Training Center in Machinga ADD when funds are made available. Returns are still being awaited from ADDs where demonstrations were conducted in the past two FY 99 and FY 2000.

I.A.2.b.(5)(k) Documented impact: An achievement is that 41 professional workers were trained in IPM cultural practices, and are in a position to influence their farmer clientele on improved production practices for beans.

I.B. Constraint #2: Limited Storage Options

I.B.1. Research area: Control of storage insect pests through genetic and agronomic means

I.B.1.a. Background: Bruchids are a major problem for storage of bean seed for propagation and consumption. Studies were conducted (1997-1999) in most regions of Tanzania and all regions of Malawi at different times of the year. Preliminary indications are that both *Zabrotes* subfasciatus and/or *Acanthoscelides obtectus* were prevalent at some locations but not others and at different times so, for widespread resistance, we need to have resistance to both species of bruchids. Indigenous storage methods have been investigated. Five advanced lines have been developed with *arcelin* 1 that confers resistance to *Zabrotes subfasciatus*. One variety, a Rojo backcross line, is nearing final testing and should be released in 2002. Other lines may be suitable for release as well. As such, this research has not yet had documented impact on the smallholder but is expected to prolong the time a farmer may keep seed. We need to determine the utility of these lines in on-farm trials. Additional resistance to *Acanthoscelides* is needed because this is the prevalent bruchid species in some parts of the region. Other arcelin alleles (*Arc-2* and *Arc-4*) may confer better resistance to *Acanthoscelides*. By reducing the contribution of phaseolin to seed storage protein (by using a phaseolin null mutant), a larger proportion of seed storage protein will

be arcelin, and these seeds may be more toxic to bruchids. We are developing arcelin (+) phaseolin (-) lines through backcrossing to improved lines. In addition, a wild tepary accession has been identified that confers strong resistance to both species of bruchids. We need to determine mode of resistance and transfer into common bean.

There is limited information on the prevalence, distribution, status and types of storage pests, particularly bruchids in Malawi. Information is also limited on the interventions taken by farmers to deal with bean storage pests. Surveys were initiated in 1997/98 and continued in 1998/99 but all major bean-growing areas/ADDs have not been covered. The FY2001 surveys will therefore cover the unsurveyed areas.

I.B.1.b. Proposed research area workplan and subsequent annual progress report

I.B.1.b.(1) Activity #1: Development, evaluation and release of alternate arcelin lines
I.B.1.b.(1)(a) Priority: Essential
I.B.1.b.(1)(b) U.S. researchers: Myers* (Tanzania)
I.B.1.b.(1)(c) HC researchers: Nchimbi-Msolla, Misangu (Tanzania), Bokosi, Chirwa (Malaŵi)
I.B.1.b.(1)(d) Methodology: Backcrossing into Rojo and Kalima of *arcelin 2* and *arcelin 4*, phaseolin null seed storage proteins is to be completed. The presence of the proper arcelin allele and absence of phaseolin will be verified by protein gels and PCR. Material will be provided to breeders in Tanzania and Malaŵi for evaluation of resistance, and field performance with eventual release of lines to occur.
I.B.1.b.(1)(e) Anticipated (1 year) results of activity: Advanced lines in improved backgrounds with *Acanthoscledies* resistance and enhanced *Zabrotes* resistance will be identified.
I.B.1.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers can store beans for longer periods of time, increasing food security	2002 and after	Backcross lines lacking phaseolin, but conferring resistance to bruchids obtained

I.B.1.b.(1)(g) Budget:

Malawi $0 (included in I.A.2.b.4.)	
Tanzania	3,500
OSU	4,100
Total (Direct Costs only)	$7,600

I.B.1.b.(1)(h) Major changes: Concerns were raised as to whether arcelins actually confer bruchid resistance. These concerns arise from a recent publication that suggests that linked factors, rather than arcelin *per se* condition resistance. To address these concerns, additional studies were conducted in addition to the backcrossing project. Seed from segregating populations using the SMARC lines was sent to Tanzania from Oregon so that bruchid testing could be performed directly, rather than making selections based on arcelin alone. In addition, a study was performed to document the effect of bruchid damage to seed for planting.
I.B.1.b.(1)(i) Progress during the past year in Oregon: BC_1F_2 lines (derived from SMARC *Arc-2* and Arc-4 crossed to the recurrent parent Rojo) were screened using SDS-polyacrylamide gel electrophoresis for the presence of the appropriate arcelin band (either arcelin 2 or arcelin 4), and the absence of phaseolin seed storage protein. Using this procedure, 34 were selected with the appropriate genotype, and were crossed to Rojo to produce the BC_2F_1. The seeds of which were grown at the Vegetable Farm in Oregon during Summer 2001 to produce the BC_1F_2. The lines were grown with their respective nonrecurrent parents from the previous generation (BC_1 lines), and with Rojo. The BC_2 lines more closely resembled Rojo than did the BC_1 lines, and the present similarity suggests that no further backcrossing may be needed.

During the growing season, the BC_1 lines became infected with BCMV whereas the BC_2 lines remained healthy. Seed from harvested lines for the most part resembles the Rojo parent (large red kidney).

Tanzania: Research on the development of beans resistant to *Acanthoscelides obtectus* continued. A total of 92 bean lines from the US were tested for resistance against *A. obtectus* in the laboratory. Of these, 42 lines were crosses of SMARC 2-PN1 x Rojo while 50 lines were crosses of SMARC 4-PN1 x Rojo. Now in the BC_1F_3, the crosses were identified in Oregon as phaseolin null and arcelin + in the BC_1F_2. These lines should be homozygous for lack of phaseolin, but will segregate for arcelin. The materials were tested in a non-replicated trial whereby 5-25 seeds (depending on the number of seeds available) of each entry were placed in a vial. To each vial, freshly laid eggs of *A. obtectus* were added at a rate of 3 eggs per seed. All vials were then covered with perforated lids and placed in an incubator adjusted at 26-28^{0}C and 70% R.H. After 26 days F_1 adult bruchids started emerging from the bean seeds. These were counted and removed daily. The experiment was terminated 60 days from the date it was started.

Results indicated that most of the lines were susceptible to *A. obtectus* but lines 2-2-8, 2-2-17, 2-2-20, 2-2-41, 4R-8-20 and 4R-10-2 showed high levels of resistance. These lines are now being re-tested in a replicated trial using CRD in order to further confirm whether they were genetically resistant or simply escapes. All 92 entries are also being tested for resistance to *Zabrotes subfasciatus*.

Bean loss assessment due to planting bruchid-damaged seeds - Most farmers in Tanzania plant their own saved bean seeds. However, because of poor storage facilities farmers' seeds once in a while may be damaged by bruchids. When this situation prevails farmers look for alternative sources of undamaged seeds. However, some farmers may not obtain undamaged seeds from elsewhere and therefore plant bruchid-damaged seeds as long as such seeds can germinate.

An experiment was conducted to determine the effect of bruchid-damaged seeds on plant development and grain yield. The experiment was planted in the glass house using the RCBD with 4 replications. The seeds were planted in plastic pots. The treatments included seeds with one, 2, 3 or 4 holes. Undamaged seeds were used as a control.

Results indicated that there was poor plant development, high susceptibility to powdery mildew disease and low grain yield on plants originating from bruchid-damaged seeds (Tables 1 and 2). It was concluded that farmers should refrain from planting bruchid-damaged seeds, and that arcelin resistance (in addition to storage techniques) would result in better quality seed for planting.

Table 1. Means of plant developmental characteristics and disease severity

Treatment	G.P	N D FF	P.L (cm)	P.H (cm)	DPM	SPM (1-5 scale)
0 hole	81.3 a	30.8 b	10.9 a	31.7 a	63.9 d	1.0 c
1 hole	81.3 a	30.9 b	10.2 a	29.4 a	63.9 d	1.0 c
2 holes	68.8 b	30.9 b	10.0 a	28.7 a	66.1 c	1.4 b
3 holes	43.8 c	31.8 b	8.8 b	27.2 b	69.4 b	4.1 a
4 holes	25.0 d	37.5 a	8.4 b	26.2 b	76.5 a	4.1 a
LSD	1.2	1.0	1.4	3.9	1.7	0.1
Mean	60.4	32.4	9.7	28.7	67.8	2.3
SE	0.36	0.30	0.40	1.13	0.49	0.04
CV	33.6	2.1	9.2	8.8	1.6	3.5

Means in the same column followed by the same letter are not statistically different ($P<0.05$) following separation by least significant difference test.

*Abbreviation; G.P = Germination percent, NDFF = Number of days to first flower appearance, P.L = Pod length, P.H = Plant height, DPM = Days to physiological maturity, SPM = Severity of powdery mildew.

Table 2. Means of yield components of bruchid damaged seed.

Treatment	NPP	NSP	Wt. Of 100 seed (g)	Yield/Plant (g)
0 hole	2.3 a	3.5 a	27.0 a	2.5 a
1 hole	2.5 a	3.1 b	25.9 b	1.9 b
2 holes	2.4 a	2.7 bc	16.9 c	1.0 c
3 holes	1.8 a	2.5 c	14.3 d	0.8 c
4 holes	1.4 a	2.1 c	9.8 e	0.4 d
LSD	1.4	0.4	0.5	0.3
Mean	2.1	2.8	18.8	1.3
SE	0.13	0.13	0.17	0.09
CV(%)	13.14	10.6	2.0	14.8

Means in the same column followed by the same letter are not statistically different ($P<0.05$) following separation by least significant difference test.

* Abbreviation; NPP= number of pods per plant, NSP = Number of seeds per pod.

I.B.1.b.(1)(j) Current status of the project: Oregon: Seed is being cleaned and examined. Final selections will be made based an arcelin screen, and the arcelin + phaseolin – lines will be forwarded to SUA for bruchid screening studies, selection and eventual release of a *Acanthoscledies* resistant variety.

I.B.1.b.(1)(k) Documented Impact: None yet.

I.B.1.b.(2) Activity #2: Incorporate *Acanthoscledies* resistance from tepary bean into common bean

I.B.1.b.(2)(a) Priority: Essential

I.B.1.b.(2)(b) U.S. researchers: Myers*

I.B.1.b.(2)(c) HC researchers: Nchimbi-Msolla, Misangu

I.B.1.b.(2)(d) Methodology: The exact program will depend on what progress is made in FY 00. A *Phaseolus acutifolius* accession resistance to *Acanthoscelides* will be crossed to *P. vulgaris* in FY 00. First attempts will be made with *P. vulgaris-P. acutifolius* congruity-backcross lines (obtained from Peter Ascher, UMN) to determine if introgression can be accomplished without embryo rescue. If this approach fails, then embryo-rescue will be used. Depending on whether F_1s are fertile or sterile, backcrosses with embryo rescue may or may not be required. Screening of F_2s for bruchid resistance will be done prior to further backcrosses, and the genetic control will be analyzed. The seed protein profile of the resistant accession will be compared to that of other tepary lines, and to common bean.

I.B.1.b.(2)(e) Anticipated (1 year) results of activity: Information on mode of resistance found in tepary bean will be derived.

I.B.1.b.(2)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Less damage in the field from bruchids, and farmers can store beans for longer periods of time, increasing food security	2003 and beyond	Resistance in tepary bean characterized; Fertile interspecific hybrids recovered; Genetic analysis of resistance completed; Advanced lines with *A. obtectus* resistance released and in use

I.B.1.b.(2)(g) Budget:

Tanzania $0 (included in A.2.b.(4)(g)	
OSU	5,400
Total (Direct Costs only)	$5,400

I.B.1.b.(2)(h) Major changes: (Oregon) G40199 continues to be difficult to bring into flower in the winter greenhouse in Oregon. When planted in the fall, it flowers only sparsely prior to June. During the summer months, it has a much more prolific flower production, however, we do not have the physical resources to make the crosses during the summer given the demands of the field season. During the spring 2001, we made a limited number of crosses to common bean, but as in the previous season, pods developed but then aborted about two weeks after

fertilization. Because of the difficulty of working with this accession, it was decided to emphasize genetic analysis and characterization of the novel seed storage protein, and to wait until the renewal phase to initiate wide hybridization assisted by embryo rescue.

I.B.1.b.(2)(i) Progress during the past year: (Oregon) Segregation of a unique seed protein band was studied in the F2 of a cross between the wild tepary bean accession G40199 and a cultivated brown-seeded tepary accession. At about 36 kd, the major band for the seed storage protein is of similar size to those of the various arcelins found in common bean. G40199 was crossed to a cultivated tepary bean that lacked the 36 kd band. Individual F^2 seeds were analyzed for seed protein content. Of 24 seeds analyzed, 17 possessed the novel band while 7 lacked the band. This fits a 3:1 ratio for this band behaving as s single dominant gene ($\chi^2 = 0.22$, P-0.64). These seeds were sent to SUA for testing to determine whether bruchid resistance co-segregates with the presence of the novel seed storage protein band.

I.B.1.b.(2)(j) Current Status of the Project: (Oregon) Preliminary data suggests that the novel tepary seed storage protein is heritable as a single dominant gene. It remains to be determined if this seed storage protein is a member of the arcelin family, and whether it is correlated with bruchid resistance. Tests are currently underway at SUA to determine if seed storage protein composition in the F_2 material corresponds to bruchid resistance. In the next phase, plans are to conduct studies to characterize the novel seed storage protein and determine if it does confer bruchid resistance, in addition to transferring that resistance into common bean.

I.B.1.b.(2)(k) Documented impact: None yet.

I.B.1.b.(3) Activity #3: Bean bruchid prevalence and variation assessment--survey of seasonal variation of bean bruchid species

I.B.1.b.(3)(a) Priority: Essential

I.B.1.b.(3)(b) U.S. researchers: None

I.B.1.b.(3)(c) HC researchers: Nyirenda*

I.B.1.b.(3)(d) Methodology: Work started in FY99 will be continued. Beans and bruchid samples were collected from farmers' storage facilities in major bean-growing areas in Kasangu and Lilongwe ADD and in Zomba, Baklaka and Ntaja RDPs of Machinga ADD at different times of the year to determine the bruchid species most prevalent in space and time during the year. The next steps are to identify bruchid species from samples reared in the laboratory; estimate damage level of bruchids from samples and farmer interviews, and, using the questionnaire, establish methods for use in bean storage and control of bruchids.

I.B.1.b.(3)(e) Anticipated (year 1) results of activity: Information on seasonal prevalence of bean bruchid species and their damage level and methods of bean storage and control will be available from Kasangu, Lilongwe and Machinga ADDs.

I.B.1.b.(3)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers' willingness and ability to store beans for longer periods of time	2002 and thereafter	Clean seed and beans more available; price of beans consistent throughout the year
Increased household food security and improved nutrition	2002 and thereafter	Clean beans more available at markets and household levels

I.B.1.b.(3)(g) Budget:

Malawi	$2,000
Total (Direct Costs only)	$2,000

I.B.1.b.(3)(k) Documented impact: Impact has not yet been assessed.

I.C. Constraint #3: Insufficient Research for Improved Nutrition and Processing

I.C.1. Research area: Bean culinary and nutritional quality issues

I.C.1.a. Background: Beans in East Africa regions are produced for both cash income and consumption. They are consumed by the farming community (about 85% of the population) and by urban dwellers. For both groups, firewood and charcoal are the major fuel for cooking. However, 30 years of growing tobacco as an income-producing crop in both Tanzania and Malawi has resulted in destruction of forests and the environment. Firewood is currently difficult to get in the rural areas and remains a scarce and expensive commodity in most urban areas. The new bean varieties produced by the program should therefore be those that can be cooked with less fuel-wood. There is a need to institutionalize screening for fast-cooking varieties with the breeding scheme.

Methodology for cooking trials has been well established. The past research has helped to identify superior lines with rapid-cooking capabilities. Efforts to evaluate cookability of the new bean varieties under laboratory and field conditions will be continued.

Customer preference and acceptance of the new bean varieties released by the breeders is an important aspect in achieving the anticipated impact in nutrition and health. Sensory evaluation of the released bean varieties and overall acceptability of the bean lines by consumers in laboratory, households, and urban cafés and street food stalls needs to be done. Broth characteristics and storage stability (shelf life) of the cooked beans need to be addressed as they influence customer preference and acceptability.

I.C.1.b. Proposed research area workplan and subsequent annual progress report

I.C.1.b.(1) Activity #1: Screen advanced breeding lines for cooking time and preferences
I.C.1.b.(1)(a) Priority: Essential
I.C.1.b.(1)(b) U.S. researchers:
I.C.1.b.(1)(c) HC researchers: Ngwira, Mwangwela* (Malawi); Mosha, Nchimbi-Msolla Tanzania)
I.C.1.b.(1)(d) Methodology: Bean materials consisting of eight bruchid-resistant lines, early generation lines that have undergone preliminary selection, and those varieties in on-farm trials will be evaluated for cookability in the laboratory using the Mattson cooker and firewood as a fuel source. The Bunda College community will be involved in evaluating the sensory characteristics of the bean lines.
I.C.1.b.(1)(e) Anticipated (1 year) results of activity: Lines with quick cooking ability identified.
I.C.1.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Increased income for farmers who grow the fast-cooking beans	FY 2002 and beyond	Documentation of fast-cooking bean varieties; New fast-cooking lines released.
Increased consumption of beans in areas where new varieties are available	FY2002 and beyond	Documentation of farmers and consumers preference for fast-cooking varieties

I.C.1.b.(1)(g) Budget:

Malawi	$3,000
Total (Direct Costs only)	$3,000

I.C.1.b.(1)(h) Major changes: SUA did not send materials to Bunda for cooking time evaluation because nearly all SUA advanced lines had been screened the year previously by Mr. Mosha, before he began his graduate studies at MSU.

I.C.1.b.(1)(i) Progress during the past year: Twenty-six bean varieties and breeding lines were evaluated for cooking time using a Mattson bean cooker. The Malawian advanced breeding lines included in this study were generated from the Bean/Cowpea CRSP breeding program at Bunda College, and the Malawian varieties were released by the Bean/Cowpea CRSP program. All other materials included in the study are being evaluated by the Bean/Cowpea CRSP breeding program at Bunda, but were developed by partner programs in the region.

The cooking time tests were conducted in the Foods Laboratory at Bunda College of Agriculture from September 2000 to March 2001. Bean cooking time was evaluated using three types of cooking water: deionised, tap and borehole water. The work was conducted as a two factor randomized complete block design. Fifty bean seeds of each material were soaked overnight (16 hours) in deionised, tap, or borehole water. Twenty-five soaked beans of each material were then selected, placed in individual perforations of the Mattson cooker, and a stainless steel rod was placed on each bean. The Mattson bean cooker together with the beans was placed in a 2-liter beaker containing cooking water, and placed on a hot plate. The same type of water was used to cook each variety as was used for soaking, therefore each variety was soaked and cooked in these types of water (deionized, tap and borehole). The beans were cooked until all rods penetrated the beans. The bean sample was considered to be 100% cooked when the metal rods had pierced all twenty-five beans. Each treatment (bean material X water type) was replicated three times for a total of 234 samples. The data was analyzed using Anova in the MSTAT statistical package.

There were significant differences in cooking time between bean materials within the three types of cooking water, implying varietal influence in cooking time of the beans (Table 1). Generally, cooking time of all bean materials was fastest in deionised water, second fastest in tap water, and slowest in borehole water. In deionised water, cooking time of most of the bean materials was fast to medium. The cooking time of beans in deionised, tap and borehole water ranged from 53 minutes for 3J/2 to 101 minutes for AND 65, from 61 minutes for Bwenzilana to 132 minutes for ZPV 292, and from 88 minutes for 2-10 to 231 minutes for DC 86-250, respectively. Only six materials had cooking time in tap water that were faster than or equal to cooking time in deionised water – AND 656, Sugar 47, DC 184-35, Fitomeko, Bwenzilaana and Sugar 59. One material, DC 95-170, had cooking time in borehole water that was faster than in tap water. There were also bean materials such as ZPV 292 where the difference in cooking time between tap and borehole water was minimal. These differences in the cooking time of beans due to type of cooking water need to be further investigated to allow breeders to determine the characteristics for selection.

Table 1. Cooking time (minutes) of 26 freshly harvested dry bean varieties and breeding lines in three types of cooking water.

	Types of Cooking Water		Differences in Cooking Time			
Variety	**Deionised (D)**	**Tap (T)**	**Borehole (B)**	**T - D[x]**	**B D[y]**	**B T[z]**
3J/2	53	83	187	30	134	104
Kalima	57	64	96	7	39	32
IZ 226-1	60	78	203	18	143	125
Sugar 59	62	62	146	0	84	84
DC 86-191	62	100	162	38	100	62
DC 86-244	62	90	147	28	85	57
2-10	63	67	88	4	25	21
15 P/8	64	98	192	34	128	94
AI 97	65	94	155	29	90	61
DC 96-95	65	79	150	14	85	71
ZPV 292	66	132	148	66	82	16
And 278	67	108	145	41	78	37
Enseleni	67	90	161	23	94	71
Bwenzilana	69	61	128	-8	59	67
DC 86-250	72	94	231	22	159	137
Fitomeko	73	67	128	-8	55	61
Kanzama	74	79	209	5	135	130
Sugar 56	76	91	145	15	69	54
2G/2	83	91	197	8	114	106
DC 184-35	86	75	102	-11	16	27
2N/2	86	93	155	7	69	62
Sugar 47	86	75	180	-11	94	105
DC 95-170	88	112	94	24	6	-18
PC 512 –B4	95	100	121	5	26	21
ZPV 906	99	114	184	15	85	70
AND 656	101	74	151	-27	50	77
Mean	**73**	**87**	**140**	**14**	**67**	**53**

[x] Time to cook in tap water – time to cook in deionised water
[y] Time to cook in borehole water – time to cook in deionised water
[z] Time to cook in borehole water – time to cook in tap water

Households in Malawi use either tap or borehole water for cooking. To better reflect the expected cooking time in households, it is necessary to consider the cooking time in these two types of water. The mean increase in cooking time in tap water as compared to deionised water was 14 minutes, which was a relatively small increase in cooking time. The mean increase in cooking time in borehole water as compared to deionised water was 67 minutes, which was a relatively large increase. It may, therefore, be possible to use cooking time in deionised water as an indicator of cooking time in tap water, but it is not possible to use cooking time in deionised water as an indicator of cooking time in borehole water. Long cooking time in borehole water is considered as an unacceptable character in new bean varieties. Bean breeding lines that are still within the breeding program should be evaluated so that this aspect of cooking time can be taken into consideration before considering a line for release. Fast-cooking breeding lines and varieties can be used as parents depending on the other traits being developed within the breeding program.

Bean/Cowpea CRSP-released varieties Kalima and 2-10 were two of the fastest cooking materials in all three types of water. The Malawian cross 3J/2 was the fastest cooking material in deionised water, had a cooking time near the trial mean in tap water, and was slow cooking in borehole water. All of the other Malawian crosses (2N/2, 15P/8 and 2G/2) also took a very long time to cook in borehole water. Long cooking time in borehole water is considered an unacceptable character in these beans. There was a significant interaction ($p<0.01$) between bean material and type of cooking water. These results indicate that the cooking time of bean materials is dependent on the type of water in which the beans are cooked. Bean materials such as DC 86-191, IZ 226-1 and 15 P/8 were very slow cooking in borehole water as compared to tap and deionised water. This difference in response to type of cooking water was also reported by Mwangwela (2000) where beans with similar cooking time in deionised water had significantly different cooking time when cooked in tap water or borehole water.

Differences in cooking time are probably due to differences in constituent factors, possibly pectic substances. Tap and borehole water that contains significantly higher calcium levels than deionised water would result in longer cooking times because of the interaction of calcium ions with the pectic substances in the bean cotyledon to form calcium pectates, which restrict cell separation during cooking. However such a proposition needs to be verified in a controlled experiment to determine the content of pectic substances in these beans.

These findings indicate that the cooking time of some bean materials depends on the type of cooking water. Some fast cooking beans such as Kalima, DC 95-170 and 2-10 would be suited to a wide variety of areas that include both hard water (high calcium and divalent cation levels) and soft water (low calcium and divalent cation levels) because the increase in cooking time due to change in type of cooking water was minimal. Other bean materials such as 3J/2, IZ 226-1, DC 86-191, 15P/8, DC 86-250, Kanzama, 2G/2, Sugar 47 and ZPV 906 would be fast cooking only in areas with soft water but would be very slow cooking in areas with hard water. Based on this information it is necessary to test the cooking time of bean breeding lines using several types of water before the line can be classified as fast cooking.
I.C.1.b.(1) (j) Current Status of the Project: Screening is performed on an annual basis to assist the breeding program.
I.C.1.b.(1) (k) Documented impact: An achievement is that fast cooking lines adapted to a wide variety of water types have been identified.

I.D. Constraint #4: Insufficient Socioeconomic/WID Research to Optimize Production Gains

I.D.1. Research area: Adoption and Impact Studies

I.D.1.a. Background: In both Malawi and Tanzania seed multiplication and dissemination schemes for secondary crops such as beans are not well developed or coordinated. (Research addressing this constraint is found in Constraint #6). As a consequence, seed of improved varieties of beans is not readily available to smallholder farmers. This has limited our abilities to conduct adoption and impact assessments. Baseline studies have been carried out in Tanzania and Malawi in areas where we anticipate seed will become available in the near future. In Malawi, in one ADD where Kalima was made available, a willingness to adopt study was carried out in 1998-99. During 2000-01, additional adoption and impact assessments will be conducted in Malawi and Tanzania. NGOs have come to play a major role in the agricultural sector in Malawi, often eclipsing the government extension service and programs in the specific areas where they work. While the CRSP has provided seed for NGO seed multiplication programs in the past, this year it will seek to establish more direct and on-going ties with 2-3 NGOs whose objectives and programs overlap with the CRSP's, to carry out

adoption and impact assessments of Kalima. NGO programs often target their programs at women farmers, as women headed households are over represented among the poorest category in Malawi.

The Malawi project has had a longstanding interest in bean biodiversity at the farm level, having in the early 1990s documented the food security and nutritional value of farmers' practices of growing multiple varieties of beans. During 2000-01, a study will be undertaken in an area where baseline data is available to examine the impact of market liberalization and NGO food security programs on farmers' planting practices, varietal choices, and number of varieties kept on-farm.

The Bean/Cowpea CRSP in Tanzania has bred and introduced two bean varieties in selected farming communities in the country. The areas where such varieties are grown and marketed include Morogoro and Kilosa districts, Morogoro Region; Kongwa districts, Dodoma Region and some areas in Tanga and Arusha Regions. Farmers and consumers in these communities will be interviewed to assess the extent of new varieties.

I.D.1.b. Proposed research area workplan and subsequent annual progress report

I.D.1.b.(1) Activity #1: Collaboration with NGOs in seed dissemination and impact assessment – Malawi and Tanzania
I.D.1.b.(1)(a) Priority: Essential
I.D.1.b.(1)(b) U.S. researchers: Ferguson* (Malawi)
I.D.1.b.(1)(c) HC researchers: Masangano (Malawi), Temu, Magayane, Kibiby (Tanzania)
I.D.1.b.(1)(d) Methodology: Over the last five years, the number of international and indigenous NGOs with a focus on food security and poverty alleviation has grown in Malawi. We plan to strengthen and formalize our ties with two to three of these organizations whose goals overlap significantly with ours. Seed of new bean varieties produced at Bunda College will be sold preferentially to these organizations for their food security and seed multiplication programs with the understanding that the NGO will collaborate on follow-up adoption and impact assessments. Attention will be paid to if and how these NGOs take gender into account in their seed multiplication and food security programs.

In Tanzania, impact studies for SUA-90 and Rojo will be conducted in areas where they were distributed in Morogoro and Dodoma regions (low altitude areas).
I.D.1.b.(1)(e) Anticipated (1year) results of activity: Measurement of yield in comparison with local varieties, and willingness to adopt studies will provide us with indicators of the impact of these new varieties on farm households. Information on farmer/consumer preferences and acceptability criteria will also be directed back to the breeding and improvement program.
I.D.1.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers' yields from improved varieties will be greater than from local landraces. Farmers will express willingness to replant the new varieties	2002 and beyond	Increased yields and adoption of new varieties

I.D.1.b.(1)(g) Budget:

Malawi	$6,000
Tanzania	6,000
Total (Direct Costs only)	$12,000

I.D.1.b.(1)(h) Major changes: Tanzania: Due to limited amount of Rojo and SUA 90 seed available in the regions, it was not justifiable to conduct an intensive study on adoption and impact assessment. Efforts were directed towards activities that will create more impact and accelerate adoption of SUA 90 and Rojo varieties. Several activities were conducted:

- Promoting SUA 90 and Rojo to parliamentarians, farmers in Tanga and Arusha (regions known to grow bean for commercial purposes).
- Promoting SUA 90 and Rojo during farmers week show (selling seeds and grain [food].
- Training and recruiting seed producers in Lushoto and Korogwe (Tanga region) and Arumeru and Monduli (Arusha region). This helped to build more stocks of seed for further distribution.
- Producing more extension fliers and training booklets for farmers and consumers.
- Identifying future collaborators in seed/grain production and marketing.

I.D.1.b.(1)(i) Progress during past year: Malawi: Collaborations have been established with ActionAid and Concern Universal where, in both cases, we have been able to distribute Kalima and Nasaka bean seed varieties. In addition to Kasubgu ADD, ActionAid is also very active in the Lake Shore areas of Salima ADD where they have been promoting production of winter bean crops. They have tended to like Nasaka bean seed for such areas, and the variety has done well, maybe because there is less disease pressure in the winter crop.

One adoption/impact assessment study has been conducted by Julius Mangisoni and James Bokosi in Thiwi Lifidzi of Dedza District where Concern Universal is most active. A report of the results of the study is being compiled and will be submitted later.

Tanzania: Preliminary surveys (PRA) show that limited amounts of Rojo seeds were produced in Morogoro and Dodoma regions. Some farmers in Morogoro used the seed as food and some stored the seed without proper treatment against storage pests thus, the seed was destroyed. Collaboration with LVIA, the NGO in Dodoma area continued, however the amount of seed produced remained very small.

Production of Rojo and SUA 90 during short rains in high- and mid-altitude areas proved to be possible. Irente Farm located in Lushoto provided the following information:

Table 1. Irente Farm: Production of SUA 90 and Rojo Seed, 2000/01 Short Rain Seasons

Variety	Area Planted (ha)	Seeding Rate (kg)	Production (kg)	Yield (kg/ha)
SUA 90	0.75	34	619	825
ROJO	0.50	27	221	442
LYAMUNGO 90	2.20	87	647	294

The high yield of SUA 90 was attributed to high tolerance to high moisture (too much rain). The Lyamungo 90 variety was most affected by too much rain followed by Rojo. The low yield for Rojo also was partly due to plot characteristics (the plot was hilly and machine planting was not desirable). This shows that SUA 90 and Rojo varieties can perform as well from high-altitude to low-altitude areas.

People in different geographical locations (different cultures) showed different preference patterns for SUA 90 and Rojo, before cooking and after cooking. However, for all groups, Rojo was considered a good color for marketing (before it is cooked). After cooking, some prefer Rojo while others prefer SUA 90. For some reason, people in the Arusha area did not like the color of Rojo after cooking–they said "it is just too red, like blood." However, the

people in Lushoto prefer Rojo for its good and heavy broth and taste. It is therefore recommended that more analysis be done in a wider market to see what are the consumer characteristics that are most preferred. Past research has mainly used farmers to rank preferences. The results are therefore limited to subsistence farming. Accelerated adoption of the new varieties requires follow up of preferences of the wider market than simply farmers.

The production of Rojo and SUA 90 seeds using short rains in high- and mid-altitude areas in the Tanga region enable the project to distribute seeds in the Arusha region for further seed multiplication and testing. One group of primary school teachers, one secondary school, one teachers' training college and three farmers were provided with SUA 90 and/or Rojo seeds for planting in 2001 during the long rainy season in March-April. All farms were in the low-altitude areas on Monduli and Arumeru districts. All participating farmers and representatives from the institutions were provided with information on agronomic and consumer characteristics of SUA 90 and Rojo, and they were impressed and eager to be contracted as seed producers. The price offered (Tshs 400/=) at the time of harvesting was impressive as well. Production levels were as given in Table 2.

Table 2. Arusha: Production and Yield Levels of SUA 90 and Rojo Seed Producers

Farmers	Variety	Area Planted (ha)	Production (kg)	Yield kg/ha
Kiserian:				
Gadi	SUA 90	0.5	900	1,800
Primary school	SUA 90	0.25	300	1,200
	Rojo	0.25	300	1,200
Monduli:				
Gadiel	SUA 90	0.34	140	412*
Justice	Rojo	0.34	560	1,647
Teachers college	Rojo	0.44	600	1,344
Total production/ Average yield		2.12	2,800	1,321

**Note that low yield was due to water logging on the bean plot, which led to late planting and the effect of cold weather before pod formation.*

All farmers indicated that both varieties yield higher than the traditional varieties grown in the area. Good consumer qualities were also acknowledged. In the Arusha area, farmers preferred SUA 90 to Rojo after cooking. Monsanto bought 500 kg of SUA 90 seeds from the Kiserian village. It is not clear what they were going to use the beans for. The information from Monsanto indicated that they need beans for donations to schools, the question of why specifically SUA 90 beans could not be answered.

After the seed was made available using the short rain period, the project concentrated on promoting production and marketing of SUA 90 and Rojo for food purposes. Some farmers in Arusha regions who are traditional growers of beans during the short rains were provided with seed and information on the agronomic practices. Extension officers in the villages agreed to collaborate with the project in advising farmers, visiting farm plots, and creating awareness of the new bean varieties and their qualities. Six acres of Rojo and seven acres of SUA 90 are expected to enter into production of food grain during the short rain, October-December 2001 in Monduli and Mbunguni areas. With estimated yield of 600 kg per acre, it is expected that we will have respectively three and approximately four metric tones of Rojo and SUA 90 food

grain by January 2002. Farmers requested the project to help or collaborate with farmers' organizations to develop marketing strategies for the new varieties. Plans are underway to contact the Monduli Primary Cooperative Society (that is now in the business of collaboration). Also, market expansion of Rojo in Morogoro and Dodoma require similar efforts but not immediately as they will enter market-oriented production next season, April-June, 2002.

Seed distribution during farmer's week in the Nanenane farmers fair was a success. Dressed and well-packaged seed were sold at Tshs 800/= and food bean at Tshs 400/=. A total of 31 kg of seeds were sold for each variety, Rojo and SUA 90. A total of 30.5 kg and 29.5 kg of SUA 90 and Rojo respectively were bought for food. This activity provided a niche for the new varieties to be tried by farmers and consumers in various regions. Fifty-one customers purchased seed, food beans or both. Those who purchased seeds were given information on farming practices. Customers were from Morogoro, Dar es Salaam, Zanzibar, Mbeya, Dodoma, Mwanza and Tanga. Records of where customers reside (villages, streets and districts) are kept for possible follow-up in the future.

I.D.1.b.(1)(j) Current status of research: From the promotion activities, several organizations showed interest in collaborating with the project in the areas of marketing and/or production of SUA 90 and Rojo seed (Table 3).

Table 3. Collaboration: Organizations and individual companies showing interest in participating in the production and marketing of SUA 90 and Rojo seeds.

Name of organization and address	Area of interest and remarks	Estimated area of production (ha)	Estimated quality to market (kg)
Badpest Service P.O. Box 1260 Morogoro	Bean production: need to produce the crop this year	50	0
Agric. Division, Mohamed Enterprise P.O. Box 20660 Dar es Salaam	Bean production, marketing and distribution	500	0
G & G Investment P.O. Box 747 Morogoro Maeda3202@yahoo.com	Seed marketing: interested in marketing improved seeds	0	500
Monsanto (T) LTD Arusha, HQ Monarusha@africaonline.co.tz	Seed marketing: they need marketing strategies	0	—

I.D.1.b.(1)(k) Documented impact: Contract seed producers realized more cash income than they would get if they continue with their traditional enterprises. Farmers realized that when they plant improved and better quality seeds, they obtain more yield and, due to the fact that quality seed attracts a price premium, their income increases two-fold. Training of contract seed producers raised awareness of the importance of improved seeds and general agronomic practices in bean production. A total of 16 farmers were trained in Tanga and Arusha regions in seed production.

I.D.1.b.(2) Activity #2: Market liberalization, food security and bean diversity study - Malawi
I.D.1.b.(2)(a) Priority: Essential
I.D.1.b.(2)(b) U.S. researchers: Ferguson* (Malawi)
I.D.1.b.(2)(c) HC researchers: Mloza-Banda, Masangano (Malawi)
I.D.1.b.(2)(d) Methodology: Return to Dedza Hills/Bembeque where studies of the role of intra-varietal diversity were carried out in the early 1990s to assess the current status of bean

varietal diversity and the factors which have lead to either its propagation or reduction. Farmers' seed inventories will be examined to determine how they have changed in composition over the ten-year period. In particular, we will identify new varieties that have been introduced and the factors which account for their adoption and spread. We will also examine whether, as market liberalization proceeds, more men farmers have taken up bean production as a cash generating enterprise and what differences, if any, exist in men and women's varietal selection.

I.D.1.b.(2)(e) Anticipated (1year) results of activity: (1) Greater understanding of the impact of market liberalization and NGO seed multiplication efforts on bean intra-varietal diversity and the role of this diversity in current farming systems. (2) Examination of if and how new improved bean varieties are integrated into farmer varietal mixtures. (3) Enhanced on-farm conservation of bean plant genetic resources that include landraces and improved genotypes. (4) collaborative relationships with extension staff and selected NGOs and enhanced and increased understanding on their part of the role and value of diversity in sustainable food security programs.

I.D.1.b.(2)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers retain landraces on-farm and integrate improved varieties into seed stocks Consumer qualities maintained and/or incorporated in landraces or improved genotypes Expanded food security and sustainability gained through retention of bean diversity for socio-economic gains	2001 and thereafter	Farmers interviewed, factors influencing seed adoption and conservation identified

I.D.1.b.(2)(g) Budget: Malawi $5,000
Total (Direct Costs only) $5,000

I.D.1.b.(2)(h) Major changes: This study and a number of the other ones proposed for 2000-01 were postphoned due to the lack of transportation. It will be conducted in the Bembeque area of Dedza Hills RDP in March 2001, just after harvest. The farmers will be selected and the instruments will be pre-tested in late December 2001. Bembeque is one of the areas where the original study by Dr. Ferguson was conducted in 1990. We will be able to examine how diversity of bean landraces on farms has changed since 1990 and to examine some of the reasons for these changes, if we find them.

Another study was conducted in August this year (2001) on the impact of cross-border trade on the movement of beans between Malawi, Mozambique, Tanzania and Zambia. The results of this study are being compiled and a seperate report will be submitted later.

I.D.1.b.(2)(i) Progress during past year: None to report.

I.D.1.b.(2)(j) Current status during past year: See comments under I.D.1.b.(2)(h).

I.D.1.b.(2)(k) Documented impact: None.

I.D.1.b.(3) Activity #3: Facilitate collaboration among regional team and between regions

I.D.1.b.(3)(a) Priority: High priority

I.D.1.b.(3)(b) U.S. researchers: Ferguson* (Regional Facilitator)

I.D.1.b.(3)(c) HC researchers: Mabagala (Tanzania), Masangano, (Malawi)

I.D.1.b.(3)(d) Methodology: Funds will be used to facilitate visits between researchers in Tanzania and Malawi to exchange data and germplasm, and to coordinate research. Finally, if

sufficient funds are available, interregional interactions will be sought. In particular, we would like to exchange information and ideas with the LAC project.

I.D.1.b.(3)(e) Anticipated (1 year) results of activity: Research coordinated on an annual basis.

I.D.1.b.(3)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
More efficient use of resources will lead to shorter time to disseminate technologies to farmers	2002 and beyond	Number of meetings between researchers

I.D.1.b.(3)(g) Budget:

MSU RF (includes $8,000 for RF travel to engage in impact and diversity study research and promote collaboration)	$9,467
Total (Direct Costs only)	$9,467

I.D.1.b.(3)(i) Progress during past year: Inter-regional collaboration was confined to the Regional Bean Meeting held in Arusha, Tanzania, in January 2001. Representatives from CIAT, from NGOs who collaborate with the region were invited to present research papers. Representatives from the LAC region will attend the Regional Bean Planning Meeting scheduled for March 2002 in Malawi.

The Regional Facilitator made one trip to Malawi in June where she conferred with Dr. Mloza Banda and the graduate student (C. Mzembe) who is going to carry out the bean diversity study. The student's proposal was reviewed and revised and a research strategy was put in place. The research was delayed until March 2002 as there was no vehicle available to conduct the study when it was originally planned.

The RF funds were used for Carol Miles' trip to MSU to develop the seeds portion of the new proposal. Miles met with Snapp, Ferguson and Maredia for two days in May 2001.

I.D.1.b.(3)(j) Current status of research:

I.D.1.b.(3)(k) Documented impact: An achievement was that further networking among CRSP researchers (as well as others in the region) was enhanced, which should lead to better communication and cooperation.

I.E. Constraint #5: Insufficient Cadre of Trained Personnel

I.E.1. Research area: Degree training

I.E.1.a. Activity #1: Training (to be) completed this year–None

I.E.1.b. Activity #2: Continuing training–None

I.E.1.c. Activity #3: Proposed new training

I.E.1.c.(1) Name of student: Christopher Mzembe
Gender: Male
Nationality: Malawian
Degree: M.Sc.
Discipline: Rural Development and Extension
Educational institution: Bunda College of Agriculture, University of Malaŵi
Date training proposed to begin: June 2000
Date training anticipated to end: June 2002
CRSP funding: Total
Priority: Essential
Budget: $8,000 (Malawi)(Direct Costs only)
Status: On schedule

I.E.1.c.(2) Name of student: Theobald C. E. Mosha
Gender: Male
Nationality: Tanzanian
Degree: Ph.D.
Discipline: Community Nutrition
Educational institution: Michigan State University
Date training proposed to begin: September 2000
Date training anticipated to end: June 2003
CRSP funding: Total
Priority: Essential
Budget: $21,000 (plus $14,000 carried over from FY00)(Tanzania)(Direct Costs only)
Status: Mosha is studying with M. Bennink in the Food Science and Human Nutrition Department of MSU. He has successfully completed his first year of course work and has drafted a dissertation proposal. He is making excellent progress.

I.E.2. Research area: Non-degree training–None

I.F. Constraint #6: Insufficient Access to Improved Seed, Especially Preferred Varieties

I.F.1. Research area: Seed multiplication, dissemination and quality concerns

I.F.1.a. Background: Barriers to seed dissemination have been a major constraint to the determination of impact from the SUA and Bunda programs. The Bean/Cowpea CRSP in Tanzania has bred and introduced two bean varieties in selected farming communities in the country. In addition, other new varieties are coming on-line. During 1994/95, farmer participatory research was used in early generation selection to identify desirable lines from a cross of SUA advanced lines with Kablanketi (a fast-cooking, high quality, but low-yielding indigenous variety). Advanced lines are now available for testing with the eventual release of a superior variety of the Kablanketi type. A number of other materials resistant to major pests and diseases are in the final stages of release, due in 2002. In Tanzania, the major constraint to increased bean production is the unavailability of seed of new varieties. First, state seed multiplication facilities have not produced the anticipated quantities of seed, and second, villagers who have received seed did not trade this seed beyond their areas. In response to these issues, the project has studied seed systems and has trained smallholder farmers in seed multiplication, particularly women farmers. Fourteen farmers in Kilosa and Kongwa were trained in 1997/98. In 2000/01, the project will be working with the Italian NGO, LVIA to train additional 19 farmers in the Kongwa and Morogoro districts. Currently, the amount of seed produced by these farmers is too small to determine marketing issues; however it is clear that promotion of seed production and the use of certified seed by small-

scale farmers is necessary to ensure the viability of these small-scale seed production enterprises.

In Malawi, the project has one released new variety, Kalima, plus 4-5 varieties released in the early stages of the project (1980), one of which (Nasaka) has had wide acceptance. The project currently has a number of new varieties in the final stages of testing for release by the MOAI in 2001-02. As in Tanzania, a major constraint to increased bean production and consumption has been the lack of means to get seed of CRSP varieties into the hands of farmers. In 1999, Dr. P. Kambewa, who completed his Ph.D. dissertation in Agricultural Economics at MSU, identified two smallholder seed multiplication schemes. The first scheme was supported primarily by donors or the government, was commercially oriented, and reached approximately 118 farmers. The second scheme resulted in seed supplies to smallholder farmers, contributed to seed security of these farmers, and reached approximately 5,000 to 6,000 farmers. The first scheme produced certified seed that was inspected while the second scheme produced seed without following the strict procedures of seed multiplication. Commercially-based farmers sold their seed to the National Bean Program and the MPTF, therefore it was not possible to ascertain if there was a demand for this seed among smallholder farmers. This suggests that these farmers knew there was not enough demand for their seed. These findings have implications for strategies of technology transfer overall and for new variety dissemination in particular, i.e., the subsidies which the NGOs are providing in seed multiplication are vital for seed multiplication. Unless other strategies are developed, NGOs will continue to play the major role in seed multiplication. The challenge to the CRSP is therefore to develop strategies that will provide enough seed to the NGOs that multiply seed. Apart from ActionAid, which contracts for seed production, others search for seeds just prior to planting time. As a result of these findings, the Malawi project is strengthening its ties to ActionAid and Concern Universal, two of the largest NGOs which work in major bean growing areas. A workshop on seed systems to communicate Dr. Kambewa's and other researchers findings was held in Malawi in August 1999. During the last four years, Bunda College has stepped up efforts to multiply foundation seed of Kalima. In 1997/98, Bunda researchers sold 4 tonnes of seed to NGOs. During 1998/99, approximately 10 tonnes of Kalima and 2 tonnes of Nasaka seed was distributed in the new Starter Pack Program sponsored by the Ministry of Agriculture and Irrigation (MOAI). This program came about as a result of requests by donors to eliminate agricultural subsidies. With price supports removed, many of the most poverty-stricken farmers became even poorer. To deal with the poverty of the majority of smallholders in Malawi, in 1998 the government initiated the Starter Pack Program to provide farmers with small quantities of legume seed of their choice (bean, soya bean, groundnut), maize seed and fertilizer. The program reached an estimated 2.5 million farmers during 1998/99 and was expanded during 1999/2000 both in numbers of farmers reached and in quantities of inputs provided. The Starter Pack Program is funded by the World Bank and other donors. This program may provide a vehicle for disseminating improved bean varieties, including Kalima, to large numbers of the most needy farmers, if it is continued in 2000-01.

I.F.1.b. Proposed research area workplan and subsequent annual progress report

I.F.1.b.(1) Activity #1: University-based multiplication of varieties Rojo, Kalima, and Nasaka, and advanced breeding lines
I.F.1.b.(1)(a) Priority: Essential
I.F.1.b.(1)(b) U.S. researchers: Miles* (Tanzania)
I.F.1.b.(1)(c) HC researchers: Nchimbi-Msolla, Mtenga, Magayane (Tanzania); Bokosi, Chirwa, Masangano (Malawi)

I.F.1.b.(1)(d) Methodology: The CRSP-released bean varieties in Malawi (Kalima and Nasaka) and Tanzania (Rojo and SUA 90) will continue to be multiplied to provide high quality, disease-free seed for distribution to government seed agencies, NGOs, and farmers. It is anticipated that in Malawi, 10 ha of Kalima will be grown on the University farm during the 2000-2001 cropping season. It is also anticipated that five sites within Malawi will be chosen for multiplication of 1 ha of Kalima. The production hectarages in Tanzania will be smaller due to limited availability of land for multiplication. Seed multiplication needs to be maintained because it sets the stage for two other related CRSP activities; viz. the impact assessment studies (see Constraint #4) and the provision of a channel for dissemination of the upcoming varieties. In Tanzania, advanced breeding lines (Kablanketi crosses, nematode resistant lines, and arcelin-containing lines) will be multiplied for use in on-farm trials (see I.A.2.b.4.).

In Malawi, there were 3 ha of Kalima and 4 ha of Nasaka multiplied in the rainy season and 1 ha of Kalima and 2 ha of Nasaka multiplied under irrigation. In total, there were 10 ha for seed multiplication. We increased multiplication of Nasaka since we had a very high demand for the variety. There was 3.2 metric tonnes of Kalima and 3.1 metric tonnes of Nasaka which has been sold (some of the seed was sold to individual farmers). The irrigated crop is still being harvested.

In Tanzania, bean varieties Rojo and SUA 90 and advanced lines of Kablanketi crosses, nematode resistant lines, arcelin-containing lines, and several other lines were multiplied at SUA Mafiga and Horticulture Unit farms during the long rainy season (April-June). Seeds of SUA 90 and nematode resistant lines were also multiplied under irrigation at the Horticulture Unit farm.

I.F.1.b.(1)(e) Anticipated (1 year) results of activity: A steady supply of recently released and new potential varieties will be available for further increase and distribution.

I.F.1.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers utilizing improved bean varieties	2001 and thereafter	Amount of seed and number of varieties available

I.F.1.b.(1)(g) Budget:

Malawi	$1,000
Tanzania	5,000
Total (Direct Costs only)	$6,000

I.F.1.b.(1)(h) Major changes: Tanzania: No major changes. In Malawi, production of Nasaka seed was increased because there is still an increase in the demand for this seed, especially for farmers who grow it as a winter crop along the lakeshore areas. The disease pressure in the winter crop is less than the rainfed crop.

I.F.1.b.(1)(i) Progress during the past year: Malawi: In total, 6.0 metric tonnes of seed has been distributed for further multiplication by smallholder seed multiplication schemes. The distribution of this seed was done through Concern Universal in Thiwi Lifidzi RDP and ActionAid, Malawi in Salima ADD.

In Tanzania, for the past year, a total of 1800 kg of variety Rojo and 523 kg of SUA 90 were produced at SUA Mafiga and Horticulture Unit Farms during the long rains (April-June). A large plot measuring 3/4 hectare of SUA 90 was also planted in October under irrigation at the Horticulture Unit Farm. The seeds of SUA 90 grown under irrigation will be harvested in December. The irrigation plots were planted in October and therefore may be best to include in next year's report.

Seven nematode-resistant advanced lines were multiplied and the amount of seed produced ranged from 5 to10 kg for each line. The seeds of 27 drought resistant lines were also increased and the amount of seed produced ranged from 4 1/2 to 10 kg for each line. The seed multiplied for 5 arcelin-containing lines ranged from 4 to 5 kg per line. The seeds of 10 lines obtained from other research institutions (Selian Agriculture Research Institute and Uyole Agriculture Center) were also multiplied and the amount of seed produced ranged from 1 1/2 to 3 kg per line (only 50-100 seeds were initially received).
I.F.1.b.(1)(j) Current Status of the project: There is much demand for the varieties in Malawi and it is thought that seed multiplication for the varieties will continue in the foreseeable future.
I.F.1.b.(1)(k) Documented impact: In Malawi, an outcome of these efforts is that an increased number of farmers are now using the varieties, especially in Thiwi Lifidzi and Salima RDPs. Thiwi Lifidzi RDP received 3 MT of Kalima seed for smallholder seed multiplication scheme while Salima ADD received 3.250 metric tones of Nasaka seed also for smallholder seed multiplication scheme in the 2000/2001 growing season. The seed in Thiwi Lifidzi was multiplied under rainfed conditions while the seed in Salima RDP was multiplied under rainfed conditions. Once the seed is multiplied, it is sold to other farmers in the same area resulting in increased adoption of the variety.

In Tanzania, an achievement is that sufficient seed was multiplied to plant advanced yield trials and on-farm trials in the next season. Seeds of Rojo and SUA 90 will be distributed to collaborating NGOs that are producing seeds.

I.F.1.b.(2) Activity #2: Collaboration with NGOs and farmers for seed multiplication and dissemination
I.F.1.b.(2)(a) Priority: Essential
I.F.1.b.(2)(b) U.S. researchers: Miles* (Tanzania)
I.F.1.b.(2)(c) HC researchers: Nchimbi-Msolla, Kibiby, Magayane (Tanzania); Masangano (Malawi)
I.F.1.b.(2)(d) Methodology: Support will be provided to smallholder seed producers and NGOs for the production, packaging, distribution, and marketing of seed. In Tanzania, ten farmers previously trained in seed production in Kisanga and Msolwa villages will continue producing seeds, and will be provided with support as needed. We will also provide support to LVIA and previously trained farmers at Kongwa. We expect to train 12 additional farmers from Maharaka and Msongozi villages in Morogoro rural district. In Malawi, we will partner with two to three NGOs working in major bean growing regions to disseminate seed to their programs (see Constraint #4). Additionally, the CRSP may provide bean seed at cost to the FAO small- scale farmer irrigation project. Farmers in this project will have the opportunity to participate in the production of approved seed for local dissemination.

We continued to provide support to small-scale seed producers in Kilsa and those working with an Italian NGO, LVIA, in Kongwa districts for the production, packaging, distribution and marketing of seed. In Tanzania, fourteen farmers previously trained in seed production in Kilosa and Kongwa districts continued to produce seed in 2000/2001. In addition, in 2000-2001, the project trained a total of 41 farmers and village extension officers in Morogoro rural, Kongwa, Lushoto, Monduli and Arumeru districts in Morogoro, Dodoma, Tanga and Arusha regions respectively. The training emphasized the importance of improved seed, and bean seed multiplication, packaging and marketing. The project will continue to provide technical and financial support to both previously and newly established seed production schemes for the 2002-2003 seasons. In 2001, collaboration with private seed farms such as Irente Farm in Lushoto district and government institutions (Irikisongo Secondary school and Monduli College) in Arusha for quality seed production and distribution started. In 2002-2005, work is intended with women's groups in Lorlkisale village in Monduli district, and

Members of Parliament through district officials who requested CRSP seed distribution in Kigoma, Shinyanga, Tabora, Arusha, Mara and Bunda regions. There will be collaboration with World Vision and other NGOs for wider seed production and distribution of CRSP varieties. The formation of sustainable seed production schemes in different parts of Tanzania for released and about-to-be released CRSP varieties will continue to be established and supported.

I.F.1.b.(2)(e) Anticipated (1 year) results of activity: Smallholder farmers producing enough bean seed for widespread distribution to growers in the Kilosa and Morogoro rural districts in Tanzania and in the areas covered by the selected NGOs in Malawi.

I.F.1.b.(2)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers have better access to improved lines and thereby greater food security	2002 and beyond	Increased availability of improved SUA lines in Kilosa and Morogoro rural districts and in areas covered by the NGOs in Malawi

I.F.1.b.(2)(g) Budget:

Malawi	$ 2,000
Tanzania	5,000
WSU (includes salary for admin. asst. for regional project)	33,844
Total (Direct Costs only)	$ 40,844

I.F.1.b.(2)(h) Major changes: In Malawi, no major changes. In Tanzania, we selected and collaborated with medium-scale farmers for seed production and dissemination instead of with small-scale farmers. Experience, in 1997/98, with small-scale farmers in Kilosa and Kongwa districts resulted in the production of small quantities of seed. These small-scale farmers are subsistence farmers with low economic status. These farmers did not store CRSP seed and instead sold the seed as grain, making it unavailable as seed for growers in Kilosa and Kongwa districts. For a more sustainable seed scheme, we believe that medium-scale farmers are a more appropriate choice for initial seed producers.

I.F.1.b.(2)(i) Progress during past year: In Malawi, our collaborative efforts have resulted in the distribution of 7.25 MT of bean seed to smallholder seed multiplication groups in Salima and Dedza districts in Central Malawi. Collaboration with Concern Universal, an NGO operating in Dedza District, resulted in the distribution of 3 MT of Kalima bean seed in Thiwi Lifidzi RDP. Collaboration with ActionAid resulted in the distribution of 2.05 MT of Nasaka and 2.20 MT of Kalima seed in Salima ADD. One officer from ActionAid in Malawi and one officer from Concern Universal attended our Regional Bean Workshop in Arusha Tanzania as part of our efforts to collaborate more closely with them.

In Tanzania, more seed of SUA 90 and Rojo varieties have been distributed for further multiplication by small-scale seed multiplication schemes in Morogoro, Dodoma, Arusha and Tanga regions. The distribution of this seed was done through village extension workers, NGOs (LVIA) and institutions (Irikisongo Seconday School and Monduli College). As a result of our choice in 2001 to select and collaborate with medium-scale farmers for seed production, farmers in Arusha and Tanga regions indicated they would like to plant increased acreage with CRSP varieties and would like to increase the amount of seed they produced (12bag/farmer/acre). If we collaborate with more farmers of this scale, CRSP varieties will be more available and accessible in a shorter time period.

In 2001, national promotion was done through members of parliament in Dodoma region and Farmers' Day (Nanenane) in Morogoro Region. Seed of improved varieties including SUA 90

and Rojo were distributed to the members of parliament for trials and tasting. Through these promotional activities, we received more contacts from individual people, seed companies such as Monsanto, and regional officials who wished to establish a seed production scheme or collaborate in production and marketing of CRSP varieties. Monsanto has shown an interest in collaborating with us to market SUA 90, and also to be a stockist for our seed varieties in the Arusha Region. Follow-up on this kind of collaboration is essential for the sustainability of seed production and marketing, will ensure that seed is available to farmers, and will likely have a positive influence on overall project impacts.

Some government district officials and farmers are becoming more aware of the importance of CRSP varieties in their areas and to the nation at large. For instance, in 2001 at the International Trade Fair in Dar es Salaam, Irente Farm from Lushoto district displayed at its own cost the CRSP varieties SUA 90 and Rojo. The trade fair attracts people from all over the world and was a good marketing strategy to reach people from different regions and to expose them to CRSP varieties. The farm sold all the seed they had packed for the trade fair. At the Nane Farmers' Day in Morogoro this year, the district office in Lushoto sent one farmer producing Rojo and SUA 90 to display his varieties and methodologies to farmers and consumers who attended the event.

I.F.1.b.(2)(j) Current Status of the project: Collaborative efforts to distribute seed through NGOs will continue for some years. NGOs work with grassroot farmer organizations and are able to make quick impact at the grassroots level. This impact is worthwhile and effective in regards to CRSP variety dissemination.

In Tanzania, there is an increased demand for CRSP varieties. The project should collaborate with more government and non-government organizations for seed multiplication and dissemination of CRSP varieties. The project also needs to increase promotional activities for its varieties.

I.F.1.b.(2)(k) Documented impact: Achievements are that in Malawi, 7.25 MT of seed was distributed to smallholder seed multiplication groups: 3 MT of Kalima through Concern Universal in Dedza district; and 2.2. MT of Kalima plus 2.05 MT of Nasaka through ActionAid in Salima ADD.

SEASON	AREA	VARIETY	YIELD	SALES	BALANCE
1999/2000	3.5 ha	Kalima	3.0 tonnes	3.0 tonnes	-
2000/2001	3.0 ha	Kalima	3.2 tonnes	1.2 tonnes	2.0 tonnes
	4.0 ha	Nasaka	2.3 + 800 kgs	2.05 tonnes	0.95 tonnes
Irrigation 2001	1.0 ha	Kalima	Not yet harvested		
	2.0 ha	Nasaka	So far 8 tones have been harvested and we are still harvesting		

In Tanzania, an outcome is that there is an increase in the number of farmers now using CRSP varieties, especially in Kongwa and Kilsa districts. There is an increasing demand for CRSP varieties in Arusha and Tanga Regions as well, and it is anticipated more access to and availability of CRSP varieties in these regions. In Tanga region, Rojo variety was sold at 500-600Tshs/kg this season compared to 200-300Tshs/kg for other bean varieties. In Arusha, farmers removed the placards placed in their fields because of the theft by other farmers and consumers who were impressed by the performance of CRSP varieties compared to their own varieties.

I.F.1.b.(3) Activity #3: Ministry of Agriculture Starter Pack Program - Malawi
I.F.1.b.(3)(a) Priority: (1) Essential
I.F.1.b.(3)(b) U.S. researchers:
I.F.1.b.(3)(c) HC researchers: Masangano* (Malawi)
I.F.1.b.(3)(d) Methodology: The CRSP will multiply seed of improved varieties (Kalima and Nasaka) to sell to the MOAI for inclusion in the MOAI Starter Pack Program, if it is continued. In this way, one-half to two kgs of seed will be distributed to several thousand farmers. This may set the stage for an adoption and impact study in 2001, depending on whether it will be possible to trace where the CRSP varieties were made available.
I.F.1.b.(3)(e) Anticipated (1 year) results of activity: Kalima and Nasaka will be distributed to many of the most needy farmers in the country.
I.F.1.b.(3)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Improved varieties grown utilized by farmers	2001 and thereafter	Number of farmers using CRSP improved varieties

I.F.1.b.(3)(g) Budget:

Malawi	$2,000
Total (Direct Costs only)	$2,000

I.F.1.b.((3)(h) Major changes: There is a major change on the Starter Pack Program to what is called targeted Input program. This program is very much reduced in volume and CRSP bean varieties could not be taken up with the reduction in the volumes involved in the program.
I.F.1.b.(3)(k) Documented impact: An outcome is that in the previous year, 3.1 MT of Kalima and 0.9 MT of Nasaka were produced and distributed to the Malawian MOAI for the Starter Package Program. This seed has gotten into the hands of farmers, but the extent of impact is unknown.

I.G. Constraint #7: Insufficient Extension Services Supporting Beans in the Region

I.G.1. Research area: Training for agricultural professionals and farmers

I.G.1.a. Background: Low adoption of recommended technologies for beans still remain a major problem in the region despite the development of new high yielding varieties and recommended cultural practices. One major problem for the low adoption is the lack of extension services supporting beans. The extension services in the region hardly promote bean technologies and farmers mostly use traditional ways of producing the crop. A workshop on bean seed production and entrepreneurship was conducted in August 1999 in Malawi which involved NGOs, other organizations and entrepreneurs engaged in seed production and distribution. CRSP researchers from Tanzania attended the workshop and made presentations on the seed situation in Tanzania. Dr. P. Kambewa presented a summary of his dissertation findings on an institutional analysis of seed multiplication schemes in Malawi. Other CRSP researchers, members of the NGO community, government officials and seed entrepreneurs made presentations sharing lessons learned in bean seed multiplication and dissemination. A proceedings and a special publication of the Malaŵi Journal of Science and Technology was published. Greater coordination among the University, National program, NGO seed programs and the private sector was established.

Food crop production in Malawi has been viewed in the past as for subsistence needs. However, the society in Malawi is evolving and changing to a marketing economy quickly. Food crops in many areas are also serving as cash crops to provide the necessary cash in the new economy. As a result, there is need to instill a concept of 'business' in the minds of the bean farmers in general and those participating in seed multiplication and dissemination in particular.

In Malawi during 1996/97, a study of farmer knowledge of seed-borne diseases of beans was conducted. Information from this study will result in 1999-2000 in the development of a pamphlet for extension agents on low input measures to control bean diseases on-farm. During FY98 and FY99, courses were given to extension field assistants and officers and a selected number of research field assistants in Karonga, Shire Valley and Blantyre Agricultural Development Divisions (ADDs) and in Dedza Hills, Thiwi Lifidzi and Ntcheu Rural Development Projects (RDP) of Lilongwe ADD and Namwera RDP of Machinga ADD. Participants were trained on how to manage the survey and how to identify bean stem maggot (BSM) and other bean insect pests, and how to select farmers to be used in the BSM surveys. Participants were also given a handbook, *Pests, Diseases and Nutritional Disorders of the Common Bean in Africa, A Field Guide* (published by CIAT and supplied by the National Bean Research Programme). The vast majority of extension agents currently have no information about seed-borne diseases and pests of beans or means of on-farm control. Additional training is needed in the area of seed production and disease and insect problems. Also, variety descriptions are needed to increase dissemination of recently released varieties.

I.G.1.b. Proposed research area workplan and subsequent annual progress report

I.G.1.b.(1) Activity #1: Field day to promote SUA/Bunda bean varieties and improved bean cultural practices
I.G.1.b.(1)(a) Priority: (2) High priority
I.G.1.b.(1)(b) U.S. researchers: Miles*
I.G.1.b.(1)(c) HC researchers: Masangano (Malawi), Nchimbi-Msolla, Kibiby, (Tanzania)
I.G.1.b.(1)(d) Methodology: In Malawi, the Ministry of Agriculture and Irrigation was requested to include CRSP bean varieties in some of their FFS, EPA and RTC demonstration activities. It was also proposed to conduct field days for farmers in conjunction with these demonstrations to expose farmers to these varieties. A follow-up study had been proposed to determine if farmers' perception and willingness to adopt the varieties had changed as a result of the demonstrations. Our CRSP varieties were planted in some of the Ministry demonstration plots.

In Tanzania, field days will be conducted for farmers around the Morogoro region. These farmers also assisted in evaluation and selection of the upcoming varieties. They learned the advantages of using good seed and how these crops are best produced. Storage and marketing issues were discussed with these farmers.
I.G.1.b.(1)(e) Anticipated (1 year) results of activity: More farmers learn about improved lines.
I.G.1.b.(1)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers utilizing CRSP improved varieties	2002 and beyond	Number of farmers attending field days

I.G.1.b.(1)(g) Budget:

Malawi	$3,000
Tanzania	2,000
Total (Direct Costs only)	$5,000

I.G.1.b.(1)(h) Major changes: In Malawi, budget and transportation constraints at Bunda at the time the beans were in the field, the field day event and the follow-up study were not conducted. Field day and follow-up studies should be included in the next workplan.
I.G.1.b.(1)(i) Progress during past year: Bean varieties were included in Ministry of Agriculture and Irrigation FFS, EPA and RTC demonstration activities. Collaboration has been established and will be followed up in the next workplan.
I.G.1.b.(1)(j) Current status of the project: Needs one more growing season.

I.G.1.b.(1)(k) Documented impact: To be reported on in the next annual progress report.

I.G.1.b.(2) Activity #2: Training of trainers (extension workers) for support of seed production farmers.
I.G.1.b.(2)(a) Priority: (1) Essential
I.G.1.b.(2)(b) U.S. researchers: Miles
I.G.1.b.(2)(c) HC researchers: Masangano*, Mloza-Banda (Malawi)
I.G.1.b.(2)(d) Methodology: We had proposed to provide additional training to crop inspectors and extension personnel who advise bean producers on commercial seed production. Unfortunately, due to cash flow problems at Bunda College in 2000-01 this activity was cancelled. It had been our intention to invite crop inspectors and extension personnel to the University farm to view the new CRSP varieties and to learn better ways of producing seeds. Upon return, trainers would have assisted with local field days where they will explain the advantages of using these new varieties. These trainers would have also provided small farmers with information on bean seed quality issues, thereby ensuring the quality of the certified bean seed that these farmers are producing.

A three day to one week workshop was proposed in Malawi with some local NGOs (at least one from each region of the country). The main objectives of the workshop were to inform the local NGOs of the Bean/Cowpea CRSP objectives in improving food security and increasing incomes of small holder farmers as well as maintaining crop diversity at the farm level. Small holder farmers tend to have multiple objectives for their farming activities. These objectives include food production for their subsistence needs, increasing income and ensuring food security for their households. They achieve these objectives by adopting different strategies, including growing high yielding varieties, growing varieties that mature at different times and growing varieties that have different characteristics such as disease resistance, drought tolerance and improved cooking time and palatability. To fulfill these multiple objectives, farmers have maintained a diversity of their crops and varieties where each crop or variety fulfills a specific objective. A good example of this strategy is the way farmers traditionally grow beans in Malawi: they purposely mix different cultivars on the same piece of land. This has helped farmers in several ways including ensuring a steady supply of beans during the food shortage period. Growing beans that mature at different times has helped them have beans for food earlier in the growing season as well as later. Farmers in Malawi have also been seen to mix in the same field, high yielding, marketable beans that tend to be less palatable or difficult to cook with low yielding household consumption beans that are more palatable or easier to cook. Maintaining crop and varietal diversity at the farm level is a necessary strategy that farmers have used for their sustainable livelihoods. Most NGOs have however tended to look at only one major objective, that of increasing crop production for increased food security and income. These NGOs have therefore tended to promote the specific varieties for achieving this single objective while undermining the objective of maintaining crop diversity. Our workshop was primarily aimed at providing information to the NGOs on the need to maintain crop diversity at the farm level. The second objective of the workshop was to provide information and map out strategies for making bean seed varieties released from the Bean/Cowpea CRSP more accessible to farmers in Malawi. From the workshop some NGOs would have been selected to participate in seed distribution to farmers. Strategy for following up on the farmers who received seed from the NGOs would have been worked out so that studies to determine the impact of the varieties could be conducted with these farmers.
I.G.1.b.(2)(e) Anticipated (1 year) results of activity: Farmers have greater knowledge of the business of farming in general and seed production in particular. An increased appreciation among NGOs of need to maintain crop diversity at the farm level as well as increased access to bean varieties released through the Bean/Cowpea CRSP project.
I.G.1.b.(2)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Farmers better off with improved income from more efficient business practices	2001 and beyond	Number of extension personnel trained
Farmers maintaining a diversity of bean varieties More farmers utilizing improved bean varieties	2001 and thereafter	Average number of varieties per farmer and number of farmers growing improved varieties

I.G.1.b.(2)(g) Budget:

Malaŵi	$4,000
Total (Direct Costs only)	$4,000

I.G.1.b.(2)(h) Major changes: Postponed to the next annual workplan.
I.G.1.b.(2)(i) Progress during past year: Not yet done.
I.G.1.b.(2)(j) Current status of the project: To be conducted in the next period.
I.G.1.b.(2)(k) Documented impact: None yet.

I.G.1.b.(3) Activity #3: Training of trainers on diseases and insects for farmer field schools
I.G.1.b.(3)(a) Priority: (1) Essential
I.G.1.b.(3)(b) U.S. researchers: Miles*
I.G.1.b.(3)(c) HC researchers: Nyirenda, Msuku, Mloza-Banda.
I.G.1.b.(3)(d) Methodology:
During FY97, 98.and 99, data were collected on prevalence of disease problems found on bean seed offered in markets in all bean-growing areas of Malawi. Data were also collected on all insect pests found in bean crops in most bean-growing areas and at different times of the year. These data are important for insect pest and disease control programs. During FY01, methodologies for control of major pests and diseases identified previously will be determined by farmers themselves using the Farmer Field School (FFS) approach. In this approach the extension staff act as facilitators but decisions are actually made by the farmers. This tool has been used with success in Ghana. The project will, therefore, draw on the achievements obtained in the West Africa CRSP.

The Ministry of Agriculture and Irrigation in Malawi, with the UNDP, is establishing FFS on a pilot basis in Kasangu ADD. Four extension field staff have been trained in Ghana. The FFS will be established during the rainy season. The CRSP researchers will participate as subject matter specialists.
I.G.1.b.(3)(e) Anticipated (1 year) results of activity: Pests and diseases are the major biotic constraint to bean production in Malawi. A cadre of farmers, most of who currently cannot recognize these problems, will be better able to recognize and control them. This would assist in increasing bean production.
I.G.1.b.(3)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
By improving the farmers' understanding of the biotic causes of reduced bean yields, farmers will be able to control the insect problems and ensure increased yield production. This would eventually assist in alleviating their poverty and improving their situation.	FY99-00	Control practices implemented by farmers; Pests and diseases less of a concern by farmers; Increased yields

I.G.1.b.(3)(g) Budget:

Malawi	$3,000
Total (Direct Costs only)	$3,000

I.G.1.b.(3)(h) Major changes: One workshop has been conducted and the two remaining will be conducted in the next annual workplan.

I.G.1.b.(3)(i) Progress during past year: A two-day workshop following the FFS model was conducted from September 23-25, 2001 for Mzuzu and Karonga ADDs at the Mzuzu Residential Training Centre. Eleven participants representing development officers (Dos) from the main bean-growing areas in Karonga and Mzuzu ADDs attended. The majority of the participants came from Mzuzu ADD and included extension workers who had previously participated in insect identification surveys, as well as some research assistants and farmers. The participants were taught the biology of bean field and storage pests and were shown how to identify these pests and received a study guide, the handbook "Major Diseases and Insect Pests of Beans (*Phaseolus vulgaris*) in Malawi: Problems and their Control" (Msuku W., V. Saka and D. C. Munthali). Due to unforeseen circumstances the field practical that was scheduled had to be cancelled.

During the course of the workshop, it was observed that all of the participants had a limited knowledge of bean insect pests and diseases and the methods/technologies that farmers use to control them. It was therefore decided to identify key trainers from all ADDs in Malawi and train them in insect pest and disease identification and control. These trainers would then train other stakeholders including extension workers, farmers and NGO personnel in their areas.

I.G.1.b.(3)(j) Current status of the project: This activity is very close to its end. Based on our experience with this first workshop, it was decided to identify key trainers in each region, train these key trainers and have them in turn train extension and NGO personnel as well as farmers in their areas. Two more workshops are being planned, one at Mponela RTC for Lilongwe, Kasungu and Salima ADDs, and the other at Namaisi RTC for Machinga, Blantyre and Shire Valley ADDs.

I.G.1.b.(3)(k) Documented impact: An outcome is that extension workers have received training in bean insect pest and disease identification and control.

I.G.1.b.(4) Activity #4: Develop extension bulletins on control of bruchids/diseases

I.G.1.b.(4)(a) Priority: (2) High priority

I.G.1.b.(4)(b) U.S. researchers: Miles* (Tanzania)

I.G.1.b.(4)(c) HC researchers: Nyrienda, Masangano Mloza-Banda (Malawi)

I.G.1.b.(4)(d) Methodology: Previous surveys in Malawi on seed-borne diseases indicated that extension staff are not able to identify bean production problems properly. A pamphlet has, therefore, been developed at Bunda for identification of problem insects and diseases. A publisher is being engaged to publish the pamphlet purposely for extension personnel. Another general pamphlet is required that explains how to produce best bean crops economically. A third pamphlet is required on storage and marketing of beans. All these pamphlets are intended for extension staff for better advisory services. Fliers are needed that contain pictures of seeds and plants of recent releases. These could be laminated for extension personnel. At the beginning of the seasons there is need to disseminate information on CRSP varieties widely through papers, extension meetings, and even radio advertising.

I.G.1.b.(4)(e) Anticipated (1 year) results of activity: Information on bean production and CRSP technologies widely disseminated.

I.G.1.b.(4)(f) Anticipated impact to which this activity will contribute, time frame and indicators:

IMPACT	TIME FRAME	INDICATOR
Improved standard of living for farmers because they are more knowledgeable about bean production	2001 and beyond	Publication of pamphlets

I.G.1.b.(4)(g) Budget:

Malawi	$3,300
Total (Direct Costs only)	$3,300

I.G.1.b.(4)(h) Major changes: Instead of emphasizing bruchids and diseases, these brochures mainly emphasized the characteristics of our released varieties. This change was made because most of the NGOs and extension staff working in areas where our seeds were sent demanded that information.

I.G.1.b.(4)(i) Progress during past year: We produced 1000 brochures. This was done using a team of extension and computer technicians who were given the design of the brochures and they made a stencil. One of the publishing companies (Montfort Press) was requested to print them. The brochures have since been distributed to ADDs with bean growing areas.

I.G.1.b.(4)(j) Current status of the project: Brochures on our released varieties are now available to farmers and extension staff. However, we still need to produce brochures which emphasize the control of bruchids and diseases next year.

I.G.1.b.(4)(k) Documented impact: One achievement is information about our released varieties is now available to farmers and extension staff. Publications and field schools will more rapidly disseminate CRSP-developed technologies.

II. ACTIVITIES DURING YEAR FROM CRSP SUPPLEMENTAL FUNDS NOT INCLUDED IN WORKPLAN

II.A. Activity #1: Funds to allow Manual Amane, Grain Legume Coordinator, Instituto Nacional de Investigacao Agronomica (INIA), Maputo, Mozambique, to travel to Bean Research Workshop held in Arusha, Tanzania, January 12-14, 2001

Background/justification: Invited to the workshop at the request of Dr. Irvin Widders, Director, Bean/Cowpea Collaborative Research Support Program

U.S. researchers: n/a

HC researchers: n/a

Methodology: n/a

Anticipated (1 year) results of activity: Mr. Amane, a potential collaborator, will meet B/C CRSP team members and representatives from NGOs and government in Tanzania and Malawi.

Anticipated impact to which this activity will contribute, time frame and indicators:

Budget: $1,844

Progress during past year: Mr. Amane actively participated in the workshop as anticipated. Links forged at the workshop will help establish future collaborations.

Current status: Activity has been completed.

II.B. Activity #2: Reimburse Washington State University for travel expenses for Regional Advisors' meeting in Arusha, Tanzania, January 15-16, 2001.

Background/justification: Meeting expenses for Regional Advisors were reimbursed to Washington State University, which had reimbursed the participants as part of their travel to the Bean Research Workshop.

U.S. researchers: n/a

HC researchers: n/a

Methodology: n/a

Anticipated (1 year) results of activity:

Anticipated impact to which this activity will contribute, time frame and indicators:

Budget: $9,666

Progress during past year: See report that follows.
Current status:

II.B. Activity #3: Funds to conduct a Bean Research Workshop in Tanzania were awarded in FY00. The workshop was held in FY01.

Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs
Impala Hotel, Arusha, Tanzania, January 12-14, 2001

Summary report: Participants in the workshop included eight members of the CRSP team from SUA, 10 from Bunda, and three from the USA. Also participating were seven representatives from non-governmental organizations in Tanzania (LVIA, SARI, and Technoserve) and two from Malawi (Concern Universal and ActionAid), two from the Tanzanian government, two from CIAT, and one from Mozambique. Total number of participants was 35.

The workshop included three sessions: Seed Multiplication and Dissemination; Plant Protection and Seed Quality; and Entrepreneurship and Marketing. The focus of the workshop was to discuss current projects and explore potential for collaboration among the CRSP, NGOs and government agencies in seed multiplication and dissemination. Participants made presentations on their projects and activities, and the group then divided into three working groups (Plant Protection, Breeding, and Seeds) to discuss future collaborative work and planning. A complete list of the workshop participants, the agenda and the papers for the Proceedings are on the East Africa CRSP web site, **http://eastafricacrsp.wsu.edu/**. The Proceedings will be printed as soon as all papers are completed, likely in early 2002.

The workshop planning committee, Carol Miles, Robert Mabagala, and Charles Masangano, set all agenda and logistics via email. The workshop was scheduled for late March and was to be held in Mbeya, Tanzania, a convenient mid-point for Tanzania and Malawi participants to travel by road. In October, the committee was challenged by the request from the MO to advance the workshop date to January and to combine the workshop with the RA meeting so that renewal projects could be discussed. These changes brought about a change in venue to Arusha, Tanzania and this necessitated the Malawi team to travel by air. Hotel and meeting accommodations could not be confirmed until mid-December thus, airplane travel arrangements were made around the Christmas holidays when businesses in the U.S., Tanzania and Malawi are not operating at full capacity and arrangements are extremely difficult to finalize. This led to the U.S. planning team (Miles and Poole) working throughout the Christmas holidays to purchase tickets and finalize workshop details and budget issues. A wire transfer of funds to Tanzania for workshop expenses was unduly delayed because of the Christmas holiday season, creating financial hardship for both the Malawian and Tanzanian team members.

Despite financial difficulties, the CRSP team produced an outstanding workshop. Participation was good and discussion was excellent. Relationships among CRSP members, NGOs and government representatives were advanced and activities were expanded among these individuals. It is, however, a strong recommendation of the planners that such an event (1) not be scheduled again so close to the Christmas holidays and (2) that dates for an event of this size not be moved up by several months if it results in cutting planning time in half.

III. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 2001

III.A. Constraints Related to Level of, Delay in Receiving, or Reporting of CRSP Funds:
Tanzania: There were often delays in receiving reimbursement funds from WSU, due to various reasons ranging from late receipt of allocations, which interferes with WSU's ability to pay expenses on subcontracts, to SUA's regulations for expenditure of grant funds, to staff turnover in the WSU accounting office. As a result of reimbursement delays, periodically there was a serious lack of funds to timely perform the planned FY 01 research activities.

Malawi: Project research was delayed by lack of a CRSP vehicle. The vehicle was hit head-on last year by another vehicle and three people in the other vehicle died as a result of the accident. It took quite some time to get the insurance company to pay on its policy and then to get USAID approval and funds to replace the vehicle. In the meantime, we were able to borrow or rent vehicles from other projects at Bunda College but not on a sustained basis.

The Malawi Bean/Cowpea CRSP also suffered delays in obtaining funds caused by general cash flow problems in the University of Malawi accounting system. This problem has now been corrected.

General: In the remainder of the present granting cycle and in the future funding cycle, an easy, fast, and reliable mechanism needs to be developed to get funds for workshops, and special travel to individuals in a timely manner. This is not so much of a problem for U.S. scientists, who can usually get travel advances if needed through their institutions. It is a major problem for HC scientists, who generally lack personal funds, and cannot get a travel advance from their own institutions. U.S. institutions will not advance funds to individuals who are not employed by that institution (even when there is a subcontract in place) and HC institutions will not advance funds without having the earmarked funding in place. To plan and execute a workshop or similar meeting requires creative accounting that leaves individual projects liable, or requires that a U.S. researcher carry large sums of cash to the meetings. The latter approach may make such an individual the target of theft or bribery, or may place them in violation of various country's currency laws.

III.B. Leveraged Funds:

Myers received $50,000 from the Oregon Processed Vegetable Commission for Green Bean Breeding, and $5,000 from the National Plant Germplasm System to screen the *Phaseolus coccineus* collection for resistance to white mold.

Gilbertson received the following leveraged funds:
- Detection of bean infecting viruses in California bean seed production fields, California Crop Improvement Association, $8,000.
- Management of common bacterial blight on red kidney beans, Menomin Seed Co., $5,000.

III.C. Other Funds:

Robert Mabagala was awarded funds ($7,000) by DANIDA to print a technical Bulletin: Halo Blight, Common and Fuscous Blights of Beans with Special Reference to Tanzania: Field Inspection and Certification Procedures.

V. IDEAS FOR STRENGTHENING PROJECT

(Mabagala) There is a need for increasing the funding level for regional travel activities to forge collaborative research activities in the new member countries.
(Mozambique/Zimbabwe) In the East Africa region, as well as the former countries, such travel activities have remained very limited due to low funding.

(Myers) See also Section III (Constraints to Funding). It cannot be emphasized enough how great a problem there is in our current funding mechanism in getting funds to individuals to attend meetings and workshops.

IV. PUBLICATIONS, PRESENTATIONS AND AWARDS IN FY 2001

IV.A. Refereed Publications:

Crnov, R. and R. L. Gilbertson. 2001. Outbreak of Clover Yellow Vein Virus in a Bean Field in Colusa County, California. Phytopathology 85:444. Publication no. D-2001-0123-01N.

Ijani, A. S. M., R. B. Mabagala and S. Nchimbi-Msolla. 2000. Root-Knot Nematode Species Associated with Beans and Weeds in the Morogoro Region, Tanzania. African Plant Protection 6(2) 37-41.

Myers, J. R., K. D. Stewart-Williams, R. E. Hayes, J. J. Kolar and S. Singh. 2001. Registration of UI 259 Small Red Bean. Crop Science 41:1643-1644.

_____. 2001. Registration of UI 320 Pinto Bean. Crop Science 41:1642-1643.

_____. 2001. Registration of UI 465 Great Northern Bean. Crop Science 41:1644-1645.

Mkandawire, A. B. C., R. B. Mabagala and R. L. Gilbertson. 2001. Genetic Diversity among Bacteria Causing Common Bacterial Blight of Bean: Evidence of Pathogen/Host Co-Evolution. Phytopathology 9:S64. Publication no. P-2001-0461-AMA.

IV.B. Non-Refereed Publications:

Barnes-McConnell, P. and A. B. C. Mkandawire. 2000. Participatory Plant Breeding in Bean/Cowpea Collaborative Research Support Program (CRSP). GRCP. Scientific Basis of Participatory Plant Breeding and Conservation of Genetic Resources. Oaxtepec, Morelos, Mexico, October 8-14. Report No. 25. University of California Division of Agriculture and Natural Resources, Genetic Resources Conservation Program, Davis, CA.

Chiumia, L. and W. Msuku. 2001. Status of Common Bean Mosaic Virus in Common Beans in Malawi. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

Gilbertson, R. 2001. Detection of Bean Infecting Viruses in California with an Emphasis on the CRSP Facilitated Work. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html.

Mkandawire, A. B. C. and R. L. Gilbertson. 2001. Attempts to Eradicate *Xanthomonas campestris* pv. *phaseoli* from Bean Seed Using Surface Disinfection. Bean Improvement Cooperative 44:135-136.

Miles, C. 2001. Seed Dissemination and Promotion in the United States to Increase Bean Adoption. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

Misangu, R. 2001. The Effect of Sowing Bruchid Damaged Bean (*Phaseolus vulgaris* L.) Seed on Germination, Plant Development and Yield. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

Mtenga, K., F. Magayane, A. Matee and C. Miles. 2001. Existing Mechanisms for Smallholder Seed Production and Dissemination in Tanzania: A Case of SUA B/C CRSP. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

Myers, J., D. Kean, J. Davis, S. Nchimbi-Msolla and R. Misangu. 2001. Backcross Breeding to Introduce Arcelin Alleles into Bean Cultivars. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

Ngwira, M. and A. Mwangwela. Culinary Characteristics of Selected Bean Varieties in Malawi. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

Nyirenda, G. 2001. Preliminary Results of Bean Insect Pests in Karonga Agricultural Development Division and some parts of Lilongwe and Shire Valley Agricultural Development Divisions in Malawi. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/ proceedingsTOC.html

Temu, A. and K. Mtenga. 2001. Situation and Outlook of Development of Seed Production and Marketing Systems in Tanzania: Implications to B/C CRSP Seed Multiplication and Distribution Strategies. Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs Workshop Proceedings. Arusha, Tanzania, January 12-14, 2001. http://eastafricaCRSP.wsu.edu/workshop0101/proceedingsTOC.html

IV.C. Presentations:

The following were presented in Arusha, Tanzania, Jan. 12-14, 2001. in the Workshop "Bean Seed Multiplication, Dissemination, Entrepreneurship and Quality Concerns in East Africa: Current Status and Future Needs": (not included above because web publications not yet available).

Bokosi, J. Progress on Breeding Programs in Malawi.

Mabagala, R. Overview of Bean Pathogens Disseminated Through Seed.

Massangano, C. Factors Influencing Farmer's Willingness to Adopt Kalima in Malawi.

Nchimbi-Msolla, S. Performance of 35 Common Bean Obtained from the Drought Resistant Nursery.

Nchimbi-Msolla, S and R. Misangu. Seasonal Distribution of Bruchids in Bean Seed in Areas of Tanzania.

Rweyemamu, C. Common Bean Drought Studies – Environmental Basis of Genotype Differences.

IV.D. Awards and Recognitions:

Robert Mabagala was Founder Member of Tanzania Association of Phytopathologists. He was also appointed Senior Editor of the Association Newsletter and Member of the Executive Committee of the Association.

Susan Nchimbi-Msolla was promoted from Senior lecturer to Associate Professor effective July 2001.