Collective Action for Rehabilitation of Global Public Goods
CGIAR Genetic Resources Systems - Phase 2 (GPG2)

Activity 2.4

(Develop and disseminate decision-support tools to enhance the cost-effectiveness of collection management)

Final Report

Evaluating Cost-Effectiveness of Collection Management: *Ex-situ* Conservation of Plant Genetic Resources in the CG System

March 2010

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Acknowledgments

This activity involved an intensive data collection. To complete this activity we counted with the help of several staff across center that gladly provided us with information or guided us to the right sources. We would like to thank:

CIAT: C. Bejarano, M. Cortez, J. Martinez, J. Mena, A. Palau, L. M. Quintana, J. Soto, J. Uribe
CIMMYT: V. Chavez J. Gumafelix
ICRISAT: R.P. Thakur, A.G. Girish, B. Ashok Kumar
IITA: A. Bamikole
IFPRI: P. Zambrano, S. Yan
ILRI: J.Bongo
IRRI: M. Aquino, P. Gonzales, A. Telosa, M. Telosa, T. Santos
Consultants: V. Komerell, B. Koo

In particular, we would like to thank Brigitte La Liberte (project coordinator until January this year) for the remarkable support in completing this activity.

SECTION 9

Costs Effectiveness of Germplasm Collections in the CG system

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Cost information is useful to monitor the performance of the genebanks. Thus, managers, users, and donors of the genebanks can have an idea of the relative costs of managing plant genetic resources. This information can be used to make users but especially donors aware of the actual costs of conserving and distributing accessions and in this way facilitate fund raising. Managers however do have an idea of genebank operational costs. What is then the added value of using a periodic system to collect costs information for the genebank manager? In this section we present some specific cases where the information collected in the genebanks visited can help in the decision process. It is true that the current amount of information does not allow us to make conclusions across centers, but it does allow for some analysis within the centers.

1. Rationalization

Rationalization within a genebank and across genebanks is recurrent discussion in the CG system. The information collected in this evaluation can help to address partially some of the main points raised for an informed decision about rationalization.

a) Duplication and molecular characterization

One of the goals of a genebanks is to conserve unique genetic material[29], however duplication is often unavoidable. Duplication of genetic material is associated with costs inefficiencies, as the material has to be periodically regenerated, tested, or stored. The costs are particularly high for materials that are conserved in-vitro. The real problem of eliminating and avoiding duplication relies on the difficulty to actually find the duplicated material. While molecular techniques are becoming more affordable it is still expensive to do a full screening to determine if an accession is a duplicate or not. But, is

[29] We do not discuss here the underlying concept diversity and of what constitutes a unique material as there might be different points of view and ways to measure it. Nevertheless

it actually less expensive to eliminate duplication than actually keeping the duplicates? What are the steps necessary to eliminate duplication and what kind of resources are needed?

Note that the cost of conserving a duplicate depends on the material under evaluation (size, multiplication method, storing method, level of domestication). Moreover, the proportion of duplicates in the collection can considerably affect genebank costs. Take as an example the case of the European Genebank Integrated System (AEGIS) which goal is to create an integrated genebank system for conserving the genetically unique and important accessions of Europe and making them available for breeding and research (ECPGR 2008). The level of duplication across European genebanks participating on this initiative has been estimated around 35% or higher. AEGIS is expected to increase the long-term costs effectiveness of the collection management by controlling redundancy and duplicates more effectively. A reduction of the high duplication level can lead to a considerable cut on operational costs across the system. In the case of the CG system this value is probably lower across collections as different genebanks have different crops mandates. With the exemption of some materials[30], there is however no information available about the level of duplication within each genebank, or the information is very limited.

In CIAT a new material of cassava that is going to be added to the collection is subject to a molecular and biochemical characterization. Assessing the costs incurred in performing this operation can provide useful information and help in the decision of discarding materials Vs maintaining long-term expenses by keeping a duplicate in the collection. In other words the costs information generated by the operation can help to conclude on avoiding duplication. Notice that avoiding and eliminating duplication are different concepts. Using CIAT's information as an example, the additional annual cost of using molecular and biological characterization techniques to identify duplicates and add them to the collection (US$ 108.7 per accession) is presented in Table 9.1. In in-perpetuity terms, the additional cost of non –identifying a duplicate would be equal to the cost of

[30] At CIAT, although the level of internal duplication varies from crop to crop the level of internal duplication for cassava is around 8%, and with a specific research going on in tracking these internal genetic copies. In common bean the level of internal duplication may be around 5-6%, higher in Central America (15-18%), lower in the Andes (3%), intermediate in southern Europe and Africa (10%).

conserving and distributing this material as a different accession. In other words this would add US$ 1,313.71 per accession to the total genebank in-perpetuity costs. It is important to mention that the molecular characterization is carried out once the passport data have been checked throughout carefully. In other words, molecular characterization is done when there are suspicions that materials are genetic copies of each other.

IITA is presently working on molecular finger printing of the yam and cassava collection. This is to reduce the level of duplicates and also guide future collecting mission /acquisition from National genebank.

Table 9.1. Molecular characterization costs vs. cost of conserving a duplicate

Goal	Average Annual Costs		Average In-Perpetuity Costs
	Without Characterization	With Characterization	Without Characterization
Conservation	90.85	144.89	542.52
Distribution	47.65	101.69	771.19
TOTAL	138.51	246.58	1,313.71
Additional		108.07	1,313.71

b) <u>When location does not matter: Outsourcing</u>

Some operations performed by a genebank could be or "outsourced" (done by a third party). These operations tend to be related to laboratory analysis like viability testing or molecular characterization. Long-term storage of seed germplasm could as well be outsourced since the location of the storing facilities would not affect the quality of the operation. A comparison of operating costs of viability testing in different materials with a reference value by a private laboratory is useful for an analysis of potential advantages and disadvantages of having this operation outsourced. Staff qualification, costs of transportation, availability of the information, and timing of the operation within the flow of the genebank operation are crucial factors to take into account for making a decision about outsourcing or doing it at home.

There are several laboratories around the world that provide germination and viability tests. If the service is going to be outsourced then it is important to select a laboratory that not only offers a good quality-to-price service but that it is also located within reasonable distance. Table 9.2 presents a quick comparison on germination costs across genetic materials in the CG system, and approximated fee charged by two international and accredited seed testing laboratories in the US and in the UK.

Table 9.2. Comparative costs of germination testing (US$)

Material	Own Genebank	IOWA State University, Seed Testing Laboratory (USA)	Seed Testing Station of the Science and Advice for Scottish Agriculture (UK)
Common bean / CIAT[1]	4.48	12	24.7
Tropical forages/ CIAT[1]	9.84	30	28.6*
Wheat / CIMMYT[2]	6.19	17	26.4
Maize /CIMMYT[2]	4.42	12	26.4
Sorghum, ICRISAT[2,3]	2.71	17	26.4
Groundnut, ICRISAT[2,3]	2.72	18	24.7
Chickpea, ICRISAT[2,3]	2.54	18	24.7
Annual legumes, ILRI[2]	27.59	30	28.6*
Perennial legumes, ILRI[2]	28.21	30	28.6*
Cowpea, IITA[1]	6.04	18	24.7
Rice, IRRI[1]	1.20	17	26.4
Wild rice, IRRI[1]	16.02	31	28.6*

[1] Information from 2008
[2] Information from 2007.
[3] Cost for wild materials tend to be higher. According to CIRSAT estimations wild chickpea testing costs US$12.56, wild Pigeonpea US$ 14. 30, Wild groundnut US$ 16.75, wild sorghum US$12.60, wild pearl millet US$ 14.60, and wild small millets US$ 10.40.
* Probably higher

In all the cases, the fees charged by the private laboratories are higher than the estimated costs for the CG genebanks. For instance, according to the estimations for 2007, the average cost of testing seed viability at the CIMMYT genebank was about US$ 6.19 per accession. This cost only includes operational costs. If capital costs are taken into account the total value increases to US$ 9. The International Seed Testing Association (ISTA) provides a list of accredited laboratories around the world that carry out these tests. The prices listed for these test in UK vary considerably across countries and laboratories. For instance, The Seed Testing Station of the Science and Advice for Scottish Agriculture[31] charges US$ 26.4 (£16.2) per sample for a basic germination test, and requires 7 – 14 days to provide the results. Germination test prices can be higher than that when other test are included, like 1000 seed weight and seed rate table, as in the case of the National

[31] Prices of 2008 can be found here: http://www.sasa.gov.uk/seed_testing/osts/test_fees.cfm

Institute of Agricultural Botany (NIAB) based in Cambridge that charges US$84.5 (£ 52) per sample.

To the fees reported by the private laboratories it is necessary to add the VAT and the costs of sending the materials. Since all the genebanks in the CG system have the laboratories and personnel trained to perform this operation, it is clear that the additional cost charged by the private laboratories does not justify the outsourcing of this operation. In addition to the higher costs there are also plant quarantine issues. Seed health testing is an expensive operation and it does not justify doing it for outsourcing germination evaluation.

2. Operations within the Genebank

a) <u>Diversity and Economies of Scale</u>

There are several genebanks in the CG system, like ICRISAT, ILRI and IITA that deal with multiple crops. The intricacy of the flow of operations increases with the number of crops or types of materials. This has implications on the operational costs and also on the possibilities for economies of scale. In the case of genebanks that deal only with seed propagated materials (ICRISAT, ICARDA) the effect on costs could be less remarkable. The combination of clonal and seed crops definitively adds to the complexity in the decision making, giving less scope for selection of cost effective practices. Table 9.3, shows the average general and information management costs for the genebanks included in this study.

We expected that average management costs would tend to be higher in centers with a larger diversity of materials not only in terms of number of species but also in terms of materials that required different conservation and regeneration practices. All genebanks hold in their collections materials that required special regeneration techniques such as wild materials, or materials that need to stay in the field for more than one season such as forages and other perennial crops like Musa. A few genebanks also have materials that require special storage techniques like in-vitro cultivation or cryopreservation such as cassava, musa or yam. The differences across materials and centers however have not been as drastic as expected.

But, would there be differences if we concentrate on the type of material and conservation technique? The conservation of clonal (cassava, musa, yam) and seed crops (cowpea, soybean, beans, etc.) is a distinct characteristic of CIAT and IITA genebanks. While it is difficult to compare costs across centers because of a number of considerations (location, agro-ecological conditions, labor costs, etc), the comparison among seed and clonal crops could be interesting for genebank managers. Table 9.4 provides this information.

Table 9.3. Comparing average general and information costs given the conservation technique required (US$/accession)

Genebank	No. Acc.	No. crops/crop types (No. of species/ taxa)	Materials	General Management Costs (US$)	Information Costs (US$)
CIAT	65,510	3 (795)	Clonal: Cassava, Seed: Beans, Tropical Forages	1.37	2.29
CIMMYT	148,561	2 (7)	Seed only: Rice, Wheat (Barley, Rye, Triticale, Teosintle, *Tripsacum*)	1.02	0.97
ICRISAT	118,882	6 (11)	Seed only: Sorghum, Groundnut, Chickpea, Pigeonpea, Pearl millet, Small millets (Foxtail millet)	1.17	0.31
IITA	28,433	7 (60*)	Seed: Bambara, maize, Cowpea, Soybean Clonal: Yam, cassava, musa,	1.58	1.61
ILRI	18,745	8 (750)	Seed: Annual legumes (3,658), perennial legumes (6,879), annual grasses (1,051), perennial grasses (3,370), fodder tress <3 years (2,708), fodder tress > 3 years (831), other annual (138), other perennial (116)	1.26	1.88
IRRI	110,817	2	Seed: Rice (*O. sativa, O. glaberrima*), Wild rice (XX)	0.86	0.84

(*) The exact number of available species is unknown

Table 9.4. Conservation of clonal and seed crops across centers

Genebank	Type of Material		Conservation Method	No. Accessions	General management costs ($/ acc)	Information management costs ($/ acc)
CIAT	Clonal	Cassava	• In vitro (MT) • Cryopreservation (LT) • Bonsai	6,467	1.37	1.54
	Seed	Beans	• Cold room (ST & LT)	35,903	1.37	2.25
		Tropical Forages	• Cold room (ST & LT) • Field genebanks (MT)	23,140	1.37	2.55
IITA	Clonal	Cassava	• In vitro (MT) • Cryopreservation (LT)	3,368	1.47	1.85
		Yam	• In vitro (MT & LT)	3,039	1.67	1.95
		Musa	• In vitro (MT) • Cryopreservation (LT)	173	1.47	1.45
	Seed	African yam bean	• Cold room (MT & LT)	152	1.47	1.45
		Bambara	• Cold room (MT & LT)	1,843	1.47	1.45
		Cowpea	• Cold room (MT & LT)	15,113	1.64	1.56
		Maize	• Cold room (MT & LT)	878	1.47	1.45
		Soybean	• Cold room (MT & LT)	1,751	1.47	1.45
		Wild Vigna	• Cold room (MT & LT)	1,516	1.47	1.45
		Mis. legumes	• Cold room (MT & LT)	600	1.47	1.45

Note: ST stands for short term storage; MT stands for medium term storage; LT stands for Long term storage

b) Cryopreservation and In-vitro conservation

Cryopreservation is still an operation under research for genebanks working with clonal crops. CIAT for example has only around 640 accessions of cassava under cryopreservation of more than 6,000 accessions held by the genebank. The development of the cryopreservation protocol is an on-going activity. While this operation has been proven to be effective, there is still some discussion about the need to guarantee the integrity of the material stored. Currently all the cassava accessions are stored in-vitro in CIAT, and safety duplication copies are sent to CIP for storage. Given the short storage life of the in-vitro materials the costs of storing and duplication are significant for the genebank. The most cost effective practice according to the cryopreservation expert in CIAT is therefore a combination of short term storage and distribution using in-vitro material, and a long term storage and duplication using cryopreservation techniques. Table 9.5 shows cost information that supports this statement[32]. Since these are average costs

[32] These figures however do not cost the risk of having problems with the integrity of the collection.

the difference across centers is given by the number of accession manipulated which is considerably lower in the case of IITA and thus the costs considerably higher. Note that CIAT and IITA do not use the same in vitro conservation process for cassava. CIAT system is less demanding as it requires only 1 subculture per year in comparison to IITA system which requires 1 to 2 subcultures per year. The genebank at IITA is adjusting the technology to CIAT standards to reduce the cost for cassava. It is important however to take into consideration the time to regenerate a full seeding from in vitro plant. The IITA strategy may provide a faster system *i.e.* request may be processed faster which also have some economic value.

Table 9.5. Average conservation cost for clonal crops for CIAT and IITA (US$/accession)

Genebank	Genetic Material	Total No. Access.	Cryopreservation		In-Vitro		Field Genebank	
			No. Access.	Cost ($/ acce.)	No. Access	Cos ($/ acce.)	No. Access	Cost ($/ acce.)
CIAT	Cassava	6.467	640	44.20	8,261	14.28		
IITA	Cassava	3,368	50	53.23	2,455	9.84	3,388	3.36
	Musa	173	36	26.55	230	8.24	482	3.32
	Yam	3,039			1,641	8.24	3,200	3.32

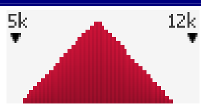
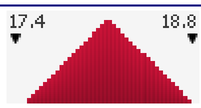
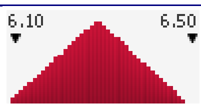
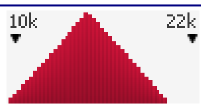
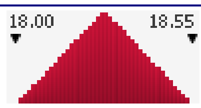
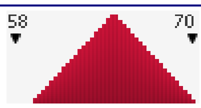
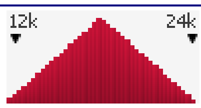
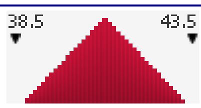
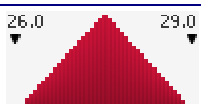
3. Financial Aspects

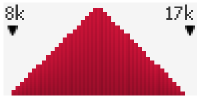
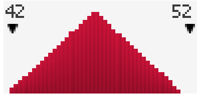
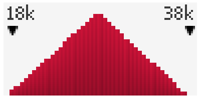
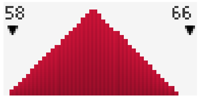
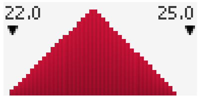
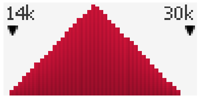
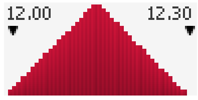
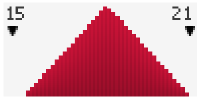
a) Labor cost in Developing countries

Genebanks make use of temporary and casual labor to accomplish several specific activities across operations. The use of casual labor is particularly intensive for field activities that are part of regeneration and characterization of materials. Seed cleaning is also a labor intensive activity. One of the advantages of being located in a developing country is the availability of comparatively cheap labor. In some countries however the cost of temporary labor has increased in the latest years, as a consequence of economic development or competition with stronger sectors of the economy.

Hyderabad is a city that is growing fast due to the computer and software industry. As a result of that demand for both qualified labor as well as temporary labor is increasing. This high labor demand creates possibilities for higher labor wages in the near future. Table 9.6 presents the results of a simulation for the ICRISAT genebank, assuming an increase that varies from 0% to 50% of current wages. The table presents the variation of total variable labor costs and the effect on the average regeneration and characterization costs. We can observe that despite the 100% variation the total average costs are not significantly affected, as they represent in average only 3 – 12% of the total operational costs. So, while there is a potential increase in labor the immediate effect on the average costs is not significant but it can be significant at the aggregate level, for instance when preparing the budget for the following year, and especially when the number of accessions manipulated is high.

Table 9.6. Simulating wage increase on total labor costs and average cost of regeneration and characterization, ICRISAT

Name	Graph	No. of Accessions	Actual labor Costs	50% Variation	100% Variation
Sorghum (Total variable labor Costs (US$)			**5,580.54**	**8,324.59**	**11,078.21**
• Characterization (Av. labor cost / accession, US$/acc)		2,377	17.55	18.15	18.75
• Regeneration (Av. labor cost / accession, US$/acc)		4,603	6.11	6.29	6.47
Pearl millet (Total variable labor Costs (US$)			**10,141.94**	**15,128.92**	**20,133.28**
• Characterization (Av. labor cost / accession, US$/acc)		2,094	18.04	18.28	18.53
• Regeneration (Av. labor cost / accession, US$/acc)		793	59.72	64.80	69.89
Chickpea (Total variable labor Costs (US$)			**12,032.05**	**17,948.44**	**23,885.44**
• Characterization (Av. labor cost / accession, US$/acc)		1,200	38.97	41.08	43.19
• Regeneration (Av. labor cost / accession, US$/acc)		1,650	26.29	27.55	28.80

Name	Graph	No. of Accessions	Actual labor Costs	50% Variation	100% Variation
Pigeonpea (Total variable labor Costs (US$)			**8,341.62**	**12,443.36**	**16,559.38**
• Characterization (Av. labor cost / accession, US$/acc)		798	42.33	46.78	51.25
Groundnut (Total variable labor Costs (US$)			**18,676.61**	**27,860.26**	**37,075.90**
• Characterization (Av. labor cost / accession, US$/acc)		900	58.23	61.75	65.28
• Regeneration (Av. labor cost / accession, US$/acc)		2,400	22.09	23.40	24.71
Small millets (Total variable labor Costs (US$)			**14,487.84**	**21,611.79**	**28,760.56**
• Characterization (Av. labor cost / accession, US$/acc)		1,737	12.01	12.15	12.29
• Regeneration (Av. labor cost / accession, US$/acc)		1,737	15.69	18.23	20.79

Note: We do not have information on labor use for Pigeonpea regeneration for this year (2007). All the casual labor was reported for characterization

b) Retirement and the need for a succession plan

In several of the genebanks of the CG system crop specialist or even genebank heads are reaching retirement ages. The expertise accumulated by genebank scientists has a significant effect on the performance of the genebank and thus on its cost effectiveness. Unfortunately, it is difficult to actually measure this effect and even more to cost experience. It is possible however to assume learning lags in the performance. Hiring a new scientist in charge of one operation in the genebank can cause a lag on the activities planned for the year and generate backlogs in most of the operations. Training of new staff is therefore necessary to avoid this lags. The training is understood as a period of overlapping of experts. This practice can save the genebank operational costs and backlogs.

c) <u>Exchange rate fluctuations</u>

Most of the genebanks of the CG system are located in developing countries where some of the operational expenses (supplies and labor) are paid in the local currency. Exchange rate fluctuations over the year can significantly affect the total expenses of the genebank and thus have negative impacts on the annual approved budgets. In 2008 for instance the fluctuation of the Colombian peso was above 700 units, equivalent to a 30% of the highest value[33 34]. Similar tendencies but not as drastic has been observed in Philippines, where the fluctuation was around 20% in the same year.

On one hand the inflation rates of the countries can determine these fluctuations. On the other hand, as the food and financial crises have shown, global events can have severe impact on economies in development and thus affect exchange rates. Tables 9.7 and 9.8 below report some of potential effect of drastic exchange currency fluctuations in the total genebank expenses, as well as in the average costs of operations. These values are probably underestimated since most of the expenses in local currencies have been reported in US dollars, despite been executed in local currency.

[33] Source: OANDA (http://www.oanda.com/convert/fxhistory)
[34] See Annex 4 for a graphic representation of the fluctuation of Colombia peso from 2007 to 2009.

Table 9.7. Changes in Average and in perpetuity Costs due to Exchange Rate Fluctuations in 2008, CIAT Genebank

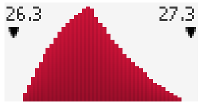
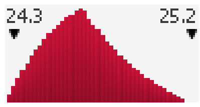
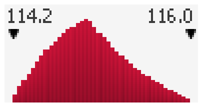
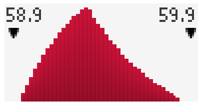
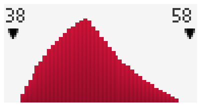
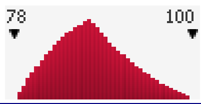
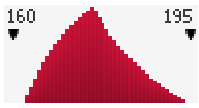
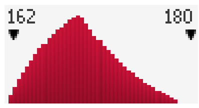
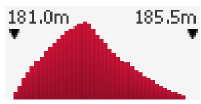
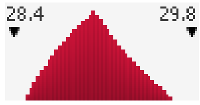
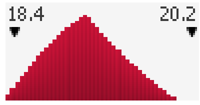
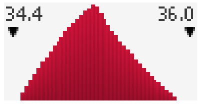
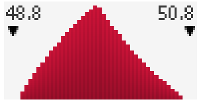
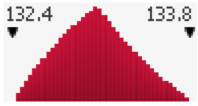
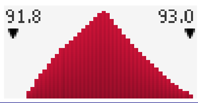
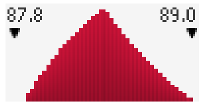
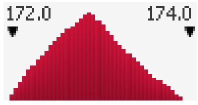
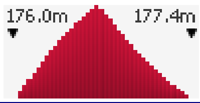
	Name	Graph	Min	Mean	Max
Beans	Ave. Characterization		26.39	26.75	27.23
	Ave. Regeneration		24.31	24.66	25.14
	Ave. Conservation		114.28	114.99	115.95
	Ave. Distribution		58.98	59.34	59.82
Tropical Forages	Ave. Characterization		39.63	46.70	56.25
	Ave. Regeneration		79.40	87.78	99.10
	Ave. Conservation		163.66	176.22	193.20
	Ave. Distribution		162.36	169.12	178.25
Total In Perpetuity for Whole Genebank			181,192,700	182,897,800	185,201,100

Table 9.8. Changes in Average and in perpetuity Costs due to Exchange Rate Fluctuations in 2008, IRRI Genebank

Material	Type of Costs	Graph	Min	Mean	Max
Rice	Ave. Characterization		28.55	29.04	29.62
	Ave. Regeneration		18.41	19.14	20.00
	Ave. Conservation		34.54	35.14	35.85
	Ave. Distribution		48.96	49.75	50.66
Wild Rice	Ave. Characterization		132.48	133.07	133.76
	Ave. Regeneration		91.94	92.42	92.98
	Ave. Conservation		87.92	88.40	88.97
	Ave. Distribution		172.06	172.90	173.88
Total In Perpetuity for Whole Genebank			176,109,800	176,674,400	177,335,800

d) Full costs recovery

As other centers in the CG system CIAT is implementing full cost recovery in their finance systems. Starting 2010 the genebank will be charged per square meter for a number of services provided by CIAT (see Annex 5). Full cost recovery means recovering or funding the full costs of a project or service. The costs directly associated with the project, such as staff and equipment, projects will also draw on the rest of the organization. For example, adequate finance, human resources, management, and IT systems, are also integral components of any project or service. The full cost of any project therefore includes an element of each type of overhead cost, which should be allocated on a comprehensive, robust, and defensible basis. In this sense, each unit within the center should be charged for each costs associated to the projects under their control.

In CIAT the implementation of this system has been scheduled for 2009. Some elements of this system are already in place, i.e. charges for computers, e-mail, internet, and related support. The implementation of this system is expected to increase the costs of genebank operations. Tables 9.9 and 9.10 present the costs of conservation and distribution of genetic materials at the CIAT genebank considering the current charging system and comparing it to the full recovery scheme implemented in 2009[35]. The tables show an increase in average and total in-perpetuity costs for all types of materials, but especially for distribution of accession of tropical forages.[36]

Table 9.9. Comparing Average In-Perpetuity Costs of Conserving and Distributing Existing Accession by the CIAT Genebank (2008)

Crops	No. of acc.	Actual Charges			Assuming Full Costs Recovery		
		Conservation	Distribution	Total	Conservation	Distribution	Total
Cassava	**6,467**	**771**	**934**	**1,705**	**825**	**990**	**1,815**
Operat.		551	771	1,323	605	827	1,433
Beans	**35,903**	**689**	**652**	**1,340**	**588**	**674**	**1,262**
Operat.		641	558	1,199	540	580	1,120
Forages	**23,140**	**956**	**4,195**	**5,151**	**889**	**6,474**	**7,364**
Operat.		849	3,114	3,964	782	5,394	6,176
All crops	**65,510**	**1,955**	**5,057**	**7,011**	**1,795**	**7,373**	**9,168**

Table 9.10. Comparing Total In-Perpetuity Costs of Conserving and Distributing Existing Accession by the CIAT Genebank (2008)

Crops	Actual Charges			Assuming Full Costs Recovery		
	Conservation	Distribution	Total	Conservation	Distribution	Total
Cassava	**2,004,462**	**1,359,683**	**3,364,145**	**2,056,898**	**1,449,709**	**3,506,607**
Operat.	582,584	308,180	890,764	635,021	398,205	1,033,226
Beans	**24,720,186**	**23,402,855**	**48,123,041**	**21,115,327**	**24,195,409**	**45,310,736**
Operat.	22,997,360	20,032,596	43,029,956	19,392,500	20,825,150	40,217,651
Forages	**22,123,207**	**97,065,430**	**131,390,819**	**20,575,856**	**149,818,450**	**181,743,038**
Operat.	30,490,783	72,064,009	102,554,791	28,089,981	124,817,029	152,907,010
All crops	**48,847,855**	**121,827,968**	**182,878,005**	**43,748,081**	**175,463,568**	**230,560,381**

[35] See Annex 6 for a table explaining cost included in the estimation of conservation and distribution costs.
[36] The dramatic increase in costs of conservation and distribution of tropical forages is due to the method used for estimated he costs. With the current charging system costs are allocated based on the number of accession held at the genebank. The use of facilities and services with the full costs recovery scheme is based on area occupied by the genebank.

e) Fund raising

Genebanks need a long term funding scheme in order to guarantee that the genetic material will be preserved not only now in 5 years but also in-perpetuity. The tool has been designed to provide future and in-perpetuity costs of conserving and distributing existing accessions. Table 9.11 is a summary of the conservation and distribution in-perpetuity cost in 2008 for CIAT genebank given the current number of accessions in the genebank. These in-perpetuity costs have been estimated using adding up the average costs of all operations undertaken for the conservation and distribution of an accession.

These estimates are available per year (2006-2008) and show an increasing trend. The variability of average in-perpetuity costs over the three years of information available is shown in Figure 9.1. In the case of conservation the costs tend to increase due to changes in the number of accessions manipulated. In general average costs are lower when more accessions are handled per year (up to a limit). Thus, the average costs of conservation and distribution of all three materials in 2006 are lower than in consecutive years. In the case of distribution of forages the effect is even larger because the number of accessions distributed, regenerated and stored was considerably lower in 2007 and 2008. Thus the specific performance in that year has a great influence on the total estimates. Once again the availability of more years of information would allow for more accurate estimations.

Table 9.11. In-Perpetuity Costs of Conserving and Distributing Existing Accessions in the CIAT genebank in 2008

Crops		No. of acc.	Total cost (US$)		
			Conservation	Distribution	Total
Cassava	**In-vitro + Cryo**	**6,467**	**2,004,462**	**1,359,683**	**3,364,145**
	Noncapital		582,584	308,180	890,764
	Capital		1,421,878	1,051,503	2,473,381
Beans		**35,903**	**24,720,186**	**34,624,429**	**59,344,615**
	Noncapital		22,997,360	31,254,170	54,251,530
	Capital		1,722,826	3,370,259	5,093,085
Forages		**23,140**	**18,438,890**	**103,187,350**	**131,796,316**
	Noncapital		24,774,360	78,185,929	102,960,289
	Capital		3,834,607	25,001,421	28,836,027
All crops		**65,510**	**45,163,538**	**139,171,462**	**1 94,505,076**

a) **Figure 9.1.** Variability in Averages in In-Perpetuity Costs across years and crops, CIAT