# The effects of the Rwandan war on crop production and varietal diversity! A comparison of two crops

Louise Sperling[1]

## 1 INTRODUCTION

The escalation of the Rwandan civil war in April 1994 resulted in the death of up to one million persons and the displacement of another two million. Agriculture, the main occupation of upwards of 90% of the population, was acutely affected as civil disruptions peaked in the middle of a major growing season. Overall harvest losses during this period were officially estimated to be as high as 60% (Dr. lyameremye n.d). The aid community feared the worst in terms of farmers' ability to find their agricultural bearings again after the war. Non-govemmental organisations (NGOs), United Nations agencies, and bilateral donors responded swiftly and on a wide scale to the post-genocide crisis: some 30 intervened in emergency seed provision during the first season alone.

This article focuses on seed and varietal issues and describes some of the precise effects of war on Rwandan agricultural systems. This task is made easier by the perhaps unique amount of immediate post-war fieldwork and pre-war research which was conducted in Rwanda. During the first three post-war seasons, the Seeds of Hope (SOH) initiative undertook surveys and intensive interviews at both a regional and nationwide level, in order to plan complementary work to that of seed relief agencies. SOH was a coalition of national and international agricultural research centres which promoted varietal and genetic assessments, and rapid multiplication of varieties (landraces and improved cultivars) for possible reintroduction into Rwanda's disturbed agricultural systems.[2] SOH looked at farmers' management of beans, potatoes, sorghum, maize and cassava. This piece, however, focuses primarily on two crops — beans and potatoes — in order to draw out insights into the *differential* nature of crop survival during times of acute stress.

In terms of pre-war research, the paper draws on work done on the Rwandan bean and potato systems over a period of ten years or more. The research was conducted in the context of a regional bean network, RESAPAC,[3] (which received technical support from CIAT, the International Centre for Tropical Agriculture) and a regional potato network, PRAPACE[4] (which received support from CIP, the International Potato Centre). Research had been conducted in areas such as: varietal improvement; food processing and storage; soil erosion and fertility enhancement; and seed multiplication options.

An introductory caveat is necessary. At the time of writing, the Rwandan situation remains fluid; guerrilla attacks continue and refugee camps still house Rwandans outside their country's borders. The findings and projections of this piece refer to the situation as of November 1996. At that time, over one million Rwandans (approximately one eighth of the total population) remained in neighbouring Zaire, Tanzania and Burundi. The return of several hundred thousand of these refugees in December 1996 may have altered the bean and potato seed need profiles, although the author expects that the varietal situation, and hence diversity assessments, remain unchanged.

## 2 BACKGROUND; RWANDAN AGRICULTURE

Though a tiny country (26,000 km$^2$, traversable by car in just three hours), Rwanda harbours enormous ecological diversity. The countryside is punctuated by hundreds of rolling hills, giving rise to myriad social and agricultural micro-niches. Altitudes range from 1,000 to 4,500 metres and rainfall varies from about 800 to 1,600 mm p.a.

Landlocked and without important mineral deposits, Rwanda relies on the increasingly stressed agricultural sector as the backbone and blood of its national economy. In pre-war Rwanda this sector exhibited all the characteristics and problems of small farm agriculture. Large families cultivated garden-sized plots with nothing but hoes and limited amounts of manure. Fields were intensively intercropped (bananas, beans, local greens, sweet potato, cassava) and with an exploding population (3-7% p.a.), farms of less than a hectare were increasingly fragmented into five, ten, or even 20 separate parcels.

National indicators suggest how stretched this central African country was becoming, even before the war. Population density was the highest on the continent (445 persons/km$^2$ arable land), per capita income among the lowest ($US 285 p.a.) and chronic malnutrition

Louise Sperling is a Senior Scientist, International Centre for Tropical Agriculture (formerly Research Associate, ODI Seeds and Biodiversity Programme). She can be contacted at:

c/o Frankenstraat 26
2582 SL The Hague
The Netherlands

*Teh* +31 (70) 355 9963
*Email:* l.sperling@cgnet.com

touched over 50% of children under the age of six. Omnipresent poverty appeared to be exacerbating what was already a tradition of highly individualistic (and stressed) social ties. Hunger leads to desperation. For instance, in the early 1990s, pre-war, it was not too unusual to hear of someone being beaten to death by neighbours for stealing cassava roots. Historically, such serious communal sanctions were purportedly reserved only for the theft of high-value livestock.

It would be inaccurate to speak of any one crop as *the* key to Rwandan agriculture. Bananas, used mainly for making beer, are the lynch pin of many social transactions and are a good income generator. Beans are the 'meat' of the countryside. Cassava and sweet potatoes are what really keep poor stomachs full and sorghum is vital for making children's porridge. This article focuses on beans and potatoes because of the interesting contrasts they offer in terms of seed needs and varietal diversity, rather than for any reasons of overall importance in Rwandan agricultural systems.

## 3 OVERVIEW OF BEAN AND POTATO DIVERSITY AND PRODUCTION; PRE-WAR

### Beans

Pre-war, beans were a relatively high value crop grown by over 90% of farmers in all regions of Rwanda. In the years immediately preceeding the civil war, Rwandan bean consumption per capita was the highest in the world (50 kg p.a.). The rich could afford to eat beans twice or three times a day, while the poor would sell part of their bean stocks to purchase lower value cassava (the money generated from the sale of 1 kg of beans buys 4 kg of starch - the difference between filling four stomachs versus eight).

Although they originated in MesoAmerica and the Andean region, beans *{Phaseolus vulgaris,* Z.) have developed an important secondary centre of diversity in the central Africa region. It is thought that they were brought to eastern Africa by Portuguese traders in the 16th century. They seem to have made their way to Rwanda between 1576-1609, when *mwami* (king) Kigeli II sent forces to quell opposition in part of the present-day area of Cyangugu, a prefecture in western Rwanda.

Most Rwandan farmers grow beans during both major cropping seasons, with a good number trying to intensify production for a third season in the lowland valley bottoms. Farmers tend to grow the same varieties for both home use and sale. Beans are grown in mixtures of anywhere from three to 30 components, with a single farmer sometimes managing two or three different varietal blends (Lamb and Hardman, 1985; Voss, 1992). Unusually, Rwanda's growing urban population has not yet demanded that the rural producers 'homogenise' their product to a single uniform variety; mixes of varieties still sell at roughly the same price as pure strains.

It is important to note that free bean seed exchange was not very common in pre-war Rwanda. Best friends, immediate family, or dear neighbours might get a handful of seeds (say 100 g) here and there, but this would certainly not be enough to make a dent in sowing needs. SubstantiaTquantities of seed were therefore routinely obtained through off-farm informal channels, mostly purchased from local markets, or sometimes from neighbours or town merchants. Studies suggest that the formal sector only supplied about 2-3% of the bean seed sown in pre-war Rwanda, although this seemingly token amount was of great importance in that it was the main source of new varieties.

A number of studies suggest how vast pre-war bean genetic diversity in Rwanda may have been. The *Institut des Sciences Agronomiques du Rwanda* (ISAR) collections were said to have contained some 700 local varieties and a USAID/ISAR study conducted in 1984 identified 284 major components in major bean-producing zones (Lamb and Hardman, 1985). In 1992 researchers collected 5,000 farmer mixtures from all regions of the country except for the north (where the first incursions of the war had already begun) and isolated 545 different grain types (Scheidegger, 1993).

While the number of bean phenotypes in active use is impressive, their spatial distribution is also notable. Relatively few varieties are found throughout the country, partially because bean production zones are so diverse, extending from 1,000-2,200 metres. However, even within zones, over short distances, bean variability is great. For example, a 1991 study in southern Rwanda sampled 75 mixtures collected within 10 km radius and found that over 30% of the mixtures were grown only in a single farmer's field (Cishahayo *et ah,* n.d.).

### Potato

Like beans, potatoes *(Solanum tuberosuni)* originate in the Americas, in this case in the Andes. However, they are a much more recent introduction to Rwanda, having arrived during the period of German colonisation (1894-1916). Their nomenclature illustrates these origins. The first Rwandan epithet for potatoes, *'intofanyi',* is a corruption of the german *'kartofen',* while the current name, *'ibirayi'* dates from World War II when the Belgians took over the role of colonisers. *'Ibirayi'*derives from *'uburayi',* meaning 'that which is from Europe'.

Potatoes play a very different role to beans in the lives of Rwandan farmers. They are cultivated on a much more limited scale, mostly at higher altitudes (above 1,900 m), although potato production has recently been increasing in the mid-altitudes (particularly in marginal areas of the South) as an important poverty reduction measure. They are grown largely as a cash crop; the increasingly large town and urban population of Rwanda craves french fries.

Other features which distinguished potato from bean systems in Rwanda in the pre-war period were:

(i) The varietal diversity in potatoes, both countrywide and on an individual farm basis, was not very extensive. Reports dating back 25 years show five major varieties of potato in use (Durr, 1983). National surveys conducted in 1985 suggested that a total of

three to four dozen varieties were used (Haugerud, n.d.)- In 1992 farmers identified 41 varieties that they had ever planted (unpublished data, PRAPACE/ CIP database). Only four of these 41 varieties were sown by more than 5% of farmers.[5] Equally, mixtures of potato varieties — in this case, mixtures of improved varieties - never seemed to be very important. While work in 1985 cites the average number of potato varieties grown by any single household as four to five (Haugerud n.d.), research in the early 1990s suggested that the number had already narrowed to one to three (unpublished data, PRAPACE/CIP database).

(ii) Potato cultivation in Rwanda, unlike the cultivation of beans or any other major crop, had a strong tradition of accompanying *purchased* input use. As of 1992, 93% of farmers regularly used fungicide on their potato crop, •with *69%* of farmers in major potato producing areas Using fertiliser *{ibid).*

(iii) The formal sector was an important source of potato seed. Evidence suggests that by 1992 over 25% of potato farmers used improved seed from development projects or government extension, with this figure rising to 32% in areas of intensive potato production (P. Ewell, pers. comm.). Farmers looked to the formal sector primarily as a source of clean seed of existing varieties but also to obtain the few new varieties that were available and interesting. A 1992 survey showed that only 4% of farmers received potato seed free, either from family or neighbours (unpublished data, PRAPACE/CIP database).

In many respects, then, pre-war potato systems in Rwanda were quite unlike pre-war bean systems. Potato production was geographically concentrated and tied to purchased inputs. The formal sector played an important role in seed supply and varietal diversity was not large. However, similarities did exist. In both bean and potato systems the 'social exchange of seed' (giving seed free) was nearly non-existent and, of course, both crops were grown by small farmers as Rwanda is almost exclusively a country of small farmers.

## 4 KEY PATTERNS OF THE WAR

The specific effects of the Rwandan war on bean and potato production are elaborated in section 5. This section presents several overview observations about the effects of the war on Rwandan agriculture to help frame the interpretation of the findings.

### Genocide and "war

Rwandans themselves often distinguish between the genocide and the war *per se.* Almost all regions were affected by the genocide (although to very different degrees) but many regions, for example most of the southwest, experienced few or no direct effects of the war; fleeing populations might have passed through, but not much more.

The genocide, the worst in history, took place over about an eight to ten week period, from early April to June 1994. It broke out with the shooting down of the presidential plane on April 6,1994. As farmers normally start planting for the second main season in January/ February, most crops had been sown when the 'balloon burst'. The Rwandese Patriotic Front (RPF) gained control of much of the country by early July, just around harvest time in most areas.

The war, that is the fighting between government and RPF troops, took place at different times in different parts of the country. Indeed, whether, as of early 1997, the war is 'over' is open to interpretation. The intensive period of fighting within Rwanda ended quickly — within several weeks. Parts of the north were affected in early 1991-1992, while for much of the rest of the country, the war started in July 1994 with the southward advance of the RPF. The fleeing government troops and killing squads forced many civilians to leave their homes so as to deliver to the victor an 'empty' country. Over a million Rwandan civilians crossed national borders. Nevertheless, at least three to four times that number stayed in Rwanda.

By the time sowing took place in September/October 1994 a good measure of internal stability had been achieved, although incursions at Rwanda's border still persisted. A new government structure was also firmly in place by this time. For the purposes of this paper, the first 'post-war' season started with the September/ October 1994 sowing.

### Agricultural disruption: the broad view

While the effects of the war were very intensive for several months, those who did not flee (either from the genocide or from the RPF forces) were able to harvest much of what they had sown. Of those who did flee but who eventually returned, the majority lost one sowing season. This relatively short duration of the direct conflict makes the Rwandan war very different from many of the other recent wars on the African continent. For example, the Liberian war endured for at least five seasons and episodes of fighting in Guinea-Bissau lasted some 13 years (see analysis of Richards *et al.,* 1995).

The *relative* stability of the population was also reflected in patterns of residence and movement. Among those Rwandan farmers interviewed in late 1995, 90% had previously been farming in the same area and knew the micro-ecology, including the appropriate seeds to sow, well. Time spent away from the homestead - which is also a direct indicator of agricultural disruption - was on average, four months, although this varied greatly by region (from 3-4 weeks in the southwest to 54.6 in the northwest). Third, and most surprising given the bombardment of media images of people on the run, was that 30% of those still farming in Rwanda at the end 1995 had not been displaced at all, not even for a single day. Evidence of this was noted in two thirds of the communes sampled country-wide by the Seeds of Hope initiative (SOH Assessment Document 8). Family stability has important implications for varietal stability as stable families generally did not lose their seed stocks.

**Table 1. Overall harvest rates during the primary war season, February–July 1994**

| Crop | % of farmers who harvested at least a part of what they had sown* |
|---|---|
| Beans | 55 |
| Sorghum | 54 |
| Cassava | 91** |
| Potato | 63 |

* A total of 883 farmers were interviewed for the bean, sorghum and cassava surveys, carried out countrywide. The potato research was concentrated in the major and minor potato zones, reaching a sample of 348 farmers.

** Cassava fields were rarely completely destroyed, but select stealing was rampant (reported by 82% of cassava farmers).

The degree to which farmers were, during the primary war season, able to harvest a good portion of what they had sowed is suggested in Table 1. Overall, harvest rates were significantly better that officials first estimated, with tubers generally faring better than legumes or cereals. However, there was great variability, even over short distances. The harvesting of sorghum in central Rwanda illustrates the point: some areas in the combat zone experienced total loss of their crop while farmers as little as 25 km away reaped normal harvests.

## Infrastructural disruption — the vety broad view

It is hard to define the parameters of a 'usual' war, but the Rwandan conflict seems to have been 'unusual' in its overall aims. Neither side wanted to destroy the country *per se;* their intent was rather to change the profile of the people living it. As one official reflected, post-war, 'they wanted the same envelope - but with different contents.'

These competing goals - to 'retain what was' and yet to change the power (and population) balance — were manifest in the patterns of infrastructural damage. Most towns looked the same before and immediately after the war, with only isolated buildings belonging to government collaborators having been blown up by victorious RPF forces. Damage in the countryside was similarly selective. Over a third of farmers living in Rwanda at the end of 1995 had no damage at all to their household or property. However, houses of the murdered and/or refugees (i.e. those not interviewed) were heavily pillaged (doors, windows, roofs ripped off) or elsewhere disassembled altogether, brick by brick. As of late 1995, 7% of farmers in Rwanda reported total household destruction (SOH Assessment Document 8). It is difficult to judge how different some of the wartime behaviour was from the norm. For instance, during countrywide interviews, a good number of farmers remarked: 'Oh the stealing was terrible,' but then continued 'but this was nothing new'.

Fields also stayed in remarkably good condition during the war period (there was pillaging, but burning was very restricted), with two general exceptions. Several agricultural areas (e.g. Rukara, in Kibungo) were extensively trampled when the huge herds kept outside Rwandan borders made their way home for the first time in thirty years. Many had fled the country during ethnic purges of the late 1950s and early 1960s). Second, areas of the northeast, some of which were vacated for a full two years, experienced massive vegetative overgrowth. These 'force-fallowed' sites were subsequently difficult to re-establish into working farms.

So, in sum, for such an awful war, land and infrastructural damage in Rwanda was relatively limited. Selected houses rather than a way of life were destroyed.

## 5 BEAN AND POTATO DIVERSITY AND PRODUCTION: POST-WAR

This section draws from a series of nationwide surveys and intensive interviews conducted during the first three post-war growing seasons in Rwanda. During the first two seasons (95A and 95B) there was significant emergency relief. During the 96A season farmers were largely left to their own resources.[6] The 1996A bean research encompassed a random, countrywide sample of 883 informants, making it comparable in scope to the Ministry of Agriculture's Department of Agriculture statistics pre-war. The 1996A potato research focused on the major and important minor production zones and reached a sample of 348 farmers. There were only two stipulations in choice of respondents: the families had to be farming and had to have previously grown the crop in question. By contrast, research during the emergency period (1995A and B) focused on aid recipients (c. 80% of the total population).

## Beans

*Rate of sowing and area*

In the first two major post-war bean growing seasons (1995A and 1996A), more than 95% of those interviewed sowed beans. This figure is higher than normal and reflects farmers' rehabilitation strategy of focusing on short cycle and, if possible, high value crops. Particularly

during the first season, many farmers feared thinking too far into the future. For instance, relatively few invested in cassava, a crop that takes at least eighteen months to mature.

By farmers' own assessments, the area under bean cultivation post-war was fairly comparable to that sown pre-war. Forty-four per cent of farmers indicated that the surface area they were sowing was the same, while 14% indicated that they were sowing a larger area of beans because they wanted to rebuild stocks. Some also had access to larger areas of land (through the death of relatives and neighbours). The main reason given for diminution of bean plots (among the two-fifths of farmers who were sowing a smaller area) was lack of seed, although some also cited a greatly reduced labour force.

*Seed stocks*

Farmers were able to draw on their own seed stocks to a surprisingly large extent during both the 1995A and 1996A seasons; slightly under half the total quantity of seed sown came from farmers' own former harvests (Table 2). Given that many farmers had been dislocated just at harvest time, this use of 'own stock' is a welcome finding. Saved seed most often comprises well-adapted, location-specific bush bean mixtures, but may also include single varieties (local or improved) which the farmer finds productive or interesting because of certain quality attributes. Use of one's own stock encourages production stability and the preservation of local varietal diversity.

Seed donated by aid agencies (sometimes mixtures from neighbouring Burundi and Uganda and sometimes single Ugandan varieties) was of far greater importance during the 1995A season than the 1996A season. There are two reasons for this: (i) the 1995A sample was specifically targeted towards households which had received NGO relief; and (ii) the second survey was conducted during a period of agricultural rehabilitation; many who had initially fled were finding their way back home.

As had been the case pre-war, Rwandan farmers relied heavily on markets - usually the very small local ones located within a few kilometres of their homes - for seed during both the emergency relief and the rehabilitation seasons. Seed gifts or borrowing of seed from neighbours and kin was negligible both pre- and post-war (Sperling and Loevinsohn, 1993).

*Assessments of varietal loss and varietal reaccession*

When assessing seed stocks for possible varietal erosion, it is crucial to consider the number of farmers holding local varieties across different locations, as well as aggregate figures on kilogrammes of saved seed sown. The greater the percentage of farmers holding even small quantities of local seed, and the greater their geographical dispersion, the greater the possibility for varietal diffusion and recovery. Surveys conducted during the 1995A season showed that upwards of 62% of farmers nationwide drew on their own seed stocks to some degree with at least 40% of farmers in each prefecture accessing this source (SOH Assessment Document 1).

Does this then mean that individual farmers did not lose important varieties? Not necessarily: farmers recounted selective pillaging in many areas. They claim that even their closest neighbours may have used the wartime disruption to swipe the varieties they had always coveted.

While genetic and varietal resource assessments are often done on a broad scale, for example, by country or by eco-zone, SOH work sought to conduct highly site-specific assessments. Rwandans often spend their entire lives within the radii of several *'Conines'* (hills). This may mean that they are not able to access a variety which can be found only 15 km away from their home. Another reason why SOH concentrated on highly site-specific research was that the war had affected people in a very different manner even within a small geographical area.

The SOH research used three separate methods to analyse varietal loss in beans.

(i) *Overall assessments.* Farmers were asked to compare their current bean seed mixture(s) with those they had sown directly prior to the war. The aim was to get an idea of the overall performance of their current mixture and to document specific changes (both positive and negative) which may have occurred.

(ii) *Principal components analysis.* They were then asked to take their current mixture, separate out the principal components and compare this key

**Table 2. Sources of bean seed sown (% seed sown) in Rwanda, nationwide data, seasons 1995A and 96A**

| Source | % Total seed 1995A (N=143 farmers) | % Total seed 1996A ( N=883 farmers) |
|---|---|---|
| Own stock | 45 | 40 |
| Relief aid | 28 | 6 |
| Market | 26 | 52 |
| Friends/neighbours | <1 | 1 |
| Kin | <1 | <1 |
| TOTAL | 100 | 100 |

component profile with that used just before the war.

(iii) *Tally of loss of specific varieties.* As a third check, fanners were asked to recall an]/ varieties abandoned during the war period and *why.* Getting at this latter 'why' is very important as Rwandan farmers regularly experiment with varieties; discarding a variety is not the same as losing a variety.[7]

The results of these three methods showed that a minimal number of varieties were actually lost. Overall, 76% of farmers said that their post-war mixture was the same or better than that used during a comparable pre-war period (SOH Assessment Document 8). Eighty-four percent had all the same key components (with another 7% having two out of the three) *{ibid).* Further, although some farmers had lost varieties, reaccession was shown to be widely feasible.

This discussion of re-accession proved to be as important as discussion of varietal loss. Varieties can be lost' (for instance, poor Rwandan farmers regularly consume all their own seed) but also routinely re-accessed. Farmers' main source for re-accessing varieties was local markets, and second, friends. Knowing where a variety might be reaccessed does not, however, necessarily mean that the farmer rushes out to obtain it. There are a number of reasons why this was the case in the immediate post-war period.

(i) In many regions farmers viewed seed price as inordinately high. They therefore refrained from purchasing supplementary seed,

(ii) Farmers complained of having to buy entire mixtures in order to get the one or two varieties they really wanted.

(iii) Farmers' priorities during this period of reconstruction simply lay elsewhere. Rather than purchase the bean varieties they had lost, farmers wanted to get a door on the house, fix the windows, and maybe pay for labour they had not needed before.

While slightly more than a third of survey respondents had lost a bean variety during the war (not necessarily a key one), most could readily re-access this lost variety (see Table 3). Only 13% of the total sample of farmers presently 'did not know' where to re-access specific varieties. This number is quite small considering that on average each farmer manages 12 varieties and that here farmers are speaking about not being able to re-access a single entry (SOH Assessment Document 8).

It is important to note that a good portion of the 'lost' varieties which farmers did not know how to access were improved ones, particularly the highly desired and relatively new climbing bean varieties. These varieties could generally be re-obtained only if they had already entered the local channels (markets etc.), a process that takes about three to five years. Formal seed supply channels (the central seed service and its development project outreach) were much harder hit by the war than local sources of supply. Ironically, then, while the international community was looking to restock local germplasm (given the relatively new rhetoric of biodiversity), farmers themselves felt most help was needed in getting the newer, 'improved' introductions back.

### *Changing varietal profiles*

While there is no evidence to link war to varietal erosion, both quantitative and qualitative insights suggest that important varietal changes have occurred over the past decade in Rwanda. This is due to two related trends: the adoption of climbing varieties in an effort to intensify production and a partial shift in varieties in response to an increased incidence of root rot.

(i) CLIMBING BEANS: Research shows a swift acceleration in the adoption of improved climbing bean varieties in Rwanda. Pre-1980, about 10% of farmers, mainly in the northwest of the country, grew indigenous varieties of climbing beans. A 1992 survey showed just over 40% of farmers spread throughout the country growing improved climbing bean varieties (Sperling and Munyaneza, 1995). The post-war survey indicated that climbing bean use was still rising. These varieties were used by 48% of bean

**Table 3. Key bean varietal loss during the Rwandan war**

| Have you lost bean varieties due to the war (N=805) | Farmers % | If so, where can they be re-accessed? | | |
|---|---|---|---|---|
| No | 67 | | | |
| Yes | 33 | | % Cases (N=454) | % Farmers (N=805) |
| | | Market | 37 | 13 |
| | | Friends(direct) | 7 | 2 |
| | | Friends (indirect)* | 22 | 10 |
| | | Elsewhere | 2 | <1 |
| | | Don't know | 32 | 13 |

* Through cross-referencing interviews, the variety has been found with a neighbour 100-200m distant. Whether the farmer can re-obtain seed has yet to be tested.

farmers and accounted for a third of the total bean seed sown (SOH Assessment Document 8). Across the country there are zones where improved climbers are pushing out both local bush and local climbing types. For example, in the commune of Nyanyumba (Gisenyi), farmers describe their 'local' mixture as composed of three improved climbing varieties. The effects of the war in this last zone were minimal and farmers specifically noted that the local climbing mixes were dropped around 1992, as 'they were no longer productive'. The popularity of climbing beans is due to the fact that they can give two to four times the yield of bush varieties. In addition, many of the improved varieties show exceptional tolerance to root rot.

(ii) ROOT ROT: Farmer evaluations also showed that local varieties had been dropped due to heavy disease pressure across the country, particularly in the south-centre and parts of the northwest. In some of these areas, there has been a simultaneous shift to climbers. However, in communes of the southeast farmers are still using bush beans, but experimenting with changing the varietal profile in response to disease, notably root rot. Again, this dropping of varieties has occurred in areas in which the effects of the war were minimal. Research in south-centre Rwanda (Runinya, Butare) for three years directly before the war vividly illustrates how swift the effects of root rot can be on varietal use (Buruchara n.d.). When conducting root rot trials in 1991A, the CIAT pathologist asked farmers to use their local mixtures as the control. Each farmer used her own mixture, meaning that many mixtures were used across trial sites. Farmers tended to have 12-15 varietal components in their control mixtures. In 1992A, 1992B and 1993A comparable trials were repeated but with a smaller number of farmers. In 1992, the number of varieties in use in the control fell to three to six. In 1993A, farmers asked the researcher not to make them use their own mixtures as controls as yields from these mixtures had fallen so dramatically. Farmers preferred as local controls some of the root rot-resistant entries which the formal research system had already tested (R. Buruchara, pers. comm.).

It is important to emphasise that both these trends are the result of farmers' conscious strategies to combat stress. They result neither from war, nor from commercial pressures to modernise. In some cases, farmers are swapping part of their local stocks for newer varieties. In others, local varieties are being discarded in favour of other local varieties.

*Absolute versus relative lack of seed*

The most common stress cited by farmers in the post-war surveys was lack of seed at the household level or, more specifically, lack of money to buy necessary seed. Seed was available in the market but farmers did not have the means to *access* it and/or were angry they had to pay so much for it. This relative lack of seed in farmers' own stocks, as opposed to lack of varieties *per se* was very widespread; the problem was cited by a good portion of farmers in over half the communes sampled (SOH Assessment Document 8). Relative lack of seed is indicative of poverty rather than varietal erosion. Compensating interventions should not therefore be germplasm-based. Rather, attention should be devoted to innovative poverty-focused projects and, perhaps, selective distribution of vouchers to buy local seed.

By contrast, absolute lack of bean seed and absolute lack of varieties were rare in post-war Rwanda. These characteristics were restricted to those zones which had experienced massive killing, large transient populations, and which had tended to be ecologically marginal even before the war.

*Concluding reflections: bean seed and bean diversity*

Despite the much publicised civil war and genocide, the Rwandan bean varietal situation looks relatively promising. The limited varietal damage inflicted by the war is partly due to the pattern of the war itself and partly to the impressive response of the aid community which helped farmers to maintain adapted stocks. Further, one of Rwanda's main advantages, in terms of safeguarding diversity, lies in the characteristics of its existing pre-war seed channel structure. For self-pollinated crops, purchased seed from local markets was always of major importance to farmers. These markets were quickly re-established post-war as seeds of beans and sorghum, for example, could be restocked locally. Even during the first season post-war, surveys showed markets supplying as much seed as relief agencies. Restocking through neighbours and friends was never particularly important in Rwanda (at least not for the current generation). This meant that ruptured social relationships had little effect on bean seed systems.

Varietal diversity in beans remains impressive in Rwanda. SOH workers during the first post-war harvest of January 1995, were able to collect some 1,300 different phenotypes from a very restricted sample of about 150 households and 20 markets (S. Beebe, personal communication). The situation is, however, far from static. Farmers' strategies to intensify production and combat root rot are resulting in unusually dynamic varietal profiles for beans at the current time.

## Potatoes

*Rate of sowing and area*

The case of potatoes is very different from that of beans. Only 84% of active potato farmers interviewed had sown any potato tubers during the October-November 1995 (1995B) period. When comparing the surface area they had sown to potatoes during 1995 with that sown during a comparable pre-war period, a full two-thirds of farmers said they were planting a smaller area of potatoes post-war (pre-war farmers generally sowed about 100-200 kg of potatoes, an investment many could no longer afford). Ten per cent of farmers were not planting at all. When asked about the reasons for the contraction of potato areas, two-thirds responded: *lack of seed.* Both

Table 4. Number of potato varieties currently tried and currently used by Rwandan farmers

| Number of varieties ever tried | % of potato farmers (N=347) | Number of potato varieties currently used | % of potato farmers (N=293) |
|---|---|---|---|
| 1 | 17 | 1 | 51 |
| 2 | 31 | 2 | 34 |
| 3 | 26 | 3 | 10 |
| 4 | 16 | 4 | 4 |
| 5 | 5 | 5 | <1 |
| 6 | 2 | 6 | <1 |
| 7 | 1 | - | - |
| 8 | <1 | - | - |
| 10 | <1 | - | - |

absolute lack of seed, whether clean or otherwise, (none available either at home or in the market) and relative lack of seed were cited.

*Seed stocks*

Virtually all of the potato seed sown in the 1995B period came from farmers' own stocks (55%) or the market (42%). Exchange of potato seed among neighbours or friends had always been rare. Unlike beans, however, use of what farmers termed 'local varieties' also proved to be negligible. Only 3% of farmers claimed to have sown local varieties even pre-war, and during the first post-war season, only 5% of the seed sown was local.

Aid agencies were not a source of potato seed. Tubers are hard to move on a large scale and potato is not a priority crop nationwide, hence the agencies focused their efforts on other crops. They did, however, contribute substantial technical assistance to help reestablish domestic potato seed multiplication facilities (both through selected farmer-multipliers and the parastatals).

*Varietal loss, seed loss and reaccession possibilities*

With potatoes the issue of varietal loss never loomed large. Three officially-released varieties - Cruza, Sangema and Mabondo (the first two of Mexican origin, the latter Rwandan) - dominate potato fields, accounting for 86% of the total seed sown (SOH Assessment Document 9). Indeed, in the south-central region (Gikongoro) Cruza alone accounted for 86% of all seed sown.

Moreover, most farmers interviewed had never even experimented with a significant range of varieties. Table 4 shows the number of varieties sampled farmers currently use and the number they have ever tried. Most of the sample had tested both Cruza and Sangema with Mabondo, Montsama and Muhabura having had lesser exposure. All are improved cultivars. Few other varieties have ever reached more than a handful of farmers. This range is limited considering both farmers' high interest in potato production and their propensity for lively varietal experimentation in crops such as beans.

Obtaining adequate volumes of desired varieties of potato seed, rather than accessing the germplasm itself, was a real problem for many farmers in the post-war emergency and rehabilitation seasons in Rwanda. Overall, two-fifths of farmers said they had lost valued seed of certain varieties. The region of Byumba, where farmers were absent for about two years from the potato growing zones, was particularly badly hit; 56% of farmers there experienced significant seed loss.

Part of the problem in potato reacquisition has been the relative dependence of farmers on formal, external sources of seed. In the last ten years, farmers have come to rely heavily on development projects and the national agricultural research system (NARS) for sourcing clean seed and for accessing the few new varieties, often at subsidised prices. The war disrupted this supply as early as 1991-92 because the NARS parastatal responsible for bulking up was located in one of the war's first fronts. Many development projects began to phase out their activities during 1993-

If restocking possibilities are considered on a case by case basis (that is, where can x variety be found?), the scenario of Table 5 looks relatively grim for the potato zones as a whole. In almost half the cases, it is not clear where farmers are going to find seed of potato varieties - although about a quarter of the varieties 'lost' can be re-accessed on the market.

However, when the data is analysed from the farmer perspective within each region, it becomes clear that markets in all regions are good sources of material, and that relatively few farmers cannot find material. The 'I

Table 5. Sources where farmers can find lost potato varieties, across potato zones (N=130 farmers with 206 cases of 'loss')

| Source | % of cases of 'loss' |
|---|---|
| Market | 27 |
| Friend | 3 |
| Development projects | 12 |
| Other | 5 |
| NARS | 5 |
| Don't know | 47 |

don't know where to find x' figures are inflated because the same farmer is indicating that she/he cannot find two or three different varieties. Again, the exception was Byumba, where almost a third of the farmers were not sure where to re-access potato varietal material. There may then be an absolute lack of seed in Byumba. In other regions, however, the problem of obtaining potato seed was due to lack of money. This can therefore be considered as relative rather than absolute lack.

*Input use: fertiliser and fungicide*

Post-war surveys showed that most Rwandan potato farmers (56%) had used fertiliser at some time in their potato farming careers.[8] However, in some regions of the country, such as south-centre, farmers complained that supplies of fungicide and fertiliser dried up in 1992-93, as merchants diverted their efforts to providing supplies to meet escalating war needs. Potato production was tied to use of these purchased inputs and one reason why farmers did not look for potato seed was that the accompanying inputs they deemed to be essential were no longer available.

Twenty-three per cent of those who had previously used fertiliser were no longer doing so in the immediate post-war period because of lack of availability (the majority of cases) or high cost. The same patterns can be observed for fungicide, use of which had been even more prevalent than that of fertiliser, two-thirds of farmers having applied fungicide at some point, but only one third of these still applying it (see Table 6).

*Concluding reflections: potato seed and potato diversity*

Potato production in Rwanda was hit particularly hard by the war. Overall production is significantly down with two-thirds of potato farmers sowing a smaller area than at a comparable period before the war. Availability of seed is a general problem (although the northwest zone is slightly better off than the others). Fungicide and fertiliser use have also fallen dramatically with only 33% and 23% respectively of those who have ever tried these inputs still using them.

As was the case for beans, the war in Rwanda did not result in a problem of potato varietal loss *per se*. However, whereas the main problem in bean systems was a relative lack of planting material (farmers could not pay for seed at market prices), many potato farmers also faced an absolute lack of seed (as in Byumba) or an absolute lack of clean seed. Pre-war, production of clean potato seed had been quite highly centralised. It had been produced either within the national research programme in the northwest or in certain development projects supported by expatriate funding. Neither source proved sustainable during the wartime and immediate post-war period.

Potato farmers appear then to feel a lack of control over the process of rejuvenation of production. They have done little to rebuild potato production when compared with their active strategies for rebuilding bean production.

## 6 LESSONS

In terms of thinking about crop diversity and war, the Rwandan contrast between bean and potato systems offers a series of generalised insights about the effects of acute stress on crop diversity. They are summarised as follows:

### Post-war seed system and varietal diagnosis

1. When aiming to assess the effects of war on varietal diversity, researchers should focus equal attention on the *seed channels* which can re-supply germplasm and on the germplasm itself. The issue is not whether a farmer is using a particular variety

Table 6. Evolution in use of fungicide and fertiliser by Rwandan potato farmers*

| Use of fungicide: last time (N=273) | % of farmers | Use of fertiliser: | % of farmers last time (N=194) |
|---|---|---|---|
| 1982 | <1 | 1981 | <1 |
| | | 1983 | 1 |
| | | 1988 | 1 |
| | | 1989 | 2 |
| 1990 | 8 | 1990 | 11 |
| 1991 | 5 | 1991 | 6 |
| 1992 | 5 | 1992 | 4 |
| 1993 | 11 | 1993 | 12 |
| 1994 | 38 | 1994 | 40 |
| Continued use in 1995-96 | 33 | Continued use in 1995-96 | 23 |

* Sample focuses only on those who have tried fungicide or fertiliser.

(or set of varieties) at a single point in time, but rather whether she/he can re-access it if desired. Varietal loss is a dynamic process, but so is varietal accession. A key for understanding the processes of diversity in times of acute stress lies in the analysis of seed channels.

2. A war does not affect the functioning of all seed channels in the same ways. There may be variations according to type of system (e.g. formal vs. farmer) and according to the type of crop within any particular channel. Unexpectedly, in Rwanda, the formal seed channels took the hardest beating in the war years, while farmers' own seed systems (for beans and sorghum, at least) proved to be surprisingly resilient. For this reason, analysis of one crop cannot necessarily be extrapolated to another. Those interested in varietal diversity and rebuilding agriculture after calamity need to be prepared to adopt an in-depth, multi-crop focus.
3. It is imperative to try to distinguish between farmers' absolute versus relative lack of seed and, similarly, absolute and relative lack of varieties. Absolute lack implies a true scarcity of varieties or seed in a region. Remedial action in such circumstances should focus on re-introduction or on intervention to build up seed production capacity (as was the case with potatoes in Rwanda). Relative lack of varieties/seed implies problems with *accessing* seed, not absence of seed *per se.* Seed (and varieties) may be generally available but not within farmers' specific means. In such circumstances, interventions to counter 'seed deficits' or 'varietal erosion' should not be germplasm-based. Rather, innovative poverty-focused projects and, perhaps, selective distribution of 'seed vouchers' (to buy local seed) should be considered.

*Post-war germplasm re-introductions*

4. The Rwandan analysis clearly shows the dynamism in varietal use. Varieties in use today may differ markedly from varieties deposited in genebanks only a decade ago, even in the absence of turbulent events or strong promotional policies to use improved material. Opening up the genebanks to restore on-farm varietal diversity will not therefore automatically deliver an adapted or farmer-acceptable product in times of stress.

   The present-day trend for promoting biodiversity has led many concerned activists, environmentalists, and farming systems specialists (among others) to advocate as a near panacea the restoration of farmer germplasm to its original sites of use. Careful documentation of bean varietal use in Rwanda shows that such an approach may not always be to farmers' benefit even in low input situations with resource poor farmers. The rapid emergence of root rot in Rwanda and the change in varietal use in response to this provides just one example of the relative lack of dynamism in genebanks as opposed to farmers' fields.

   If germplasm is to be re-introduced it should, as far as possible, resemble that which farmers were using directly prior to the emergency situation (assuming that the agro-ecological context was a stable, viable one). This implies that a frontline preparedness strategy for emergency situations should focus in the first instance on understanding which farmers are sowing which varietal material and why (see also ODI, 1996).
5. It is fortunate - for both Rwandan farmers and the world community - that Rwandan bean germplasm seems to be in relatively good shape. However, SOH did, during its post-war research, prepare a contingency plan for reintroduction of bean germplasm, as the challenges of site-specific restoration became more and more apparent.

   The components of this strategy may be of interest to other potential interveners in conflict situations. Step 1: Landraces and improved varieties had already been multiplied in important initial quantities. Step 2: The germplasm was to be colour-coded by general attitudinal adaptation. Step 3: Testing of germplasm was to be decentralised to farming communities themselves, partly with the support of NGOs. In sum, farmers themselves were to be given a diverse range of germplasm to screen on-site.

   In the event the plan was never executed both because local markets soon began supplying reasonable quantities of bean seed again and also because the loss itself was not as great as had been anticipated, because of the particular patterns of the Rwandan war.
6. The final lesson from the Rwanda case centres on the return of germplasm. Restoration of germplasm means more than transferring material from one national (or international) genebank to another. Even under normal circumstances, many of the poorest are never reached by formal seed systems. This makes it particularly difficult to meet the needs of all farmers in stress situations. Germplasm is only actually 'restored' when it starts to grow again and to evolve *in farmers'fields.*

## REFERENCES

Buruchara, R. (n.d.) 'Development of management options for bean root rots: lessons learnt from research in the Great Lakes Region.' Paper presented in the *Huitième Séminaire Régional sur I'Amélioration de haricot dans la Région des Grands Lacs,* 5-8 November, 1995. Kampala, Uganda: International Centre for Tropical Agriculture.

Cishahayo, D., Loevinsohn, M., Sperling, L. and Mukagatera, V. (n.d.) 'Diversité génétique et dynamique des mélanges de haricot.' Karama, Rwanda: Institut des Sciences Agronomiques du Rwanda, manuscript.

Durr, G. (1983) 'Potato production and utilization in

Rwanda.' Social Science Department, *Working Paper 1983-1-* Lima: International Potato Centre.

Haugerud, A. (n.d.) 'Farmers' criteria in selection and use of potato cultivars.' Paper prepared for Regional Potato Germplasm Course, June 10-25, 1985. Nairobi: CIP Regional Office.

lyameremye, A. (n.d.) 'Le secteur agricole durement touché.' *Traits d'union, Rwanda 5-*

Lamb, E.M. and Hardman, L.L. (1985) *Final report of. Survey of bean varieties grown in Rwanda, fanuary 1984-fune 1985.* AID-Rwanda Local Crop Storage Cooperative Research.

Overseas Development Institute (ODI) Seeds and Biodiversity Programme. (1996) 'Seed provision during and after emergencies.' Relief and Rehabilitation Network *Good Practice Review 4.* London: Overseas Development Institute and Euronaid.

Scheidegger, U.C. (1993) *The diversity of bean varieties in Rwanda. Bean Program Annual Report 1993-* Cali: Colombia: International Centre for Tropical Agriculture.

*SOH Assessment Documents*

1 Assessment of bean seed use 1995A: Summary Report.

2 The impact of war on plant genetic resources: bean varietal assessment in Rwanda 1995A: Summary Report.

3 Assessment of bean and maize seed use 1995A in CARE zone of action.

4 Assessment of bean seed use 1995a in World Vision zone of action.

5 Assessment of maize seed use 1995 A in World Vision zone of action.

6 Assessment of maize seed use 1995A: Summary report.

7 Assessment of sorghum seed use 1995B in CARE zone of action.

8 Rwanda nationwide household survey on the status of the bean, sorghum and cassava crops. 1995: The impact of war on production and varietal erosion.

9 Rwanda household survey on the status of the potato crop, 1995.

10 Executive summary of Seeds of Hope (SOH) socio-economic analyses in Rwanda: the impact of the war on agricultural production.

*(All deposited at: Ottawa: International Development Research Centre)*

Sperling, L. and Loevinsohn, M. (1993) 'The dynamics of improved bean varieties among small farmers in Rwanda.' *Agricultural Systems* 41:441-453.

Sperling, L. and Muyaneza, S. (1995) 'Intensifying production among smallholder farmers: the impact of improved climbing beans in Rwanda.' *African Crop Science Journal Yo\.* 3(1).

Voss, J. (1992) 'Conserving and increasing on-farm genetic diversity:farmer management of varietal bean mixtures in Central Africa.' In: J.L. Moock and R.E. Rhoades (eds). *Diversity, farmer knowledge and sustainability.* Ithaca and London: Cornell University Press.

## ENDNOTES

1. This assessment work was generously supported by IDRC (the International Development Research Centre). Special thanks are extended to Joachim Voss and Luis Navarro. Colleagues at ISAR, CIP, and CIAT also provided logistical support and important research insights to this work on beans and potatoes. Special thanks go to Steve Beebe, Robin Buruchara, Peter Ewell, Ngerero Nkuriza, Neeroj Pant, Marie-Jean Uwera and Wayne Younquist. This paper is largely drawn from SOH Assessment Documents 1 to 10.

2. The Seeds of Hope Initiative was formalised in September 1995. Many African NARS (those of Burundi, Ethiopia, Kenya, Malawi, Tanzania, Uganda, Zaire and Zimbabwe) have contributed germplasm, field space, and advice to the initiative. In addition, some eight International Agricultural Research Centres are heavily involved in the Rwandan Agricultural reconstruction, namely:

   International Centre for Tropical Agriculture (CIAT)
   International Maize and Wheat Improvement Centre (CIMMYT)
   International Potato Centre (CIP and its network PRAPACE)
   International Centre for Research in Agroforestry (ICRAF)
   International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
   International Institute of Tropical Agriculture (IITA)
   International Livestock Research Institute (ILRI)
   International Plant Genetic Resources Institute (IPGRI)

3- RESAPAC = Reseau pour 1'Amelioration du Haricot *(Phaseolus vulgaris)* dans la Region de l'Afrique Centrale.

4. PRAPACE= Programme Regional d'Amélioration de la Culture de la Pomme de Terre et de la Patate Douce en Afrique Centrale et de 1'Est.

5. All these surveys were pre-war. While the conflict did start in certain zones in Rwanda in late 1990, peace reigned in areas sampled in the survey.

6. During the period of emergency aid, SOH worked closely with the NGOs CARE, Medecins san Frontieres, World Vision, Swiss Disaster Relief and Catholic Relief Services. The assessments covered the September 1994 to January 1995 (95A) and February to July 1995 (95B) seasons. They monitored the impact of aid in beans, sorghum and maize. In the third post-war season (September 1995 to January 1996 (96A)), a time of relative stability, SOH collaborated with the national programme, ISAR, to undertake the first intensive post-war agricultural surveys. In-depth interviews were conducted on potatoes, beans, sorghum and cassava, in all prefectures and two-thirds of the Rwandan communes (90 of the 144 total). About 1,200 households were covered. The sample size was large but also geographically dispersed in order that the micro-variations in effects of the war across small spatial distances could be captured.

7. A Rwandan farmer might be exposed to 100 bean varieties in a lifetime and probably tests about half of these.
8. The term 'fertiliser' generally refers to different combinations of NPK.